Tropentag 2013

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Agricultural development within the rural-urban continuum

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Preface

The annual *Tropentag*, the largest European interdisciplinary conference on research in Tropical and Subtropical Agriculture and Natural Resource Management, rotates between the universities of Bonn, Göttingen, Hohenheim, Kassel-Witzenhausen, Berlin, ETH Zurich, and the Czech University of Life Sciences in Prague.

On-going organisational support for the event is provided by the Council for Tropical and Subtropical Agricultural Research (ATSAF e.V.), the German Institute for Tropical and Subtropical Agriculture (DITSL) in Witzenhausen, and the GIZ Advisory Service on Agricultural Research for Development (BEAF). The conference stays under the patronage of the Federal Minister for Economic Cooperation and Development Dirk Niebel.

The *Tropentag* has become the most important international conference on development-oriented research in the fields of food security, natural resource management and rural development in central Europe and provides a unique platform for scientific and personal exchange for students, junior and senior scientists, development experts and funding organisations together with their international partner institutions. More than 800 participants from 75 countries underline the importance of inter- and transdisciplinary scientific exchange to address the challenges ahead of us.

The *Tropentag* 2013 takes place on the campus of the University of Hohenheim, Stuttgart from September 17 - 19. It has been organised by the Centre for Agriculture in the Tropics and Subtropics comprising 10 tropical chairs and more than 100 members from the three faculties of the university.

The theme of 2013 is "Agricultural development within the rural-urban continuum". According to projections of the UN, 70 % of the global population will be living in urban areas by 2050. This will induce some radical changes in the share and distribution of food, energy, water, nutrients, labour, and other resources between rural and urban systems. Sustainable agricultural production and short resource cycles are required to sustain livelihoods in both rural and urban communities. Enlarging the primary production base in urban areas, increasing energy production in rural areas, and strengthening the interfaces along the continuum are among the major challenges for agricultural development. This year's conference will particularly focus on how agri-

cultural systems can be interfaced efficiently along the rural-urban continuum with regard to resource availability, food production, social peace, health, ecological sustainability and related themes.

The contributions and discussions focus particularly on the following aspects of the rural-urban continuum:

- Agricultural production systems
- Resource use and energy
- People and livelihoods
- Development and markets

These will be addressed by several internationally renowned keynote speakers, via 20 oral sessions presenting more than 100 talks and by about 350 poster presentations in 30 guided poster sessions. A special session featuring the international centres IWMI and AVRDC will underline the role of the CGIAR in linking rural to urban food systems.

We hope that the scientific contributions in this conference book will help you find answers to the research and development questions related to these topics and to the theme "Agricultural development within the rural-urban continuum".

Our special thanks go to the colleagues from Berlin, Bonn, Gießen, Göttingen, Hamburg, Halle, Kassel-Witzenhausen, Prague, Rottenburg, Vienna and Hohenheim who acted as reviewers for the submitted abstracts and thus contributed substantially to maintaining the scientific standard of the conference. We like to express our gratitude to Eric Tielkes, DITSL Witzenhausen, without whose support the conference would not have been possible, and our thanks include the University of Hohenheim for providing financial and logistical support and all our donors whose financial contributions have made this conference possible and affordable especially for young scientists.

We welcome you to the University of Hohenheim and wish you an enjoyable and rewarding conference.

The organising committee of Tropentag 2013
Prof. Dr. Folkard Asch (Hohenheim)
Prof. Dr. Regina Birner (Hohenheim)
Dr. Barbara Ramsperger (Hohenheim)
Dr. Christian Hülsebusch (DITSL Witzenhausen)
Dr. Eric Tielkes (DITSL Witzenhausen)

Hohenheim, September 2013

Message

The theme for this year's *Tropentag*, "Agricultural development within the rural-urban continuum" has a very special significance. The question of how agricultural production will respond to the dramatic shift in the rural-urban continuum is not only highly relevant but also vital for the future. In developing countries, rural areas still have the highest birth rates. Therefore, even with a high rural exodus, the absolute population in these areas will experience an increase lasting far into the next decade. The size of the rural population will not start to fall until later in this century. On the other hand, cities are growing at an unprecedented rate. From the estimated global population of 9.6 billion in 2050, 70 % will be urban inhabitants.

Already today the demand for food from a growing urban population in the developing countries is huge. A large middle-class is forming in the cities of these countries too, with a growing appetite for better quality, high protein foods. Must this increased overall demand be primarily met by buying on world markets? Or could local agriculture provide sufficient goods to cover the growing demand? Increased urbanization offers huge opportunities for development, not only for cities but also for rural areas and for agriculture. Urbanisation gives many small farmers the opportunity to make the leap from subsistence farming to producing for urban markets. This opportunity to earn an income can, for many families in rural areas, be the decisive step away from poverty and hunger. At the same time, new forms of "urban agriculture" are also offering interesting opportunities for development in the growing cities.

In order to ensure that they are the main actors in the value chain, beginning with seed and ending with high quality goods on an urban market stall, smallholders have many needs that must be met: secure access to land, water and energy, to capital and production factors, and to knowledge and innovation. Higher yields and improved production are not enough. Agriculture also has to protect and make sustainable use of natural resources. This will not only secure future agricultural production, but will also help to preserve all the ecosystem services that the countryside provides for the city. Town and country live from and for each other. They can form a permanent "development partnership", with agriculture as the crucial link, for the mutual benefit of both sides.

The development opportunities that the sustainable intensification of agriculture offers for rural areas had long been neglected. Low prices for agricultural commodities

on the world markets encouraged imports of cheap food in many places and provided little incentive for countries to develop their own agricultural sectors. Over the past few years this situation has changed. Not only have the world prices for agricultural goods increased, in many countries we are now pleased to note increased political will to promote sustainable agriculture. German development policy is consistently and energetically supporting this new drive to develop agriculture. This is also because, compared with investments in other sectors, investments in the agricultural sector have by far the greatest impact on reducing poverty. When I took office in 2009, I made rural development, promoting agriculture and food security one of the political priorities of the Federal Ministry for Economic Cooperation and Development (BMZ). I also significantly expanded our financial commitments in this sector. In the past four years approximately 3 billion euros has been provided for measures in this context.

I wish the *Tropentag* every success. It can offer trend-setting contributions for sustainable agricultural production that fosters development and contributes to environmental protection.

Dirk Niebel
Federal Minister for Economic Cooperation and Development

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Plenary speeches

Agriculture under Urban Stress

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Hungry cities. Thirsty cities. Urbanisation is challenging traditional food production and resource flows. Cities are becoming sinks for nutrients exported from rural and peri-urban areas and sponges for freshwater, using formal and informal channels to address urban thirst, while releasing a highly polluted return flow. Common loops of resource recovery and reuse are getting increasingly difficult as stretched over the rural-urban continuum, with growing opportunities for peri-urban areas but also pressure from inter-sectoral competition for freshwater and urban pollution. In this complex spatial interface, urban and peri-urban agriculture appear to be at the wrong place at wrong time. And in fact, no other form of agriculture receives such a mixed reaction and limited support: in many parts of the world, urban farming is considered an oxymoron, often criticised, sometimes banned, more often ignored or neglected, but in other places also cherished, not only as a possible solution in times of political or food crisis. In such a bizarre and fragile situation, how competitive and sustainable is urban farming? Are there more pros or cons, and how significant are they? What do we know given the different forms of this 'phenomenon', starting with different definitions of both urban and peri-urban, or open-space versus backyard farming, crops versus livestock, etc. Is urban farming actually an area worth more research or is it already over-researched? How much is myth, how much reality? And if we agree to support it, do we have solutions to address urban farming challenges in view of poor sanitation, like wastewater use and food safety or safe and viable nutrient recovery from waste? And do we have uptake channels to allow those solutions to have impact?

The presentation will try to provide some initial and certainly biased answers to these questions using examples from the South, but it aims even more at the stimulation of an interesting discussion during the coming days.

Keywords: Institutional support, nutrient loop, peri-urban agriculture, research gaps, urban agriculture, water competition

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Agriculture and Agricultural Research in the Rural-Urban Continuum

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The presentation discusses the way most agricultural researchers are urban-bred or at least urban based and we have a tendency to mythologize the rural character of small-scale agriculture and the low-income rural households at whom our research is aimed. The rural-urban divide we set up has its roots in history, colonial politics and development thinking and practice and brief examples are provided of these divisions. This is contrasted with the opposite tendency in the livelihoods of many urban and rural families in the developing world, especially with structural adjustment during the 1980s and globalisation since the 1990s. For them rural and urban are points on a continuum of opportunity and struggle. This includes rural agricultural households seeking non-agricultural rural income sources to supplement their livelihoods, temporary migration, co-management of rural and urban plots and multi-locational households.

The presentation examines the reality of the rural-urban continuum in the livelihoods of low-income households in different parts of the Global South, especially Sub-Saharan Africa and Latin America. Rapid growth in urban food markets has clearly offered opportunities to farming households, especially those in peri-urban and urban areas able to access those markets. Urban growth has also offered employment in urban areas, leading to changing social and especially gender dynamics in peri-urban and rural agriculture. There have been health effects of these changes, which have not always been positive. There are also policy and institutional issues which often impact negatively on families trying to manage these changes. Finally, the presentation offers some suggestions about policy changes which could support the provision of healthy food for urban populations by households which are engaged in different points along the rural-urban continuum.

Keywords: Health effects, low-income households, social and gender dynamics, urban food markets

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Societal Challenges Along the Rural-Urban Continuum

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Up to now, global, European and German sustainability policy has radically failed. With regard to climate policy, worldwide emissions have increased since 1990 by 40 %. Even in the industrialised countries they are relatively stable only because of the collapse of Eastern European industry, the financial crisis and the shift in production capacities into transition economies. Yet, these emissions still remain on a high level: at present, the average American emits 20 tons, a German about 10 tons (if calculation tricks are removed), and an average Chinese person emits 5 metric tons of carbon dioxide per year. Climate scientists demand a global reduction by about minus 80 % up to the year 2050, and possibly 95 % in the western countries. So far, scenario-based climate projections have been too optimistic. Climate change occurs faster than anticipated. Thus, radical measures are needed to avoid resource-related wars and millions of dead – plus gigantic economic losses that would exceed the costs of an effective climate policy by a factor of 5 to 10. Radical measures are often economically profitable – even on a short time-scale – as they trigger technological innovations, *e.g.*, with energy efficiency and renewable energies. And yes, policy approaches can be named in how the European Union could effectively avert sustainability-related challenges such as climate change. At the same time, the EU could take other countries along on this necessary journey and attempt – for the first time – a true position of leadership in the international sustainability challenge along the rural-urban continuum. But instruments and principles of justice might be slightly different from what is usually debated in the mainstream discussions.

Keywords: Climate change, climate projections, policies

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People

People within the rural-urban continuum

Do Shocks Affect Men's and Women's Assets Differently? Evidence from Bangladesh and Uganda

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This paper attempts to expand our understanding of the gender-differentiated impact of shocks on assets through an analysis of new panel data from Uganda and Bangladesh looking at the impact of negative shocks and positive events on men's and women's assets. We take advantage of detailed assets and shocks modules to distinguish covariate and types of idiosyncratic shocks and types of assets according to ownership (joint, husband's, and wife's assets). These two countries were chosen because of the existence of data prior to the global food price increases in mid-2007–2008, and the opportunity to field a follow-up survey shortly afterward, in 2009 and 2010, which enables us to examine the gendered impact of the food price shock, and because they represent societies with very different social and cultural institutions, household structures, and gender norms. We pay special attention to the possible differential impact of climate related shocks, such as drought and rainfall shocks, on men's, women's, and joint assets. We also consider the impact of life-cycle events such as dowry payments and receipts, and inheritance. Estimation of an asset accumulation regression as a function of covariate and idiosyncratic shocks, with controls for baseline characteristics and asset stocks, finds that although many shocks are similar in both countries, commonly experienced shocks do not necessarily have the same effects across countries and on men's, women's, and jointly owned assets within countries. Land and assets in general were relatively well insured against food price increases in Bangladesh, but jointly held assets and wives' assets in Uganda were negatively affected. Weather shocks negatively impact husbands' assets and wives' assets in Bangladesh and Uganda, respectively. Reflecting differences in country and context, dowry and wedding expenses took their toll on wives' land in Bangladesh, and illness shocks also had a large detrimental impact on wives' assets in Bangladesh, while death negatively affected wives' assets in Uganda. Within households, however, it appears that in Bangladesh, husbands' land and assets were more negatively affected by covariate shocks relative to wives' assets, whereas in Uganda, husbands' assets were relatively protected against covariate shocks relative to wives' assets.

Keywords: Assets, Bangladesh, gender, shocks, Uganda

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Gendered Differences in Climate Change Adaptation: Implications for Rural Agricultural Systems

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Research has shown that women in the developing world are likely to bear a disproportionate burden of the adverse impacts of climate change. Not only are women more likely to be more vulnerable, and thus more affected by natural disasters, but they are also more likely to work in and depend on natural resources that are heavily affected by climate change. However, little quantitative work has been done to analyse the ways in which women and men experience climate change differently and the implications this difference has for farm-level adaptation strategies. This paper reports on a Climate Change, Agriculture, and Food Security (CCAFS) project, which developed a two round intra-household survey tool. The first round gathers plot-level production and labour information, divided by production system, while the second round collects gender disaggregated information on agricultural and livestock decision-making, use and perception of climate-smart technologies, access to credit, access to and use of climate and weather information, adaptation strategies, climate risk perceptions and management, and cognitive processes and human values. Together, the two sets of data show gendered differences in adaptation strategies, perceptions of climate risk, and constraints faced by men and women within the same rural household. The paper summarises lessons learned from field-testing the survey tool and presents the initial analysis of the data collected from the Nyando Basin in Kenya. The paper concludes by discussing the policy insights from collecting gender disaggregated data, such as an improved understanding of gender differentiated preferences for adaptation strategies and how biophysical, regional, and social contexts influence these preferences. It is expected that this new survey tool will be implemented in several CCAFS sites world-wide.

Keywords: Adaptation, climate change, gender, information, sustainability

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Measurement of Farm and Non-Farm Employment Linkages: Empirical Insights from Three Villages in Bangladesh

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The widening of the rural-urban continuum has accelerated the transformation of agriculture in Bangladesh from subsistence towards commercialisation. This has been accompanied by improved employment and income options in the farm and non-farm sector. Modern rice and non-rice crop production together with livestock, poultry and fishery enterprises contribute to employment generation through backward and forward linkages.

This field study at three locations – (i) the peri-urban fringe, (ii) near a rural town and (iii) near a rural market place – measured farm to non-farm employment linkages for two major rice crops – Aman (wet season) and irrigated Boro (dry season). The concepts and estimates of linkages are discussed and their magnitudes are determined using year-round household survey data on detailed, activity-wise labour inputs into diverse farm and non-farm segments of employment. Since Boro rice, compared to Aman rice, gives higher yields but also requires higher application of improved technology, the employment linkages were found to be stronger for Boro than for Aman rice. The estimated backward, forward and total linkages were calculated at 0.18, 0.43 and 0.61 for Boro rice and 0.14, 0.39 and 0.53 for Aman rice. For these two crops as a whole, the farm to non-farm total employment linkage coefficient was 0.58, which means that a total of 100 man days of farm employment in production activities generates 58 man days of non-farm employment in various support services, processing and marketing activities.

The main conclusion is that the green revolution driven production systems, especially rice, lead to a vibrant non-farm development in a dynamic setting. The findings imply that more investment in the intensification of rice-based production system would not only lead to food security at the farm level but it would also significantly increase productive non-farm employment opportunities. From a national policy perspective, more research and development efforts should go into accelerating potential rural growth and non-farm sector development such as input delivery, marketing, farm mechanisation, rural transport, and supply chain development.

Keywords: Backward and forward linkages, employment generation, farm and non-farm activities, farm mechanisation, green revolution, rural growth, supply chain

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Determinants of Non-Agricultural Activities for Return Migrants in Rural China

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China's agriculture is characterised by small-scale, low-income farming. At the same time, the opportunities for earning off-farm incomes are quite limited in rural China. Therefore, in order to overcome poverty, large numbers of workers have left the rural areas over the last few decades to look for jobs in the booming urban centres. However, since the onset of the global economic crisis in the late 2000s, a significant share of these migrant workers returned to their home towns and villages in rural China, and many of them were not successful in finding a productive and sufficiently profitable work at their home region. Those who remain unemployed become an economic burden to the rural regions and to those who sustain them as they increase the dependency ratio. At the same time they constitute a waste of human capital resources because their skills and competencies remain idle. Under these conditions, it is essential that regional and local governments in China apply appropriate policies for promotion of rural non-agricultural activities and optimal labour allocations, and there is also an increasing awareness about the necessity for policy action among these institutions. As a solid basis for appropriate policy design, information about the composition, personal plans, resources, and competencies of the returnees is indispensable. This, however, is still scarce, as hardly any research has been done on return migrants, their economic activities after return, and the determinants of non-agricultural activities. Our research contributes to fill this gap. It is based on a field survey implemented in Hunan Province to obtain information about the employment status and economic activities of the returnees; the major determinants of their non-agricultural accomplishments, with a special focus on the roles of their human, financial and social capital. From Probit regression, our results demonstrate that younger returnees, people with membership in cooperatives, and those without house ownership are more likely to do non-agricultural activity, while having a child reduces it. Based on the data analysis, policy recommendations are put forward which may contribute to improve the employment situation in rural China.

Keywords: Employment, non-agricultural activity, return migrants

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Strategies for Urban Agriculture in Bhaktapur, Nepal: Two Studies - One Topic

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Two autonomously written master thesis were combined to link pedological findings with a design approach of Urban Agriculture (UA) as a current tool of open space planning and as a contribution to a sustainable form of agriculture in Bhaktapur/Nepal. The combination of the two studies made it possible to get a profound knowledge of the prevailing urban development processes as well as of the nutrient management of urban farmers in the investigation area. Through the final work, the design of a "Agri-Cultural-Forum" (ACF), the discussion moved from a theoretic and abstract planning level to a site specific and spatial solution.

The pedological thesis investigated the nutrient management of small urban vegetable farms via questionnaires and soil analyses. The study determined that fertiliser input (>70 % chemical) greatly exceeds the demand of the crops and leads to high N (Ø = 380 kg ha^{-1} a^{-1}) and P (Ø = 290 kg ha^{-1} a^{-1}) surpluses. In contrast, potassium shows a balance deficit of -90 kg K $ha^{-1}a^{-1}$. Soil analyses confirmed the interview results and found an excessive P supply and a K deficiency of the soils. An acidification, due to high nitrification rates, is indicated by very low pH (3.9–6.2; Ø = 5.0). The excessive chemical fertiliser usage can result in a degradation of the soils and could be explained by a lack of agricultural advisory services for urban farmers in Nepal.

Therefore the second thesis developed a design strategy for the investigation area with the "Agri-Cultural-Forum" as a spatial component of it. The strategy "Design for Rurban Interaction" outlined UA as a tool for the urban-rural linkages, the "rurban" sphere, by unleashing socio-economic and cultural growth. In that context the ACF was designed as a multifunctional space, that is a part of a bigger "rurban" network, where free and independent training facilities, the conservation of traditional knowledge, the support of organic nutrient management and the exchange of knowledge and experiences between the farmers and other professionals will be organised.

Keywords: Bhaktapur, landscape architecture, Nepal, open space planning, soil science, urban agriculture

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Working Conditions for Hired Labor at Peri-Urban Dairy Farms in Pakistan: Comparing Lahore and Faisalabad

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In Pakistan, peri-urban milk production is an important economic activity in all major cities. The market-oriented dairy farms are very labour intensive; they employ large numbers of uneducated and unskilled laborers from the fragmented and informal labour market. Laborers are often exposed to conditions below standards formulated by the International Labor Organisation (ILO). To evaluate the discrepancy between ILO standards and dairy workers' reality, we analysed the working conditions for hired laborers on 107 peri-urban farms in Lahore and Faisalabad. Laborers were asked about their work tasks, working hours, wages, and rights at work in semi-structured face to face interviews conducted during 08/2012–01/2013.

Results show that work at dairy farms is precarious due to the handling of heavy cattle and buffaloes (risk of injury), unhygienic conditions, lack of health protection and lack of job security. Rights such as wage negotiations, granted holidays, fixed working hours and health insurance are lacking and even not stipulated by law. Such issues therefore depend on informal agreements between employer and worker, and are limited to the fixation of wages in cash or kind. The average monthly wage in Lahore and Faisalabad, respectively, was 5,500 Pakistani Rupees (PKR) and 5,000 PKR, which is less than the official national minimum wage (8,000 PKR per month ≈ 58.40 €). In Lahore, workers at 79 % farms reported to receive in-kind benefits such as daily meals, milk or dung cakes; in Faisalabad this applied to 54 % of the farms only. Female workers were hired only part-time for cleaning at 7 % of the farms in Lahore and 32 % in Faisalabad. In case of sickness, workers on 7 % and 13 % of the farms in Faisalabad and Lahore, respectively, received financial and social support from the employer. In both cities no employer offered fixed working hours, a weekly day off or paid holidays.

From our insights we conclude that working conditions for dairy workers are similar in major cities of Pakistan and the precariousness of farm work is structural rather than individual. To ensure workers' rights and improve their working conditions, regulations at national level are required.

Keywords: International labour standards, social security, wages, working hours

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Impact of International Migration and Remittances on Agricultural Development: A Study in the Rural Areas of District Toba Tek Singh, Punjab, Pakistan

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Agriculture is the key to rural development in Pakistan and the agriculture sector continues to be an essential backbone of the country's economy, contributing 21 % to GDP in 2012. It plays a vital role in ensuring food security, generating economic growth and reducing poverty. However, in many regions where smallholder farming dominates, a large share of the families are not in a position to sustain their livelihoods by agricultural activities alone, and as a result a common strategy of income generation is the overseas migration of one or more family members who provide remittances for supporting the household. Still, the question if these remittances are also used for purposes which enhance the development of the migrant families' farms, and hence contribute to the country's food production is debated. Associated with that are questions about the appropriate policy towards migration, remittances and support of migrants' households. Acknowledging that there is a close linkage between migration and agricultural development in Pakistan, the main objectives of our study were to examine role of remittances in agricultural development, as well as in the up-grading of the livelihoods of the families left behind. The study was conducted in the rural areas of District Toba Tek Singh, an area with a high rate of rural out-migration to the Middle East. The data were collected by multistage sampling. Tehsil Toba out of three District Tehsils was selected through simple random sampling technique. Four out of 32 union councils were selected randomly, and from each of them 30 respondents, *i.e.* altogether 120 respondents were picked by convenient sampling. The results reveal a strong relationship between international migration and agricultural development as most of the migrants' families invested part of the remittances in the farm sector. In particular there was an increasing trend in purchasing agricultural land, livestock, farm machinery and other inputs. International migration has a positive impact on the livelihood security of the families left behind.

Keywords: Agricultural development, international migration, livelihoods, remittances investment

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Urbanity and Rurality in Forced Migration

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The paper aims to contribute to the identification of better programming approaches for areas affected by forced migration by analysing the role of refugee/IDP (internally displaced persons) camps in their hosting areas from the perspective a rural-urban continuum. This approach makes it possible to harness the knowledge gained on rural-urban relations for developing better targeted programs for such areas. The paper develops an analytical framework, which distinguishes different types of rural-urban relations, depending on the type of camp, and the factors that influence possible livelihood strategies, such as the agro-ecological potential of the region. Empirical case studies from refugee/IDP camps in Kenya, Uganda, Congo, Chad, Pakistan and Nepal are used to apply the framework.

According to the analytical framework, large refugee camps constitute quasi-urban settings by the sheer number of inhabitants and the density of the population. Considering the low housing standards and the absence of services such as electricity, sanitation and higher education, they resemble urban slums. The surroundings of the refugee/IDP camps are typically rural, poor and sparsely populated, since host governments rarely place refugee or IDP camps in densely populated and affluent areas. The rural-urban setting constitutes both an opportunity and a challenge, which adds to the challenges arising from different language, culture, religion, and socio-economic background. The case studies show that the origin of the migrants has an important influence on the livelihood strategies that can be designed for the refugees/IDPs and their host populations. Marginal-urban migrants can make use of their "slum know-how" and engage in activities such as handicrafts and urban gardening as a basis of trade with the host population. However, violence and mafia-like structures may be a challenge in such situations. Rural migrants may have better prospects for engaging in agricultural activities in the surrounding areas of the camps, which requires, however, land use planning and other strategies to avoid conflicts over land and other natural resources. The paper provides examples of how the two groups can have different but complementing roles while at the same time pursuing one common set of livelihood objectives.

Keywords: Forced migration, livelihoods, refugees, rural-urban continuum

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Analysis of Problems with Family Biogas Plants in Central Vietnam

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The resource limitations of fossil fuels and problems coming from their combustion have led to widespread renewable energy resources. Anaerobic digestion is considered one of the most significant environmental improving technology, as it is solving waste management problems and producing biogas and at the same time is producing digestate as fertiliser for agricultural use. Where there is a big amount of biogas plants (BGP) in developing countries, there is as well a significant number of their problems and complications with them. This study aims at finding problems with this technology at the level of owners of BGP (n=100) and local facilitators (n=9) in the area of districts Huong Tra and Phong Dien (central Vietnam). The survey was carried out from July to August 2012. Methods of data collection included focus group discussions, semi-structured personal interviews and questionnaires. Collected data were processed with Statistica 10. Our findings show that average size of field of farms with BGP is larger than 2800 m^2, with almost 2000 m^2-share of rice, which is above the average of the whole country. This fact could be explained by lower density of population in the area. The survey revealed that 29 % BGP-owners have experienced problem with this technology. The main problem is connected to leakages in reactor (35 %), leading to undesired CH_4 emissions and even stopping the functionality of BGP. This was reported by 20 % of respondents within the first year of use of BGP. Further mentioned problems deal with biogas cooker (15 %) and solid digestate floating in a main tank decreasing the production of biogas (14 %). The respondents ask for better skills of masons, who are often not able to solve occurred difficulties with BGP. The study also involved the calculation of return on investment (ROI). Our findings revealed linear relations between ROI and satisfaction with BGP technology, biogas and biogas programme. In addition the study suggests improvement of skills of facilitators as principle mediators between BGP-owners and implementers, because they have a direct impact on quality of trainings of BGP-owners and masons as well.

Keywords: Analysis of problems, central Vietnam, family biogas plant, payback period of investment

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Urban Needs and Protected Areas: Interfaces between Arba Minch Town and Nech Sar National Park in Southern Ethiopia

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In 1974, Nech Sar National Park was established in close vicinity of Arba Minch town, a then-regional capital in Southern Ethiopia. To understand the multi-dimensional interfaces and dependencies between the park and the town, empirical data was collected in 2010 through interviews, focus group discussions and participatory observation. Data was analysed by using the Social-Ecological Systems (SES) framework. Arba Minch inhabitants directly depend on the park in multiple ways. The ground water springs in the park are the major sources of water for Arba Minch. The park is also the most important tourist attraction in the area. Arba Minch inhabitants depend on the park to fulfil their demands for wood, construction material and fish. The park is the main source of wood supply in the area. Poor urban households gather wood from the forests in the park primarily for income generation. Farmers from the surrounding areas also collect wood in the park to sell it to town dwellers. The two large lakes in the park are used by fishermen who sell their catch in Arba Minch town. All these activities in the park are illegal and contribute to its ecological depletion and destruction. Consequently, ever since the park's establishment, there are severe conflicts between the park authorities who strive to maintain the park as a biodiversity hotspot and town dwellers who directly or indirectly depend on its resources. In more than three decades, however, the stakeholders were unable to develop and implement sustainable resource use concepts for the park. The situation calls for working beyond the limits of defending "conservation boundaries". The livelihood needs of the urban and rural people need to be integrated into biodiversity conservation activities. National conservation policies need to recognise local realities and develop and incorporate sustainable use strategies on the scale of integrated landscapes rather than dealing with protected areas as isolated units.

Keywords: Biodiversity governance, Ethiopia, national parks, protected areas

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Urban Household Food Insecurity Amidst Price Shock: Empirical Evidence from Gulele, Addis Ababa, Ethiopia

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Food security has become one of the top priorities placed in the forefront of global development endeavours since a couple of decades. However, studies reveal that the number of globally undernourished people is significantly mounting. The situation has been fueled by dozens of factors including the food price crisis though not yet well and systematically studied, particularly in urban Ethiopia. Knowing such fact, this study tries to examine households' food security situation with the currently ignited food price crises in Addis Ababa. To this effect, mixed quantitative and qualitative research approach was used and data were collected from primary and secondary sources through a household survey among 206 households, key informant interviews and document analysis. Pertinent data on food security pillars, household food access and consumption were analysed first via HHS (household hunger scale) and FCS (food consumption score), respectively. Then, the resultant square matrix was constructed by combining the two dimensions to determine the current food security situation of households in the study area. The result of the resultant food security matrix indicated that more than half of the sample households fall either in the severely or moderately food insecure groups. During price spikes, it has been learned that consumption of inferior, lower quantity foods and increasing of work hours were common coping responses of majority of households, though the first two can potentially obstruct human development. Therefore, the problem of urban food insecurity is not a hit and run kind of event as it questions future survival and paralyse human development unless urban agriculture has been strengthened and integrated with urban development programs, credit facilities are expanded and social protection schemes in general are put in place to protect the most vulnerable and pro poor.

Keywords: Coping responses, food security, urban, urban agriculture

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Urban-Rural Pattern of Remittances and Effects on Food Security of Rural Households in Nigeria

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Remittances form a large part of the income sources of households in Africa, and especially in Nigeria. Relatives from abroad and in other urban areas serve as sources of formal, and informal, regular and occasional sources of extra income for the rural households. Thus, such incomes could be a substantial part of the family decision making matrix. The study identified the pattern of remittances that come from the urban areas in terms of cash transfers, food transfers and other forms of transfers. The study examined the extent to which such remittances determine the food security status of rural households, in terms of the food poverty line and their expenditure on basic food groups. Using the Nigerian Harmonized National Living Standard Survey, (HNLSS), 2009/2010 as the data source, the study revealed that remittances flow more from the urban to the rural areas. However, with the increased urbanisation process and the line between urban and rural being blurred, the study showed that certain parts of the urban areas also receive remittances with implication for their wellbeing. The results also show that these remittances are highly correlated with dimensions of well being, such as food security. With food poverty line of N44347 ($\approx$ €217), from the data, it is seen that rural areas have more households below this line. The presence of remittances as additional income or food sources was found to raise rural households above the food poverty. The study provides policy relevance in terms of the need for development of more structured means of flow of funds from urban to rural areas, especially in the provision of infrastructures that could also aid economic development in the rural areas.

Keywords: Food security, nigeria, remittances, rural, urban

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Socio-Economic Resilience of Poor Households in Rwanda: VUP 2020 and Girinka Program

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Rwanda is a landlocked country, situated in central and east Africa. It is one of the poorest countries in world, 166th in 186 classified. The poor households' poverty has decreased from 58.9 % in 2000/01 to 44.9 % in 2010/11. At the same period, extreme poverty showed similar patterns: on national level it fell from 40 % in 2000/01 to 24.1 % in 2010/11. This paper analyses the contribution of the social protection programs to poverty reduction of household beneficiaries: (1) The Vision 2020 Umurenge Programme (VUP), an integrated local development program which has three components: (i) Direct support for the poorest people who are not able to work; (ii) Public works, this component promotes rural employment on productive community development projects; and (iii) Financial services, which increase the access to financial services for the poor by providing loan at low interest rate. (2) The Girinka Programme known as "one cow per one poor family". This programme aims at enabling poor households to own and manage an improved dairy cow which should help the family to better their livelihood through increased milk and meat production and to improve soil fertility of their land by using the available manure.
After presenting briefly the achievements, we will compare the socio-economic conditions of genocide windows before and after launching these programs in Munyiginya Sector in Rwamagana Districts.

Keywords: Poor households, Rwanda, social economic resilience, VUP and Girinka programs

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Integrating Peri-Urban Farmers into Regional Planning: Case Study of the Oued el Maleh Valley, Morocco

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The PhD research has been realised in the framework of the project "Urban Agriculture, Casablanca" which is a German-Moroccan research project financed by the German Federal Ministry of Education and Research (BMBF) within the megacity research programme Research for the Sustainable Development of Megacities of Tomorrow". The objective of the research was to better define possibilities to integrate peri-urban small-scale farmers into the regional planning through the study of four peri-urban aspects: planning system, farm viability, public policies and management of urban-rural dynamics.

The Oued el Maleh valley situated in the periphery of Casablanca, was selected to study the direct relations between urbanisation and peri-urban farmers. This agricultural valley counts many small-scale mixed-farming family farms that are in relation with urban dwellers visiting the valley during the week-ends. Farmers are selling their products and the urban visitors enjoy a still conserved rural space. But the rapid urbanisation of Casablanca and Mohammedia means that the valley will probably change in the near future.

To understand the urban and agricultural dynamics within this valley, prospective scenarios for were developed. Variables were selected to take into account urban and rural dynamics as well as public policy aspects of the territory's development. These scenarios were not based on quantitative variables but on a qualitative approach to look at what influenced the development of peri-urban spaces and particularly peri-urban agriculture. A simple model for a simulation of farm systems and territory results was also created to better approach and quantify peri-urban agricultural situation within the scenarios.

These scenarios enable us to better understand the impacts of urbanisation on agriculture and to determine which type of urbanisation will lead to which type of urbanised agriculture. The scenarios highlight possible evolutions of peri-urban agriculture and emphasise at the same time the possible urban-rural synergies which could exist according to the type of urbanisation of agriculture. The scenarios also help us understand the role that agriculture could play in the identification of a peri-urban territory often considered as a space without identity.

Keywords: Peri-urban farmers, regional planning, scenario

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Livelihood Analysis and Transformation Dynamics in Farmer Households in Northern Benin

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Family farmers and herders in Western Africa are often poor or vulnerable and have to struggle in order to secure their livelihood. The objective of this study is to investigate the strategies and dynamics of smallholder farmers to improve agricultural production in the communes of N'Dali and Banikoara in Benin. The Systemic Approach to Rural Development (SARD) with a focus on the Sustainable Livelihood Approach (SLA) is an appropriate method for this livelihood analysis. The study investigates three principal topics: the current situation, the actual changes and their causes and the vision.

The famers of N'Dali and Banikoara can be divided into three types. Type II concentrates mainly on crop production, Type III focuses on animal husbandry, while Type I owns large areas of arable land and many animals. Farmers of each type have different assets at their disposal and choose a corresponding strategy. Many changes can be observed, which influence closely linked transformations. Population growth, the lack of arable land, the emancipation of women, etc. influence actually the farmers. Family members, powerful individuals and various organisations, have direct impact on farmers' livelihoods.

In some years, the farmer can afford to buy cattle for draft work but sometimes the cattle die or the farmer has to sell them. Communication tools, particularly radio and cell phones, are widespread. Human capital is developing positively as shown by the level of parents' education compared to their children. Natural capital reveals some problems, mainly in relation to the scarcity of arable land. Hence the farmers try to compensate for it with human capital. Social capital is characterised by extensive solidarity, which is indispensable during crises such as a scarcity of food. But there are as well some frictions between farmers and herders. Financial capital is progressing positively, but the need for money is increasing as well.

In the future, the farmers want to diversify their production. They fear both human and animal diseases. The omnipresent and most important point that the farmers mention as an essential condition for sustainable production is peace.

Keywords: Benin, household typology, livelihood analysis, smallholder farmers, transformation processes

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Urbanisation Shapes the Vulnerability of Farmers in the Decentralised Benin

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This paper offers an assessment of farmers' vulnerability to climate risks in relation to the location of farms from farmers' ordinary dwelling place in rural communities of northern Benin. The ongoing urbanisation processes in the district of Banikoara, main cotton production area of Benin and one of the biggest producers of different food crops, is considered to be responsible for the exacerbation of the existing land access problems. Sixty farmers of 40 $\pm$9 years old, cultivating 8.4 $\pm$6.02 ha and producing about 7.3 $\pm$6.65 tonnes per year, supplied empirical data in four different villages: Gomparou, Alibori, Somperekou and Godokpagounou. The key respondents were selected through purposive sampling during fieldworks. At the end of the data collection period, a half-day participatory workshop was organized for all interviewees, including some local stakeholders, in order to draw a jointly validated Sensitivity Matrix and Vulnerability Profile of farmers. Plausible exposure and impact indexes were calculated. The results show that: (i) The urbanisation process has resulted in the geographical remoteness of farms by preventing local farmers from cultivating more land. 85 % of farmers move about 10 km up and down to perform farm works, 12 % commute daily over 45 km to reach their farms and only 3 % live on or closely to their farms. (ii) Five major climate risks with highly sensitive impact indexes affect agricultural production: drought (73 %), floods (66 %), fires (60 %), lack of rainfall (60 %) and high winds (46 %); and three resources having high exposure indexes are most damaged: soil (76 %), water (68 %) and vegetation (64 %). (iii) The distance from farms to residence is a factor of vulnerability to the various climate risks leading to three categories of farmers: "Waterist Farmers" (Agri-BF) shriveled up in valley bottoms and most vulnerable to floods regardless of their residence, "Nearist Farmers" most vulnerable to droughts (Agri-CP) and at last "Farist Farmers" (Agri-CE) most vulnerable to wildfires. This vulnerability is likely to affect the national economy which is dependent on agriculture and especially on Banikoara produced cotton. These findings should be used to reframe both environmental and agricultural policies in the context of climate change.

Keywords: Agriculture, Benin, climate change, decentralisation, urbanisation, vulnerability

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Adequacy of Smallholders Farming Systems to Achieve Food Security in North Kordofan State, Sudan

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This study was conducted in North Kordofan State, Sudan in four localities, Sheikan, Umruwaba, Ennuhud and Ghibaish, and covered two consecutive cropping seasons (2007/08 and 2008/09). The area is characterised by production of both cash and food crops as millet, sorghum, groundnut, sesame and roselle. The objectives of the study were to determine optimum crop combinations, assess food security situation, net income, production factors, comparative advantage and competitiveness pertinent to food and cash crops in the study area based on efficiency of resource allocation. Primary data were collected via structured questionnaires. A multi-stage random sampling technique was employed. Linear programming (L.P), partial crop budget, robust regression, household economy approach (HEA) and policy analysis matrix (PAM) as empirical approaches were used. Optimality in the area came with cultivation of 3.375 feddan (1 feddan = 0.42 ha) of groundnut and 3.00 feddan of cowpea to get a total gross margin of SDG 1596 (10 SDG = 1.70 €). Groundnut and cowpea were accepted as best crops with gross margin of SDG 152 and 361, respectively. Resource efficiency indicated that land, labour and capital were positive and significantly corelated at one percent level. PAM results revealed that millet production has extreme high comparative advantage and competitiveness. Food security situation showed that daily energy received per person was 1243 kCal which was found to be below the recommended amount by WHO. This indicates food insecurity in the area. Accordingly, the study recommends an adoption of the optimum cropping combinations, mitigation of factors affecting comparative advantages, competitiveness of the food and cash crops and improvement of nutritional status of people by using recommended energy intake.

Keywords: Food and cash crops, food insecurity, optimum crop combination

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Trails as a Mean of Empowerment of the Landscape in Developing Countries

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A trail is a way to travel from one point to another in a territory. Trails can be planned or are just a result of customary use of movement needs. Within a planned strategy, there are several kinds of trails according to the way they are used: by foot, diving, air, via ferrata, each of which is used according to the potential of the site. As a result, trails are an adequate mean to educate society, especially urban population, about the environment and the importance of its preservation (natural and cultural values). This paper illustrates a methodology to design and construct trails in developing countries like Mexico, where there is a real need in educating society in these issues. Within the landscape, and especially the rural ones, for their appraisal and preservation, proper development of trails is a way to create advantages and more opportunities for rural people to additional ways of getting profits and at the same time protect the environment. Rural development can be helped by these opportunities, when linked to actions related to ecotourism and rural tourism. Trails and their proper implementation can help in such important aspects. There are several empirical approaches to build trails, but there are not many examples based on scientific and technical frameworks for developing countries. Mexico, similar to other countries, is experiencing landscape fragmentation and loss of natural ecosystems and environmental quality. This situation requires that rural people are adequately considered to get profits and to preserve their environment in the long term, by the proper use of trails. This paper presents the study case of the small town Coscomatepec in Veracruz State in the Gulf of Mexico.

Keywords: Developing countries, landscape, Mexico, rural development, tourism, trails

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Agricultural Development in the Knowledge Economy: "Closeness" in Access to Information and Innovation

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In the current knowledge-based system of agricultural growth and development, improved farmer access to relevant, timely and user-friendly information can be a crucial input for innovation and thus for rural and agricultural development and growth. Such innovation can come about as the effective and successful use of newly developed (or discovered) production technologies, improved harvest and post-harvest inputs and processes, the application of tried environmentally friendly production practices or organizational and institutional arrangements that support farmers in reaching new markets and better negotiation stances, among others.

Previous studies of diffusion and adoption of innovations have identified some characteristics that are more commonly found among those who innovate, such as access to sources of finance, ownership of the land on which the crop is grown, level of schooling, size of the farm. In this paper, We aim at exploring a part of the innovation process that is still considered to be contained within a black-box: what factors drive the decision of a farmer to innovate?

Learning, either through experience or through a training process and access to information are considered crucial in the decision to innovate. It is hypothesized, that if a farmer is able to observe the learning process of other farmers, he/she will profit from the investment in learning and experimenting undertaken by his/her neighbor and will him/herself perceive lower costs to learning, accelerating the decision to innovate and to adopt new farming technologies. If this is true, then, a different degree of "closeness" (in a familiar, local or experiential sense) to the sources of information on new technologies that a farmer has access to, has a different impact on his/her decision to innovate. An attempt to test this is undertaken in the context of Colombian cacao producers.

When observed in isolation, the impact of the degree of closeness of the sources of information on the decision to innovate is marginal; however, in interaction with other aspects that may be determined by the rural-urban continuum (such as availability of farm labour, how cosmopolite farmers are and their access to mobile technologies or internet), a higher degree of "closeness" to the sources of agriculturally relevant information become more significant.

Keywords: Agriculture, development, information, innovation, learning, policy

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Ethnicity, Marriage, and Family Income

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This study adds a microeconomic perspective to the discussion on ethnic diversity and economic performance in developing countries by investigating the motivation for intra-ethnicity marriage in rural sub-Saharan Africa. Specifically, the paper proposes that ethnic similarity between spouses enhances economic outcomes through a shared production technology leading to more efficient cooperation in agricultural activities. This leads to higher returns from marriage with a co-ethnic than with a non-co-ethnic so all individuals prefer a spouse from the same ethnic group. Furthermore, the framework suggests that the probability of marriage within the same ethnic group is positively related to the size of the group due to frictions in the marriage market: Search costs for co-ethnic spouses are larger the smaller the group. The theoretical predictions are supported using Ethiopian rural household data by demonstrating that inter-ethnicity marriage of the household head has adverse implications for family income. The negative effect is robust to controlling for lagged income and initial conditions, present when investigating the link with changes in family wealth, and comparable for ethnic majority and minority groups. The findings suggest that where the tradition of homogamous marriage is interrupted, for example in situations of displacement or forced migration, policies may be designed to assist in replacing these mechanisms and in facilitating the understanding and co-operation between non-co-ethnic spouses in order to secure livelihoods. This specifically applies to members of ethnic minority groups as they are often at a disadvantage in their access to, for example, production factors and also have a higher probability of marrying outside their ethnic group, which, in turn, hampers family income according to the findings of this study.

Keywords: Ethnic diversity, family income, heterogamy, marriage

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Women Collectives: A Hub of Lifelong Learning and Food Security

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This presentation emanates from a study conducted among the Bang' Jomariek women collective in rural Seme area of Kisumu County in Kenya. The initial study focused on the indigenous teaching and learning processes the women employed in the production of pots, baskets, and indigenous architecture. The study also considered the women's production of practical art items as important income generating and community development initiatives. These women and their community were the first consumers of the pots, baskets, and the indigenous architecture thus produced. A more interesting serendipity finding in the study involved the ways in which the women ensured food security for their families and community. The study found that these women have evolved a sustainable system of food production that contributes substantially to poverty alleviation in their community. This system involves an agricultural education process, easily identifiable as an aspect of lifelong learning and which proceeds in a cyclical manner with some members always present at the various points in the continuum. This collective's members have a learning/work team through which they conduct their food production activities. Members benefit from this team in various ways: learn good food production practices from others knowledgeable about the same, access a work team for their farms and so are able to produce more food than if they worked alone in the farm, and are always in a vibrant indigenous learning environment with its attendant advantages. As they worked members shared their knowledge and experience about the work at hand, and being an indigenous learning environment, they taught each other about matters as came up in their engagements.

Keywords: Food security, women

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People at the Center: Food Sovereignty and Human Rights Compliant Rural-Urban Continuum Development

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The links between agricultural and food production, how and where food is produced, access and control over productive resources (land, water, seeds, etc.), land grabbing, impact of agriculture on the environment, control over the food system overall, access to adequate and healthy diets, and food consumption patterns and quality of life are undeniable. The persistence of unacceptable high prevalence of hunger, micronutrient deficiency associated with increasing rates of overweight and obesity, especially among women and lower income populations, in a world that is wealthier than ever before in history, and fully capable of producing enough food to adequately feed all human beings, have put in question the present model of agricultural development and, in special, the governance of the food system overall. This state of affairs goes hand in hand with the enormous concentration of economic and political power in the hands of the private corporate agrifoodbusiness sector, and national and international public policies that not only fail to regulate them, but in reality serve these interests. It is fundamental that people across the food chain (production, harvest, process, marketing, consumption…), and across the life span and diversity (gender, race, ethnicity, income/class, nation…), and across urban and rural spaces, and in and out of food production work need to be put at the centre of policy making at all levels, be food sovereign and have their human right to adequate food and nutrition realised. In this, it is also central to reaffirm that this will only be reached with the full promotion and protection of women's human rights. Civil society organisations and social movements have organised themselves in a global network for the right to food and nutrition that seeks to bring together people from all walks of life, urban and rural, struggling for a human rights compliant food system. Academic and research institutions must strengthen their alliance with public interest civil society organisations, and guarantee its capacity to think outside the box and serve public interest. This will only be possible if it maintains its independence from and its critical view of private corporate sector interests.

Keywords: Agribusiness, agricultural production, food sovereignty, food system, global network on the right to food and nutrition, governance of the food system, human right to adequate food and nutrition, hunger, land grabbing, malnutrition, women's human rights

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Farmers challenges: Adoption and innovation in the process of empowerment

Technical Efficiency of Smallholder Horticultural Farmers in Ghana

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Rapid growth in the trade of high-value commodities has resulted in significant growth in many developing countries including Ghana. Trade in high-value agricultural products are displacing exports of traditional commodities. In Ghana, crops such as pineapples, mangoes and vegetables have become promising options to diversify from the traditional export base comprising of cocoa, timber and gold. While market access remains important, Ghana's major handicap is her inability to sustain export growth on the open market. The causes of these could be attributed to inefficiency, lack of competitiveness and supply side constraints. Even though horticultural exports have grown dramatically over the last decade, these have yet to fulfil their potential. Horticultural production can significantly contribute towards increasing the incomes of smallholder farmers, expanding employment opportunities, enhancing rural development and an important source of foreign exchange earnings. It also raises the demand for labour in rural areas therefore reducing the incidence of rural-urban migration. This study examines the factors that affect technical efficiency of smallholder horticultural farmers in Ghana.

Using survey data on about 6,000 farm households in 23 districts in Ghana, the study assesses the technical efficiency of smallholder horticultural farmers using the Translog functional form of the Stochastic Production Frontier. Twelve focus group discussions and twelve in-depth interviews were conducted on smallholder mango, pineapple and chilli pepper farmers in six selected districts in Ghana. Preliminary findings indicate that chemical costs, tractor costs, seed costs and labour hours all had significant positive effects on the yields of pineapple, mango and chilli pepper. With respect to production risk, the results show that fertiliser, herbicide and insecticide are risk-increasing whereas tractor and equipment and labour are risk-decreasing. Farm size, gender, and age were found to have significant positive effects on technical inefficiency of mango, pineapple and chilli pepper farmers. Years of education of farmer and farmer's experience had significant negative effects on the technical inefficiency of the farmers. Constraints to production outlined by farmers included marketing, training, funding, accessibility and affordability of inputs, land, access to credit and pests and diseases. Further analyses of both the quantitative and qualitative data are still ongoing.

Keywords: Horticulture, production risks, smallholder farmers, technical efficiency

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Understanding Local Communication Methods in Traditional Communities of Nigeria: Evidence of "Town Criers"

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Governments have been largely responsible for research and the provision of extension services in Nigeria. The emphasis has been on the transfer of technology, paying little attention to farmer development and communication needs. Recently, the high output of agricultural research has led to a large pool of new agricultural technologies, which are yet to be disseminated to farmers, particularly those in the core rural areas Private research and extension provision was expected to replace that previously provided by government but only congregate at the urban towns and larger commercial farmers. However, there have been a number of less well-known extension services to address smallholder farmers' development and information needs. The defining characteristic of these initiatives has been the training of 'town criers' who both provide development and information needs. Therefore this study examined development and information need of the resource poor and the strategy adopted to meet these needs. The study identified 2 states in south west Nigeria through simple random techniques, based on literature review and past studies, where this concept has been adopted. A focus group discussion technique and interview schedule was adopted for data collection, and a discussion guide was used in each of the group discussions. The study identified 141 'town criers' across the study areas through the help of key informants. The results indicated that all the 'town criers' are male, on average 55.5 years old and all have post-secondary education. Results from the study revealed that this channel meets about 68.5 % of the development and information need of the people. The use of 'town criers' can be more effective if the structure of receiving information for onward dissemination can be enlarged. Past studies have documented that once information/communication channels in Nigeria such as extension institution have collapsed, there is no effective communication channels in the country again. The small number of extension officers that exists only congregate at the towns, leaving behind rural areas. Thus, the use of 'town criers' in this regards can be used effectively to fill this gap and can also be trained on basic extension work.

Keywords: Information dissemination, key informant, Nigeria, participatory approach, 'town criers'

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Shocks, Coping Strategies and Vulnerability before and after the Economic Crisis: Evidence from Ethiopia

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Using rich panel data from Ethiopian households before and after the financial and economic crisis, we study the incidence of shocks suffered by households and what their strategies to cope with them are. The results first show the diversity of economic, environmental, health and other shocks suffered by households and how the crisis is likely to affect the joint distribution of these shocks. Second, they show how specific household strategies can be associated with specific types of shocks. In particular, we report how these strategies have evolved with the occurrence of the economic crisis. Third, we estimate the effects of the observed determinants of the joint data generating process of shocks and strategies at household level. This allows us to identify useful instruments on which poverty alleviation policies could be constructed in response to the economic crisis. For instance, from socio-economic characteristics of households, we find that education plays a vital role in the incidence of shocks in general and climatic shocks in particular. Households whose income source is from agriculture are highly vulnerable to shocks while access to services is relevant for health shocks. We find strong evidence that networks are significantly related to households probability of coping against any one shock. In addition, access to income generating schemes increase households' probability of coping. Finally, we propose novel vulnerability indicators and apply them to the Ethiopian context. The estimates imply that Ethiopian households are rarely able to cope with shocks and that active policies are necessary to help them smooth out the impact of these shocks on their living conditions.

Keywords: Coping, economic crisis, Ethiopia , shocks, vulnerability

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Assessing the Sustainability of Leasehold Riverbed Farming for Landless and Land-Poor Households in the Terai, Nepal

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Rural poverty remains an urgent problem in Nepal, leading to male migration to urban centres of Nepal and India. Riverbed farming is practised in the pre-monsoon season in the Indo-Gangetic plains (the Terai) of Nepal by landless and land-poor farmers. By using marginal land, riverbed farming can decrease the already high production pressure on arable land. However, little is known about the sustainability of farming in riverbeds that generally host fragile ecosystems. Also, there is a dearth of literature on the impact riverbed farming has on male out-migration.

The aims of this study are to assess the sustainability of riverbed farming and to analyse riverbed farming's impact on adopters' livelihoods. The analytical framework of SATNET Asia evaluates the sustainability of agricultural technologies according to their economic, environmental, social, and technological sustainability. The Sustainable Livelihoods Approach (SLA) offers a holistic model to assess riverbed farming's impacts on adopters' livelihoods.

Semi-structured interviews with riverbed farming groups were used for quantitative and qualitative data collection. Factors enabling or constraining the adoption of riverbed farming were determined. Income generated, how it was used, and source and amount of inputs were documented. Changes in household health, social status, and male out-migration from the community were recorded.

To evaluate the sustainability of the technology, a composite indicator based on the SATNET framework was calculated from the primary quantitative data. Using primary qualitative data and SLA, riverbed farming as a transforming process was analysed as to its impact on adopters' livelihood assets and strategies as well as their vulnerability context.

Riverbed farming was found to be sustainable economically, environmentally, socially, and technologically. Its composite sustainability indicator is presented and discussed. Riverbed farming made a significant positive contribution to household income generation. This raised the household's social status within the community, contributed to increased opportunities for children's education, and decreased vulnerability to environmental shocks. Male out-migration to cities was reduced. The study found opportunities for stronger linkages to markets and to related sectors like community seed banks. Riverbed farming is strongly recommended for diffusion as a sustainable, livelihood-enhancing technology that decreases rural out-migration while maximising marginal land use.

Keywords: Composite sustainability indicator, impact assessment, marginal land use, sustainable agriculture, vegetables

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The Role of the Individual Agency in Participatory Irrigation Management: Lessons from India

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The devolution of authority for natural resource management to local user groups has been an important approach to overcome the long-standing challenges of centralised state bureaucracies. In India, this approach was implemented in irrigation management through the creation of Water Users' Associations (WUAs), following the guidelines issued by the Ministry of Water Resources in 1987 that aimed to enhance the farmer participation in irrigation management. WUAs are also expected to facilitate local adaptation to climate change through improved irrigation management. The literature on common-pool resources following the seminal work of Elinor Ostrom has identified important design principles that can enhance the efficiency, equity and sustainability of local user groups. However, in spite of intensive research on this issue, knowledge gaps still remain regarding the question as to why some local user groups are able to overcome governance challenges such as elite capture, while others, which work under the same design principles, are not. The paper addresses this knowledge gap by conducting a qualitative case study, using the Grounded Theory approach. This methodology was selected to be able to identify in an inductive way from empirical cases those factors that may have been neglected in the literature on common-pool resources. Following a comparative approach, four villages were selected, two each in the states of Maharashtra and Andhra Pradesh. In these villages, it was found that inspite of certain governance challenges such as elite capture, rent seeking and patronage, two villages have been able to minimise them to a large extent and have enabled water distribution to become a community activity. The other two villages have, despite local governance guidelines and incentives, failed to live up to the participatory approach and are dealing with challenges such as lack of collective action, accountability and exclusion. The Grounded Theory approach identified individual agency as a major factor that plays a significant role in success of participatory irrigation management , which has been neglected in the current literature on common pool resources. The paper draws conclusions on how local leadership can be promoted to facilitate climate change adaptation in irrigation management.

Keywords: Climate change adaptation, individual agency, participatory irrigation management

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Engineering Fortification Farms: Empowering Innovation of Local Farmers on Yogyakarta, Indonesia

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In many villages on Yogyakarta people's knowledge on livestock husbandry and breeding is still traditionally implemented. In an innovative student programme called "Engineering Fortification Farms Program" training is offered to develop farmers' knowledge on livestock related themes. This programme includes mentorship for farmers, counseling their livestock, training on feed production followed by training of entrepreneurship by Bengkel Pupuk (a centre for waste product management). The implementation of these methods consists of 3 stages. The first stage is socialisation; second is implementation and third is monitoring of the programme.

As a case study this programme was implemented in the village of Hargorejo, lasting for 3 months. During this time the farmers were eager to follow any training and discussion; 85 % of the farmers came early to every event. The farmers were expected to produce approximately 200 kg supplementary feed through ensiling grass, mostly King grass, straw and leaves found around the village. This silage was provided as a primary feed during dry season. and could fufill the basic needs of their livestock and so improve the productivity.

In order to reduce the use of chemical fertilisers a further training accent was put on the use of animal wastes as organic fertiliser. Through this program the local farmers are expected to be able to fermentate feed for their cattle's nutritional supply needs during the dry season (biotechnology) independently. They can also create and manage bengkel pupuk as a livestock waste treatment facilities to improve their economy in the livestock sector. This community service programme will be able to educate farmers as a solution of livestock raising, helping farmers in feed managing problems during the dry season and optimalisation of potential waste to get a profit as a result of entrepreneurship based on animal science.This community were also expected to increase the creativity and encourage the farmers to be more productive in managing forage livestock feed. In addition, this programme will give a motivation for the farmers in Hargorejo village to be independent and have a decent life.

Keywords: Animal science, biotechnopreneur, empowering, mentorship

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Potential Adoption and Impact of Embrapa 5.1 GM Common Bean for Small and Middle Size Farms in Brazil

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Brazil is the largest common bean (*Phaseolus vulgaris* L.) producer and consumer worldwide. Main commercial grain type is "carioca" bean, the country's main dry bean class. Over 90 % of producers grow beans on less than 5 hectares. The Bean Golden Mosaic Virus (BGMV) is regarded as a major disease in common bean production in Brazil as well as in other growing countries. The control of the vector white fly (*Bemisia* spp.) demands a large amount of insecticides. In September 15, 2011, an official Brazilian authority institution approbated the commercial release of the first trait of genetically modified common beans. This trait represents a milestone in genetically modified organisms (GMO), since this is the first GM trait developed by public research in Brazil, supported exclusively by public fundings, and whose focus is on a crop that is grown mainly by small and medium size farms in Brazil. The 'Embrapa 5.1' GM trait incorporates a genetic resistance against the BGMV. In order to obtain the GM varieties, the Embrapa 5.1 trait must be incorporated into breeding lines. Now, the unsuitable areas highly infested by the white fly may become suitable again for growing dry beans. The first seeds of GM bean varieties are expected to be available to farmers in Brazil by 2015. Thus, we consulted experts to assess the potential changes in the dry common bean chain after the commercial release of GM bean varieties to seed and grain producers in Brazil. The consultation was done via electronic questionnaire with agronomic consultants, seed producers and bean processors during 1st semester 2012. In general, it is expected that (a) bean production will happen again on those BGMV infected areas; (b) production costs will be reduced (less pesticide use); (c) grain quality may improve due to less potential pesticide residues; (d) production may become more constant over the year, reducing price fluctuations; and (e) consumers will have access to cheaper food over the whole year.

Keywords: Disease resistance, *ex-ante* evaluation, green biotechnology

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Plantain Innovation System and its Effect on Technology Adoption: A Case of Plantain Farmers in Ghana

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Plantain is the 3rd most important staple in Ghana only after maize and cassava. However, over the years the yields of farmers do not compensate the annual investment by the private sector (NGOs) as well as the public sector institutions (Ministry of Food and Agriculture, Children's Rights International and Universities). FAO estimates that with the appropriate technology, research and appropriate linkages between stake holders in the plantain sector, yields can be increased from 10 Mt ha^{-1} to 30 Mt ha^{-1}.
Primary data from 250 households, extension agents, CRI, input dealers and World Vision international (NGO) in Brong Ahafo and Central regions of Ghana were used to access the plantain innovation system and how its presence or absence affects adoption. The data reveals the existing of an innovation system in the plantain sector albeit weak connections. Comparative analysis showed that farmers are the most influential in the system followed closely by extension agents with input dealers and processors having the least influence. Using network analysis measures, the data showed that there existed a reverse interaction between farmers and extension agents, extension agents and CRI but low and in some case no interaction between marketers, input dealers and processors.
Significant determinants of adoption were family assets, education, age of household head, labour, income, family size, marketing (availability and prize). It was also realised that the innovation system interaction significantly affected the adoption process. Using the Tobit model, it indicated a positive and expected relation between years of education of household head, income of family, assets and innovation system and adoption of plantain technologies in Ghana.
Availability of credit to farmers, improved planting materials, and marketing were the most prominent challenges faced by plantain farmers.

Keywords: Actors, adoption, CRI, innovation system, interactions, MoFA, NGO, technology

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The Effect of Gender on the Adoption of Agricultural Innovations: The Case of Improved Cotton Technology in Kenya

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The Government of Kenya has identified cotton as a key sub-sector in the Vision 2030 which is a vehicle for accelerating transformation of the country into a rapidly industrialising middle-income nation by the year 2030. The sector has potential to benefit 8 million people in production, ginning, marketing and other activities along the value chain. Since the crop thrives well in dry areas of the country with limited alternative opportunities for development, it is being promoted in Kenya on poverty-reduction grounds and to spur economic development in these areas. The country has potential of producing 300,000 bales of lint while the local demand is 200,000 bales per year to meet the annual local fabric demand of over 225 million square meters. In the past, lint production has stagnated at 20,000 bales, produced from 30,000 hectares under rain fed cotton production with production ranging from 400 to 600 kg of seed cotton per hectare. Over ninety percent of this production is realised from small scale producers who own less than two hectares of land. Data on the adoption of cotton varieties and inorganic fertilisers were collected through a national survey of cotton farmers carried out between March and November 2012. A three stage clustered, randomised procedure was used to select a representative sample of 500 farmers located in 50 villages throughout the country. The results from this survey suggest that gender-linked differences in the adoption of modern cotton varieties and inorganic fertilisers result from gender-linked differences in access to complementary inputs. This study further proposes the enactment of a policy that will ensure better access of complementary inputs to women especially extension services, land and labour.

Keywords: Cotton, adoption, gender, Kenya

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Plant Biotechnology and Rural Development: A Case Study from Shandong Province, China

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Bt cotton has been widely declared a success story of a cotton pest management technology that has solved major pest problems in cotton in China. Benefits resulting from Bt cotton adoption are stated to be a significant reduction of pesticide use as well as labour input and hence cost savings for farmers and decrease of environmental pollution and human health effects.

However recent evidence from a long-term, in-depth case study of some 150 farmers in five villages in Shandong province provides some evidence that the past benefit assessments could have been overestimated. Using panel data of village and farm characteristics as well as on cotton production collected through household survey and season-long monitoring in 2002, 2005 and 2012 allow a long term assessment of the technology. Using descriptive statistics and econometric analysis of the panel data set allows a more realistic assessment of the benefits, costs and constraints of this technology under farmer conditions in China. For example, results show that the profitability of the technology has been hampered by the need for more chemical control of secondary pests, and farmers are uncertain about the quality of Bt cotton seeds due to a severe lack of quality control mechanisms in place. Costs have gone up due an increase in cotton seed prices while at the same time cotton lint faced a downward trend. Finally, agricultural policy in China is changing and the government is now subsidising rice and corn production which lowers the competitiveness of cotton production among farmers. While in 2005 all farmers in the panel planted cotton, in 2012 this number dropped to just over 50 farmers. From a methodological point of view this study allows to quantify benefits in a cropping systems context, which are lower than estimates of previous studies.

Keywords: Genetically modified cotton, plant biotechnology, rural development

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Opportunities and Challenges in the Production of Maize in Northern Ghana: Insights from a Household Survey

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Maize is one of the most important crops produced and consumed in Ghana, accounting for 58 % of local cereal production. Increasing food prices worldwide and the gap between production and consumption of maize in recent years in Ghana present the country with growing import bills and higher prices for consumers. The purpose of this study was to analyse whether farmers in the northern sector of Ghana have a comparative advantage in the production of maize as import substitution. In addition the results of the study were compared with an earlier work, in the same area, before fertiliser subsidies were implemented. The effect impact of the fertiliser subsidy programme on the yield it self and consequently on the private and social profitability has been tested. Fertiliser subsidy programs are one of the most popular policy programs in Africa. In the mid-90s many countries introduced them to increase crops yield.
Household survey data of the cropping season 2010 were collected and complemented with data from different institutions. We applied the Policy Analysis Matrix (PAM), to assess policy effects on production systems, and the Cobb-Douglas production function to identify factors affecting the output of each system. The results suggest that production systems with yields above the national average of 1.5 tonnes per hectare are profitable at private level and contribute to growth of the national economy. Farming systems producing below this threshold report negative social profits, implying that they do not use scarce resources efficiently in the production of maize and depend on government intervention. However, the analysis suggests that current policies increase the profitability of maize production in the two systems analysed.
The policy implications of these findings are, first, the need to improve extension services that address the real constraints farmers face. Second, the use of fertiliser should be coupled with other inputs and knowledge to maximise the efficiency of each. Furthermore, the lack of access to credit should be addressed as well as the improvement of the infrastructural network. In conclusion, we it consider essential to combine single factors and used in synergy to realise the full efficiency of each.

Keywords: Cobb-Douglas, comparative advantage, Ghana, maize, policy analysis matrix

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Factors Affecting the Economic Efficiency among Rice Farmers in Irrigated Area of the Municipality of Malanville in Northern Benin

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Rice production is increasingly important in most rural municipalities in Benin where its cultivation is appropriate. The national needs are increasing and higher than the national production, implying huge importation of rice and loss of revenue for the country. In this context the increase of rice production becomes necessary and strategies must focus on the enhancement of inland valleys through the rehabilitation of the existing irrigated area and of the valleys which have not been arranged. This study estimates the technical, allocative and economic efficiency among rice farmers in the irrigated area of Malanville and identifies factors affecting the economic efficiency. Using a semi-structured one-on-one questionnaire, primary data were collected from a sample of 115 farmers randomly selected in the irrigated area of Malanville. The results revealed that the mean levels of technical, allocative and economic efficiency are 70.3 %, 84.6 % and 59.4 % respectively, suggesting the existence of substantial gain possibilities in output and/or decreases in cost with available technology and resources. The economic efficiency differences are explained significantly by the sex, the experience in rice production, the irrigation degree of the lands as well as the technical itinerary of the producers. Policy recommendations drawn from these findings concerned: i) that other parts of the irrigated area should be arranged so as to intensify rice production to achieve similar financial profit, ii) the maintenance of the irrigation canals by the producers and the finalisation of the interconnexion to electricity should be completed so as to avoid the regular breakdowns. This will help to supply the pumping factory adequately in order to improve the level of irrigation. iii) the management strategy should be revised and their focus reinforced on the irrigated area. iv) the capacities of the rice farmers group should be reinforced in the acquisition of appropriate fertilisers in order to permit the respect of the cultural calendar.

Keywords: Benin, Economic efficiency, irrigated area, rice

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The Silent Ontology of Farmers' Experimentation: Getting it Aloud for Promoting Innovations in Nigeria and Benin

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During the past two decades considerable advances have been made in reviving local knowledge. On-farm experimentation has been extended to empowering farmers to set their own research agenda and to take full control of them. However, the novelty of these changes has been impaired by the inherently evaluative character of scientific knowledge, which remains primarily concerned about validity and reliability. On the contrary, farmers' knowledge is essentially embedded in their cultural experience that needs to be decrypted. Since decrypting farmers' culture is a life-time challenge, most research projects use a collaborative approach to translate farmers' judgments into quantitative data or laboratory analyses to gain new information. In such joint-learning processes only the outputs of farmers' knowledge are of scientific interest but not the experiential model they stem from. The latter is inherently implicit and therefore beyond the reach of empirical observations.

In a study on the diffusion of multipurpose legume-based technologies in Nigeria and Benin, these impediments were addressed to shed some light on farmers' experimentation processes. The technology options were introduced as neutrally as possible without any specific information on how they were to be used or tested. Rather, participants were free to make their own sense of the legume options and to choose those they felt most appropriate for their goals. Based upon (1) the differentiated taxonomy systems that farmers used to select legume options (2) the spatial arrangements they employed to probe their choices, and (3) the explanations they gave of their observations, their experimentation process could be traced.

The results suggest that farmers' choices were based on plant morphological criteria from which they would anticipate the likely performance of the different legume species. Then a confirmatory, non-hypothesis-based experimentation stage followed. Instead of choosing the best performing species as confirmed by their test, the participants suggested that the promising species should be subjected to a Darwinist learning-selection process before final confirmation of their suitability. Since this third stage is purely processual and non predictable as to its outcomes, new institutional arrangements are necessary in agricultural research to effectively promote innovations such as legumes-based technologies.

Keywords: Knowledge Construction Process, Legume-based innovations, local knowledge, West Africa

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Modelling the Economic Efficiency of Investments in Cotton Production in Nord-Benin

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This study aims at analysing the effects of the investments in cotton production on the output elasticity in Kouandé and Kerou Districts in the North of Benin Republic, West Africa. Data were collected from June to September 2012 by surveying one hundred and forty (140) cotton farmers, randomly selected in the study area. The Cobb-Douglas and Translog models were estimated by considering six (06) inputs, namely: acreage of cotton, quantities of mineral fertilisers used, insecticides, herbicides, capital and family labour. The results revealed that the average acreage of cotton per farmer was 3.05 ha. Per hectare, farmers used on average 145.01 Man-Day of family labour, 305.15 kg of fertilisers (NPK and Urea), 1826.30 ml of insecticides (Thian, Serfox, Tunder, and Miticide), 3692.70 ml of herbicides (Calah and Califor G), and Francs CFA 42411 as capital. In addition, there was a high correlation between the quantity of family labour, of mineral fertiliser and herbicides and the education lever of producers. As regard efficiency, the Cobb-Douglas model showed that investing in land, mineral fertilisers, insecticides, and herbicides was technically efficient. In contrast, the Translog model revealed that the cotton productivity was rather determined by the interactions between "labour and herbicides", "labour and capital", and "capital and herbicides"; which have significantly impacts on the cotton output elasticity. Among these options, only the combination "labour and herbicides" ensure a positive and significant output elasticity and therefore, appears to be the best investment alternative. As well, training and visit systems should focus on how to strengthen cotton farmers so as they could be more efficient in investing in cotton production.

Keywords: Cotton production, investments, Kouandé and Kérou, output elasticity, Benin

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Possibilities and Acceptance of Alternative Energies from Farm Solid Waste Material (Kocho): Case Study from Kembata Tenbaro Zone, Ethiopia

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Scarcity of renewable energy and environmental changes are basic intertwined problems of global concern. Ethiopia is one of the developing countries that use high quality and quantity of energy, mainly from different forms of biomass and primarily for household consumption. In the rural part of the country, the energy use patterns are widely misunderstood because of factors such as population growth and changing consumption habits. The aims of this study were to (i) identify and quantitatively analyse farm solid waste material for its heat energy release; (ii) analyse the production of heat energy from briquettes made of Kocho fibers – Kocho is a waste product of false banana which is a primary food material for the local population; (iii) finally, propose additional sources of energy for household consumption and design a capacity building tool for local users.

The study used a stratified sample of 350 rural households in seventeen kebeles of Angacha Woreda; the Kocho residue material was collected from participating households after food consumption.

The practices of using alternative renewable energy from farm waste material decreases the negative impact on the environment and provides affordable energy as an essential condition for improving the lives in rural areas.

Keywords: Farm solid waste management, Kocho fiber briquettes, technology adoption

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Adoption of Innovations and Farmer's Attitude to Advisory Services within Rural Areas of Kembata Tembaro Zone, Ethiopia

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The research located in Kembata Tembaro zone was connecting the evaluation of qualitative and quantitative data collected for the purpose of recognising decision-making strategies of small-scale farmers in the area. Among the specific conditions of the zone belong overpopulation and soil erosion. The main aim of the research was to find approach and strategy of farmers to adopt innovations. Within the research, 125 small-scale farmers were asked by formal interview. The balanced target groups regarding gender and status (model farmer and following farmer) were surveyed in five areas (kebeles). The data were collected in September-November 2012. The data were evaluated by SPSS statistical software (descriptive statistics, Chi-square, odds-ratio). The results show that there exists statistically important correlation between the status of farmer ($p < 0.1$, r = 0. 4), personal attitude ($p < 0.05$, r = 0.182), willingness to pay for advisory services ($p < 0.01$, r = 0.311), contribution within the working group ($p < 0.1$, r = 0.147) and decision-making to adopt the innovation. On the other hand, agricultural advisory services are wide and multidimensional topic. There exist many other factors contributing to decision-making strategies, which can be explained by personal character, by previous experiences of farmers, by communication style of advisor and governmental implementation strategies. Balanced approach to implementation of innovation is important. The research results can be utilised as a supportive material for development of institutional strategies of extension services and implementation of new technologies. The results of the paper can provoke other topic related studies.

Keywords: Adoption, decision-making, Ethiopia, implementation, innovation, small-scale farmers

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Effects of Homegarden Size on Inputs and Outputs per Unit Area

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Homegarden cultivation is a traditional agroforestry practice which is widespread in many parts of the tropics especially in rural areas. Although they are essential cultivation systems in many African countries, little is known about them due to inadequate research. This research studied the effects of homegarden size on inputs and outputs per unit area. The size of the homegardens was assumed to be an essential factor influencing the amount of input required and the amount of output per unit area. We hypothesised that, if the garden is small then lower inputs are required and hence lower outputs per unit area. We conducted the study in Burkina Faso where the Bieha department was purposively selected. We conducted both a qualitative and quantitative assessment. The initial Rapid Rural Appraisal was complemented by a household survey. Tools of data collection included; observation, key informant interview, and focus group discussion. For the survey, eighty (80) households were selected based on systematic sampling. Data was collected by individual interviews at household level, and for statistical calculations, the households were subsequently categorised as small, medium and commercial based on their homegarden size. It was found that all the surveyed households managed homegardens composed of trees, crops and animals. Majority of the farmers (43 %) owned small homegardens due to land constraints. Labour was mainly provided using manpower and by household members. Mean inputs and mean outputs increased with increasing land sizes. However inputs per unit area and outputs per unit area were higher for small homegardens than bigger ones. Fertiliser application increased with increasing size of homegardens. The percentage of manure application was higher than fertiliser in small and medium homegardens while in commercial homegardens, percentage of fertiliser application was higher than manure. It can be concluded that the increase in homegarden sizes results in the need for higher external inputs. Homegardens are thus becoming commercialised and more expensive to manage.

Keywords: Agroforestry, homegarden, household, inputs, outputs

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Enhance Women Participation in Agricultural Extension Activities in India

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Women represent one of the crucial development forces in the world. But extension services in the developing countries are still facing difficulties in effectively make them involve and actively engage in agricultural activities. According to the World Bank nearly three-quarters of India's families depend on rural incomes. The majority of India's population (some 770 million people or about 70 percent) are found in rural areas. India's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes. Agriculture sector employs 4/5th of all economically active women; they make 1/3rd of the agriculture labour force and 48 % self-employed farmers. Highly involving women in agricultural production, but facing lack of women participating in agriculture extension programs, is one of the primary reasons distinguishing unsuccessful extension program from successful ones. Agricultural extension strategies traditionally have focused on increasing production of cash crops by providing men with training, information, and access to inputs and services. This male bias is illustrated in farmer training centers, which have been established to provide residential training on technical subjects. Second, women's daily workloads do not usually allow them to be absent from home for residential training; even attending short courses may cause insuperable problems in arranging substitute care for children or the home. And third, even where attendance of women is quite high as a proportion of the total, women are given instruction mainly in home economics and craft subjects, not technical agriculture. Pluses mentioned issue lower education level or not educated compels the women marginalized from extension services. Therefore to increase the agriculture productivity needs a reformation of traditional extension services, gender issues, and mobilization of information.

Keywords: Agriculture extension, constraints, productivity, women farmer

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Sustainable Livelihood Analysis of Organic Smallholder Tomato Growers in India

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In spite of the rapid growth of the Indian economy, the fraction of the rural population living in poverty has declined only modestly. Increasing indebtedness, rising input prices, changing environmental factors and rapid commercialisation have contributed to rural distress. The government of India is in the process of scaling up a national rural livelihood program. The promotion of organic agriculture is one among them where organic agricultural system increasingly plays an important role for sustainable agriculture and rural development. In this context present research tries to assess the livelihood of the smallholder organic farmers with a sample of 100 households who are cultivating organic and conventional tomatoes in Karnataka, India. It also asses, whether the adoption of organic farming can improve farmers livelihood to ensure enhanced food security and poverty reduction compare to conventional farmers. This research applies the sustainable livelihood framework in the smallholder agricultural sector to identify sources of vulnerability, support institutions, priority livelihood strategies and possible outcomes and variations across conventional and organic smallholder farmers. The farmers in the study area perceived that they improved their livelihood after conversion from conventional to organic farming. Further reduced input cost with higher yield resulted in higher net farm income. The adoption of organic farming also reduces the risk of crop failure due to droughts, pest and diseases, thereby reducing vulnerability. In addition, the results also reveal that enhanced human capital (capacity building, health), social capital (producer organisation, relations and connectedness), physical capital (production and processing equipment, certification), natural capital (soil health and water holding capacity), financial capital and better maintenance of the cultural capital contributes to an overall increase in quality life of the smallholder organic farmers compare to conventional farmers. However, the non availability of organic inputs, initial decline in crop yield, the lack of market access, lack of information and experiences are the major constraints preventing poor farmers to adopt organic agriculture.

Keywords: Organic farmers, organic tomato, sustainable livelihood

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What Do Farmers Want from Forest Plantation Scheme? Using Choice Experiment to Estimate Willingness to Accept and Contract Preferences

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Forests play an important role as an alternative livelihood for poor farmers in the mountainous area of northern Vietnam where Vietnamese government has long been supporting forest plantation via several programs. The government has recently implemented pilot projects on Payment for Forest Ecosystem Services (PFES), the first of its kind in Southeast Asia. Research on farmers' behaviour, a main provider of forest ecosystem services, can contribute to the development of a more cost-effective and higher rate of participation in the process of up-scaling the PFES to a national level. This study aims at estimating the value of willingness to accept (WTA) to plant and conserve forest using choice experiment (CE) in Hoa Binh province, Vietnam. CE is based on the decision to choose the most preferred choice constructed by different attributes, thus allows the analyst to investigate farmers' preferences and trade-off between attributes that affect their utilities. Based on farmers' experience and perspecitve of policymaker, five attributes (harvesting policy, forest maintenance, punishment rule, subsidy amount and frequency of subsidy delivery) have been selected from the literature and focus group discussions with local people. We used face-to- face interview to collect data from randomly selected 300 households for two rounds of survey in December 2011 and September 2012. In addition to socioeconomic profile and past experience of forest plantation and programme participation, respondents were asked to choose between two alternative forest plantation contracts or opt-out options if they do not want to participate in any contracts. Results show that four-fifth of households are interested in participating in one of the contracts. Regression results indicate that farmers do not only pay attention to subsidy amount but also on other attributes of forest management. The value of WTA for conservation oriented contract is much lower than forgone income of growing cash crops, however, it is higher than the average subsidy of the past afforestation programs. This result indicates that government would have to increase the level of payment for ecosystem service, compared to the subsidy offered in the past, in order to acheive the effective participation of farmers.

Keywords: Choice experiment, forest, payment for ecosystem service, Vietnam, willingness to accept

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Acceptance of Local Farmers towards Resource Efficient Production Methods at the Itaparica Reservoir in North East-Brazil

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The rural areas of the north-east of Brazil are characterised by poverty, food insecurity, and rural exodus. Due to the construction of the Itaparica dam and reservoir, about 40,000 inhabitants have been resettled and agricultural production systems changed. Extensive dryland farming and livestock husbandry have been replaced by irrigation farming. The reallocated smallholder farmers were confronted with improper soils, insufficient drainage, and deficient expert consultation. The farmers' economic situation deteriorated. Consequently, tense relationships between them and the dam operator developed. Furthermore, the environment suffered from the non-sustainable farming practices.

Considering farmers' acceptance is an important step to establish resource efficient production methods as farmers' collaboration is essential for their successful implementation. For that reason the objective of this study was to assess local smallholders' perception on their current situation, their preferences regarding alternative crops, and their willingness to change their actual production methods.

Research was conducted by semi-structured on-farm interviews. Each interview contained a quantitative and a qualitative part as well as a scoring and ranking exercise. By means of this tool which is also included in the Participatory Rural Appraisal, farmer´s preferences could be shown and different alternatives could be compared. Half of the interviewees were female farmers, so that gender issues could be considered and different needs and preferences of men and women could be regarded. The interviews were carried out in three irrigation projects at the Itaparica reservoir. These projects differ significantly in history, prosperity, and infrastructure. In this way possible discrepancies between farmers´ preferences and opinions, but also their motivations and visions, could be compared.

First analyses show no significant differences between preferences of female and male farmers. Most of the farmers are willing to change their production methods in order to achieve improvements but they are, on the other hand, highly risk averse. As a consequence, income security was considered as the most important factor of any production method. In spite of lack of free time, farmers would substitute free time for higher income. These results can be explained by crucial constrains such as bad commercialisation, restricted access to loans, and absence of consultancy.

Keywords: Agriculture, farmers' preferences, local acceptance, resource efficiency

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Communities and climate change

Vulnerability Assessment and Impact of Climate Change on Agricultural Production in Krishna River Basin, India

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The concept of vulnerability has emerged in the recent years as a cross-cutting theme in research on human dimensions of global environmental change. Vulnerability has been largely studied by scholars from various academic disciplines. The agricultural sector is highly vulnerable to climate change in many parts of the world. Vulnerability was used in relation to food security assessments, poverty mapping, natural hazard exposure, or climate impact studies. In the present paper, a vulnerability index is constructed by considering exposure, sensitivity and adaptive capacity. Multivariate statistical techniques, Ricardain and Principal Component analysis were used in assessing the impact of climate change in Krishna river basin of Andhra Pradesh in India. The impact of climate change on crop income and crop productivity analysis, using Ricardian models, indicated that temperature during North East monsoon has a significant impact on crop-net revenue. Whereas the net revenue increases initially with increase in temperature, it reaches a maximum, and then decreases, whereas the net revenue attains a maximum value at about 25.8°C. The climate variables have significant non-linear effects on the crop-gross margin per ha. South West monsoon temperature has a positive effect on the crop-gross margin across all districts.
More than 60 per cent of the area is vulnerable in the basin, where Ananthapur district is extremely vulnerable and Guntur district is less vulnerable. The adaptation strategies from such highly vulnerable areas can be studied and implemented in the less vulnerable areas to minimise the impacts of climate change over the coming years. Since climate change will result in yield and income loss, it is important to introduce different adaptation measures such as change in the cropping pattern, change of crop varieties, and investment in supplementary irrigation. It is also important that climate awareness and capacity building become an integral part of the development programs at all levels.

Keywords: Adaptive capacity, exposure, principal component analysis, Ricardian model, sensitivity, vulnerability index

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Hot Spots to Potential Impact of Sea Level Rise within Coastal Communities in Lagos State

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Global sea level rise (GSLR) is one of the notable consequences associated with the rapid on-going climate change within the Anthropocene period. Also, sea level rise has been identified to be of greatest hazard to globally distributed coastal zones including both natural ecosystems and coastal communities especially Island communities and large coastal megacities in developing countries. Since most coastal communities in Lagos state are below the present sea level, the vulnerability of such communities and inhabiting stakeholders were assessed to determine the potential impact of sea level rise and extreme weather events using a holistic approach and secondary data. From the socio-economic point of view, human settlements, fisheries and agriculture sectors are expected to be among the most impacted socio-economic sectors as they were found to be vulnerable to all impacts considered in this context. The impacts of sea level rise are expected to escalate in communities in which excessive anthropogenic activities such as land reclamation, sand mining, natural ecosystem destruction and ground water abstraction had occurred in comparison to the modeled projections. Population density, geological land forms, infrastructural development and coastal modification are among the factors influencing the vulnerability of different coastal communities. Factors considered with this study indicated that most coastal communities within metropolitan Lagos especially those in Lagos division are at higher risk when compared to less develop coastal communities such as Epe and Badagry. Gradual urban-rural migration with alternative sources of income that are not related to marine might be a plausible solution in mitigating the projected impact.

Keywords: Beach accretion and ground water abrasion, geological land forms, vulnerability

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Potential for Group-Based Approaches to Enhance Security of Assets for Women to Manage Risk under Climate Change: A PRA in Ethiopia

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Climate change is a global problem; nevertheless, those countries contributing least to global climate change suffer most from its adverse consequences, which are often magnified due to their dependence on rain fed agriculture. Ethiopia is such a country, it depends almost entirely on rain fed agriculture which contributes 42 per cent to the gross domestic product. Ethiopian women depend on natural resources, including agriculture, for their livelihoods. As they are particularly vulnerable to climate change. Their vulnerability is exacerbated by a relative insecurity of assets. Thus, with an insecurity of tangible assets, how can group-based organisations enhance the security of these assets, especially for women, in order to better manage risks posed by climate change?

By way of gender segregated focus group discussions in Amhara and the Southern Nations, Nationalities and Peoples' Region, perceptions of climate change were obtained in order to identify the most impacted areas due to climate change and adaptation strategies already appied. Furthermore, perceptions on security of assets were acquired, firstly by determining the most important assets and then by exploring the prevalent gender and asset dynamics. Lastly, existing group-based organisations with a direct or indirect link to women and/or adaptation were looked into to reveal their strengths and weaknesses, and thus to discover potentials for further development.

Most notably three group-based organisations, one gender mixed, one female only, and one generally male, are undertaking activities that strengthen local communities through self-help, knowledge sharing, external advice and awareness creation with direct and indirect spill-over effects toward enhancing control over assets for women to better manage climate change risks. Aspects insufficiently included by the existing group-based organisations, however identified as constraints by the participants are issues related to health and access to credit, particularly for women. These are therefore areas with potential for improving asset security through group-based organisations.

Keywords: Asset enhancement, climate change, Ethiopia, group-based approaches, women

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Importance of Climate Change on Farmers' Production Decisions in Nepal

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Climate change is considered as one of the major causes of uncertain farm income in rainfed agriculture. The research assesses the effects of climate variables on farm income and its impacts on farmers' production decisions. Both primary and secondary data were considered. The farm level data (specified per crop) in three growing seasons of the year July 2010 to June 2011 were collected through face-to-face interviews with 225 farm households in three tropical districts (Banke, Chitwan and Morang) of Nepal. The observed district level average data of crop yields and seasonal climate variables (rainfall, maximum temperature and minimum temperature) during 1976 to 2011 were considered for the regression (time series) analysis to create the change in crop yield equation. The independent variables in the regression were the changes of seasonal climate variables and standard deviations of climate variables within growing seasons. Based on regression equations and observed historical data, yield of major seven crops across growing seasons and districts for 35 years were predicted. The predicated crops yields were considered as the yield risk due to changes in climate variables. A mathematical programming model with the objective function of maximizing utility (expected total gross margin minus measure of its variability due to yield risk) was developed. The model was run for three districts, with incorporating average district level farming data, for two scenarios as (i) without accounting for risk and (ii) with accounting for risk. To run the model with incorporating risk, multiple runs with different risk aversion coefficient ranges from 0 to 1.65 was done. The model chose the risk aversion values 1.65, 1.45 and 1.15 for Banke, Chitwan and Morang districts, respectively, that gave the minimum deviation between the simulated and the base year land use patterns. The model results for two different scenarios yielded different land use patterns in all districts. The model results showed the high fluctuations of gross margin across the years in all districts. The research concludes that the accounting for the effects of climate variables on farm income is important and the climate change adaptation strategies need to be considered in production decisions.

Keywords: Climate change, climate variables, farmers' production decision, mathematical programming, regression analysis, risk aversion, yield risk

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Environmental Governance Analysis for REDD+ Implementation in the Municipality of Cachoeiras de Macacu, Brazil

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Deforestation and forest degradation activities are the biggest source of Greenhouse Gas (GHG) emissions in Brazil. Reducing Emissions from Deforestation and Forest Degradation (REDD+), developed under the United Nations Framework Convention on Climate Change (UNFCCC), is one mechanism that could help address both climate change mitigation and sustainable forest management including biodiversity protection and poverty reduction. REDD+ strategies aim at making forests more valuable standing than deforested, by assigning a financial value for the carbon stored in them. The overall goal of this research is to determine the feasibility of REDD+ to support suitable land and forest management in the municipality of Cachoeiras de Macacu. The municipality is located in the state of Rio de Janeiro within the highly fragmented Mata Atlântica biome. The research is based on an environmental governance analysis at the national, regional, and local scales. The elements of the environmental governance frameworks were contrasted with the elements of the REDD+ framework as the baseline, scope, funding instruments and, distribution mechanisms, in order to identify the strengths, weaknesses, opportunities, and threats for the incorporation of the mechanism in the study area. This analytical exercise allowed drawing conclusions about the major challenges that the incorporation of the mechanisms faces in the study area. The landownership hereditary system, intensive industrial and urban growth, lack of knowledge of REDD+ by authorities and inconsistencies in the law represent some of the major obstacles to define the scope into the study area. Nevertheless, the existence of public and private initiatives such as the "Reservas Particulares do Patrimônio Natural" (RPPN), the "Plano de Areas Verdes," and the creation of "Monumentos Naturales," open a window of opportunity for the development of subnational REDD+ initiatives.

Keywords: Cachoeiras de Macacu, environmental governance, feasibility, Mata Atlantica, political ecology, REDD+

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Climate Change Adaptation, Mitigation and Livelihood Benefits in Coffee Production: Where are the Synergies?

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Worldwide there are approximately 4.3 million coffee producing smallholders generating a large share of tropical developing countries' Gross Domestic Product, notably in Central America. Their livelihoods and coffee production are facing major challenges due to projected climate change. A temperature increase of 2.4 °C means that more than 50 % of today's coffee producing areas in Central America will become unsuitable by 2050, whereby some may continue growing coffee under adequate adaptation practices.

To assess potential synergies between climate change mitigation and adaptation in smallholder organic coffee production systems, we quantified (i) the potential of changes in organic coffee production and processing practices as well as other livelihood activities to reduce net greenhouse gas emissions, (ii) organic coffee farmers' climate change vulnerability and need for adaptation, including the possibility of carbon markets subsidizing adaptation.

We worked with smallholder organic coffee farmers in northern Nicaragua, using workshops, interviews, farm visits and the Cool Farm Tool software to calculate greenhouse gas balances of coffee farms. Twelve activities were found to be relevant for adaptation, whereby two showed strong and five showed modest synergies with mitigation. Highest synergies were found with activities outside of the coffee plots. These activities were afforestation of degraded areas with coffee agroforestry systems and boundary tree plantings.

The applied methodology allowed for a holistic assessment of the relevant livelihood activities of smallholding farmers to identify synergies between adaptation to and mitigation of climate change. This enabled the prioritization of climate-smart practices. Financing possibilities arise through carbon offsetting, carbon insetting, and carbon footprint reductions.

Keywords: Adaptive capacity, carbon footprint, carbon insetting, carbon offsetting, exposure to climate change, sensitivity to climate change, Nicaragua

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Women's Engagement in Climate Change Adaptation: Perceptions of Power and Knowledge in Western Kenya

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Global climate variability and shocks place growing pressure on the livelihoods, health, food production capabilities, and other aspects of the lives of the rural poor. Agriculturalists are particularly affected, making successful adaptation to the impacts of climate change critical for maintaining and improving resilience. Climate change adaptation often benefits from collective action, such as community-based adaptation approaches. Beyond the household and community benefits of these collective initiatives, group participation has been shown to increase social capital and empowerment for women, and is a determinant of asset accumulation. Likewise, women's empowerment has been linked with poverty reduction and increased investments in children, making it a critical ingredient in a sustainable development process. These issues are particularly significant in Western Kenya where livelihoods largely depend on rainfed agriculture and fishing. In addition, gender norms and power inequalities impact women's rural livelihoods and ability to cope with and adapt to climate change. In the context of collective action, these power inequalities may govern the ability of women to participate in and access group resources and to contribute their distinct knowledge and skills to the challenges at hand. Thus, it becomes critical to understand gendered concepts of power and knowledge and how they regulate the ability of women to engage in climate change adaptation. This study examines the socially constructed and gender disaggregated definitions of power and knowledge in three Western Kenyan farming communities. Taking an inductive analytic approach, qualitative data collection techniques – in-depth individual interviews, semi-structured small-group interviews, and participant observation – will provide the inputs for developing an empirically-based theory on gender, knowledge and power.

Keywords: Adaptation, Kenya, climate change, community-based approaches, gender, knowledge, power, sensitizing concepts, smallholders

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Gender, Assets and Climate Risk Management in Kenya

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Farmers in Kenya are adapting to climate change but are constrained by lack of accurate information and finances. Apart from socio-economic constraints, other factors may as well hinder farmers from adapting; which include personal values and ability to act collectively. The overall objective of this study is to assess the potential for group based approaches in enhancing adaptive capacity and resilience to climate change. The study also assess the gender differentiated adaptation options and the role of group based approaches in risk management especially dealing with shocks and assets accumulations and if adaptation to climate change help in protecting assets from climate shocks. The study uses panel data whereby households interviewed in 2009 were re-visited in 2012. Data collection relied on a mixed-method approach, including household surveys and gender disaggregated participatory rural appraisals (PRAs) in each site. A total of 360 balanced panels are used for the analysis. Preliminary results on shocks on assets using fixed effects model shows that drought and floods have a negative impact on livestock assets. Market shocks have a negative effect on small animals. Membership to community based organisation (CBO) help households in accumulating livestock assets, and this suggests the important of local institutions in dealing with shocks. Findings on gender and climate change adaptation indicate gender differences in crop and livestock production and adaptation. Women are adapting more in crops while men in livestock production. Regarding access to extension, men have high access to extension services and other climate related information than women. Findings suggest that groups are conduits for sharing knowledge, experience and agricultural information and increase the probability for dissemination of information on climate change and the appropriate adaptive responses. The study also finds that social capital increase the likelihood to access agricultural inputs and technical advice, as well linking farmers to output markets and in risk management such as credit access which are essential in adaptation to climate change.

Keywords: Climate change, gender, Kenya, livestock, shocks

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Rehabilitating Communal Assets in Rural Ethiopia – Governance Challenges and the Role of Women

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The rehabilitation of degraded watersheds in Ethiopia is an important approach to strengthen communities and their asset base, which in turn can increase resilience against climate shocks such as droughts and floods. Group-based approaches are typically used for watershed rehabilitation, especially on communal land. To ensure women's participation and access to assets is one important aspect in many of those initiatives, which include large-scale programs such as the Productive Safety Net Program (PSNP) and the Sustainable Land Management Program (SLMP). Most of the research has focused on the impact of those programs on outcome parameters such as poverty. Some governance aspects have been addressed, but comprehensive research on the diverse governance challenges that arise in the implementation of such programs is rather scarce.

Comparing different watershed rehabilitation projects, this paper analyses the effectiveness of different implementation mechanisms to address such governance challenges. The paper is based on data collected through the "Process Net-Map" method, a participatory mapping tool that makes it possible to learn from beneficiaries and implementers on the ground about potential governance challenges. Process Net-Map allows the researchers to understand the different steps of the implementation process, identify the actors involved, assess their level of influence on the outcome, and identify the "entry points" for governance problems.

The main implementation challenges lie in the level of community involvement and hence sustainability of the assets created, ensuring quality and timeliness in the procurement of material, avoiding leakage of funds and elite capture. Specific challenges arise regarding women's role in the programs, including enhancing female participation in decision-making bodies and ensuring their access to and profit from the communal assets created. Female participation in public works was studied as another sensitive topic, as projects need to balance women's double-burden of participating in public works and their high daily workload. The study assesses the strengths and weaknesses of different project implementation mechanisms to deal with these challenges and derives policy implications that aim to increase the efficiency and gender-sensitivity of programs that use group-based approaches to achieve watershed rehabilitation.

Keywords: Assets, ethiopia, gender, governance challenges, group-based approaches, watershed rehabilitation

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Gender Differentiated Asset Dynamics in Bangladesh

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Household welfare depends on a number of dimensions rather than only the financial one. Asset analysis is a crucial factor to understand the dimensions. There is evidence of disparities in men's and women's access to and control over assets. Different levels of asset ownership also have different effects on wellbeing of households and family members. For example, in Bangladesh, asset ownership by women relative to men increases expenditure on education in the family.

The overall objective of the study is to identify changes in gender differentiated asset ownership of agricultural households in rural Bangladesh by using panel data, and to see their socio-economic status by constructing asset index. Preliminary results show that natural capital such as land is mostly owned by men. However, ownership of other types of assets varies within and between households. A physical asset index is constructed by using both household durables and housing conditions by using principle component analysis. Nine components were extracted from twenty nine variables which explain about 70 % of the variation of the original dataset. The index was divided into five quintiles or socio-economic groups and mean difference between adjoining groups was calculated. Results show that for the poorest three quintiles, mean difference is not so high but gradually increasing, while for richer quintiles mean values differ largely. This reflects unequal distribution of socio-economic wealth among different people within the same group. Mean difference is 10.69 between the poorest and the richest group. To verify the asset index analysis, per capita consumption expenditure, which is a proxy of socio-economic status, was ranked in the same manner; the result supports the socio-economic ranking of the asset index.

Keywords: Asset dynamics, climate change, gender

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Farmers' Perceptions of and Responses to Climate Change in Nepal

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The study explores the farmers' perceptions of climate change and their responses to it in Nepal. Information was collected through focus group discussions (9 FGDs) and household surveys (225 HHs) in three tropical districts (Banke, Chitwan and Morang) of Nepal in 2011. Farmers responded based on their experiences of climate trends during the last ten years. Farmers perceived climate change as increased variability of temperature and rainfall, increased temperature (90.6 % HHs), shorter and warmer winter, changes in monsoon time (99.1 % HHs), reduction of annual rainfall (74.6 % HHs), decreased rainfall frequency (51.5 % HHs) and duration per event (75.5 % HHs), decreased winter rains, increased frequency of erratic rainfall, increased drought frequency and periods (60.8 % HHs), etc. The major effects of perceived changes included limited water availability (drying of streams, well), decreasing soil moisture, high fluctuations of crops yields and declining agricultural productivity, increased incidence of pests (*i.e.* snail worms) and diseases (92 % HHs), existence of unidentified pests (55.5 % HHs), emergence of new plant species (11.5 % HHs), environmental pollution, high risk in fish farming (water pollution), poor livestock health, decreasing earthworm population, shortening life cycle of crops by 10–15 days (*i.e.* rice, maize, wheat), low fruiting in fruit trees, fruits cracking (*i.e.* lime), changes in flowering and fruiting time (*i.e.* mango, jackfruit, guava), increased sand in soils due to flood, etc. Farmers also noticed the positive effect as automatic control of some pests (*i.e.* white fly in rice). Majority of farmers (92.8 % HHs) have already followed/ planned to follow some adaptation techniques such as shifting of agricultural calendar (56 % HHs), crop rotation (53.7 % HHs), crops diversification (36.4 % HHs), changes of crop types and varieties (65.7 % HHs), investment on irrigation (75.5 % HHs) *i.e.* purchase of water pumps, investment on plastic tunnels (33.7 % HHs), mulching to maintain soil moisture (27.5 %), traditional pest management (*i.e.* use of cow urine, ashes), more use of compost and FYM, provision of drainage canals in the field, agro-forestry practices, rain water harvesting. The study concludes that the farmers have perceived climate change and its effects on farming and have been trying to adapt to it.

Keywords: Climate change, climate change adaptation, farmers' perceptions

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Assessing the Vulnerability to Climate Variation of Farm-Households in the East of Thailand

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Thailand, a crucial agricultural zone, is facing climate variability and extreme events. At the regional level, the east of Thailand is a major fruit trees and rubber plantation zone. Climate variation is inevitably affecteing this essential agricultural region of Thailand. To guide a proper policy intervention, an assessment of vulnerability to climate variation plays an important role. The paper aims to assess the vulnerability index in the east of Thailand as well as farm households in Tha Mai and Khao Khitchakut districts in Chanthaburi province. Primary data of a 452 farm households and secondary data were utilised. The paper applies the vulnerability index classified into 3 factors based on Intergovernmental Panel on Climate Change (IPCC). They are 1) exposure: the nature and extent of changes to regions' climate variability, 2) sensitivity: the human-environmental conditions that can worsen the hazard, ameliorate or trigger an impact of climate variation, and 3) adaptive capacity: a process through which societies taking the measures to reduce negative effects of climate variation. The results show that among the 7 provinces in the east of Thailand, Trat was the highest vulnerable province and Rayong was the least one. The significant exposure factors were temperature, average precipitation by month and drought risk. The important sensitivity factor was agricultural water resources. Last, the crucial adaptive capacity factors were poverty incidence, gross provincial product and household workforce ratio. Chantaburi province as the study area was found to be a medium vulnerable province (0.4633). When considering the Livelihood Vulnerability Index, farm households in Tha Mai (the main fruit trees area) revealed lower vulnerability than those in Khao Khitchakut (the major rubber trees zone). Therefore, crop diversity, social integration and agricultural water management of farm-households are important adaptive strategies.

Keywords: Adaptive strategies, climate variation, East Thailand, vulnerability index

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Implementing REDD+ in Vietnam, Indonesia and Malaysia: Current Status and Perspective

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Reducing emissions from deforestation and degradation, forest conservation, sustainable forest management, and enhancement of forest carbon stocks (REDD+) is a high concern of the international agenda recently. Up to date, the progress of REDD+ in practice is still unclear, on how the mechanism can be implemented on the ground. This paper reviews how REDD+ is implemented in three Southeast Asia countries , namely Vietnam, Indonesia and Malaysia. The countries have been involved in the UN-REDD National Programmes and currently undergoing several REDD+ projects. It has so far been found that the initiative is appropriate with the national strategies with a very promising mechanism.

Vietnam, Indonesia and Malaysia have actively responded to the REDD+ initiative and committed to reduce the emission of greenhouse gases (GHG) at 20 %, 26 % and 40 % respectively, relative to business-as-usual (BAU) conditions by the year 2020. All of the three countries have adopted strategies to put REDD+ into practice with the 'National REDD+ Action Plan' in Vietnam, the 'Strategy of 26/7' in Indonesia and the 'National Strategy on REDD+' in Malaysia. Many legal documents have been identified as supporting to the REDD implementation in the respective countries. The three countries have also received different amount of financial supports from bilateral/international partnerships to implement REDD+ via projects until 2017. It is approximately USD118.8 million for Vietnam, USD1,000 million for Indonesia, and USD11.4 million for Malaysia. With these supports, the respective countries have implemented a number of activities on REDD+ such as sharing of information and experience, capacity building, policy dialogue and cooperation opportunity seeking.

The REDD+ is complicated and until today the countries are still in readiness process. Technical operations are identified as a big challenge for REDD+, particularly when it comes to the implementation at national or nested (sub-national programs, within the national system) level in Southeast Asia. There are outstanding issues of unclear pathway how to verify and determine the monitoring, reporting, verification system (MRV), benefit distribution system (BDS), and carbon market mechanism. Thus a failure to mobilize the REDD+ funds will deflate the enthusiasm to implement REDD+ activities on the ground, which means a serious delay of REDD+ implementation at the expense of both the communities that are dependent on forest resources, and the global population from continued destruction of primary forests.

Keywords: Implementation, Indonesia, Malaysia, REDD+, Vietnam

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Adoption of Land Use Options as Adaptation to Climate Change in Northern Benin, West Africa

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Land use decisions play an important role in farm management. Subsequently, supporting the farmers' practices related to land use management in times of climate change might be a relevant policy intervention for enhancing livelihoods and food security in rural areas. This study investigated the land use strategies implemented by farmers as a means of adapting to climate change. Interviews with key informants and group discussions with farmers were organised in four agro-ecological zones in northern Benin. As well, a household survey was conducted on 336 farmers to further highlight the main factors determining the farmers' decision to adopt the identified climate change adaptation strategies related to land use, using a Multivariate Probit (MVP) model. Crops association/rotation, land re-allocation, soil erosion control, and change of site are the four land use related options identified as adaptation to climate change. About 89 % of the farmers adopt at least one of these options. The socio-economic and demographic characteristics of the respondents determine whether they adopt one or another adaptation strategy related to land use management. On the one hand, the choice of land use options as adaptation strategies to climate change is positively linked with the farmer's experience in agriculture, participation in off-farm activity, and the available land. On the other hand, organisation membership and access to credit have negative effects on farmers' choice while contact with extension and household size have mixed effects. Therefore, targeting farmers that are least advantaged socio-economically may enhance their choice of adopting land use management as adaptation to climate change.

Keywords: Adaptation, Benin, climate change, determinants, land use management

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Adaptation to Climate Change in Agriculture and Livestock – The Case of Bangladesh

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Bangladesh is identified worldwide as one of the countries most vulnerable to climate change, owing to the densely populated coastal area and half of the citizens living below the poverty line. With the increasing threat of climate change, farmers need to find strategies to adapt. Adaptation is an effective way to manage long-term adverse impacts of climate-related shocks and reduce vulnerability. It requires farmers to perceive that climate is changing and become aware of the available adaptation strategies to choose from among a set of options in their own regions.

This paper seeks to explore different types of adaptation strategies farmers adopt, the determinants of adaptation strategies and constraints of adapting, differentiated for male and female headed farmers in rural Bangladesh. The study used panel data collected in 2010 and 2012 in Bangladesh to find the determinants of adaptation. Preliminary results find that 93 %of male headed households undertake adaptation strategies while the share is 75 % for female headed households. Furthermore, they suggest that total asset values, access to electricity, livestock holdings, receiving scholarships, are important positive determinants of adaptation. Off-farm employment is negatively related to agricultural adaptation. Men have a higher access to extension services than women. Gender-differentiated constraints to adaptation strategies are lack of information about climate change, shortage of money, no access to inputs and shortage of water among others. The paper provides a set of options of available adaptation strategies by region, which is important for identifying locally-appropriate policy interventions in rural Bangladesh.

Keywords: Adaptation, climate change, gender

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Strengthening Climate Change Adaptation: Are Farmers Willing to Pay for Related Agricultural Extension Services?

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Adapting to climate change is one of the most important challenges for agricultural development in Sub-Saharan Africa. In such context, the agricultural extension institutions are expected to provide additional climate related information to raise farmers' awareness on climatic uncertainty to some extent. This study analysed the farmers' willingness to be informed and to pay for agricultural extension services related to climate change. It was conducted in four agro-ecological zones in northern Benin through a survey method on respondents, using structured interviews based on a questionnaire. A total of 336 smallholder farmers were randomly sampled in the study area. As a result, farmers were aware of climate change and adapt their farming system. They were very willing to be informed about both climate change predictions and documented adaptation strategies. However, they were willing to pay more for documented climate change adaptation strategies than for climate change predictions. The Heckman Probit and the Seemingly Unrelated Regression models highlighted that age, respondent's level of education, experience in agriculture, access to credit, contact with extension service, perception of and adaptation to climate change, farm size, and organisation membership have significant and differentiated effects on the farmers' willingness to be informed and to pay for agricultural extension services related to climate change. As policy recommendation, climate change information generated by provided by the scientific community should be widespread. The extension institutions need to be reinforced by hiring personnel and providing them with valuable information in order to fulfil the needs of farmers. This raised the extension officers' capacity building issue which should be addressed as well.

Keywords: Benin, climate change, extension services, willingness to be informed, willingness to pay

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Procedures for Preventing a Water and Food Crisis in Egypt under Future Climate Change Employing Remote Sensing

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Egypt is one of the most vulnerable countries to prospective impacts and hazards of climate change. The hazards will touch major resource sectors including water, land, coasts, and agriculture. Many climate scenarios predict that rainfall in the Nile basin will be highly sensitive to climate change and, consequently, might affect the Nile flow into Lake Nasser. Moreover, the temperature rise will influence evaporation from Lake Nasser, as well as the evapotranspiration from agricultural lands, leading to lower crop yields. In addition, the Nile delta, supporting 40 % of the Egyptian population and most fertile lands, is vulnerable to impacts of sea level rise that might affect over 760 km^2 by the year 2100 including costal and agricultural lands due to seawater intrusion and increased groundwater salinity. Actions must be taken to diminish the climate change hazards. The major actions must consider human migration from the delta to south of Egypt providing them with opportunities for agricultural and industrial activities. Other measures might be taken to decrease the evaporation losses from Lake Nasser through reducing the water surface area. This study analysed three alternatives: (i) constructing a new dam at 130 km upstream the High Aswan Dam, (ii) eliminating Khor Kalabsha, and (iii) integrating both alternatives together. Landsat TM images were used to simulate the lake morphology at different water levels to model the lake hydrological characteristics. The results demonstrated that alternative (iii) will save about two billion cubic meters of water by the end this century, in addition to providing 1200 km^2 of land for settlement of migrated population from the northern coast.

Keywords: Climate change, evaporation losses, Lake Nasser, landsat images, sea rise

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Perception and Adoption Processes Regarding Index-Based Insurance for Managing Climate Risks in Agriculture in Benin

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Agricultural production, pillar of food security and economic growth in African low-income countries, is genuinely affected by climate change. Nowadays, index-based risk transfer products occupy an important place in international discussions on coping and adaptation strategies. This study was carried out in rural Benin to investigate adoption processes in order to provide likely pathways of success of such mechanisms well believed to improve livelihoods of agricultural households. Sixty cotton and food crops farmers in the district of Banikoara in northern Benin, regularly courted by three companies, promoters of index-based insurance, supplied empirical data through semi-structured interviews. The mixed approach used has combined content analysis of key informant discourses and statistics. Spearman's rank correlation was used to supply local index-based insurance model suggested by farmers. The results showed that: (i) the problems of existing agricultural funding mechanisms, the recent national scandals over money investment and the lack of outreach services lead to the rejection of crop index-based insurances in rural areas; (ii) the involvement of authorities in charge of agriculture in the shaping and the monitoring of insurance products as well as the engagement of farmers' organisations in decision-making and extension processes represent an important safeguard for grassroots farmers; (iii) index-based insurances are blamed to be weakly specified in respect of the heterogeneity prevailing in agricultural communities and the climate risks diversity; (iv) farmers opt for an insurance model which cover three major hazards (droughts, floods, crop fires) and simultaneously two crops (cotton and one food crop) with some margins for animal divagations. The potentially adoptable insurance contract includes a one-year trial agreement, a monthly willingness-to-pay of 5000 FCFA ($10), a quarterly option to pay and a systematic compensation during the same month of unforeseen damages. Integrating this endogenous design in climatic insurance policies should help improving farmers' capacity to adapt to environmental changes so as ensuring production systems sustainability.

Keywords: Agriculture, Benin, climate change, index-based insurance, perception and adoption processes

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Livestock Wealth and Social Capital as Insurance against Climate Risks: A Case Study of Samburu District in Kenya

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We explore whether households accumulate livestock wealth, structural social capital (SSC) and cognitive social capital (CSC) as we move from wetter to dryer environment in Arid and Semi-Arid Lands (ASALs) using data collected from 500 households from Samburu District, Kenya. We hypothesised that households accumulate livestock wealth, structural and cognitive social capital as insurance against risks and shocks associated with climate. To test these hypotheses we used simple regression (SLR) and a generalised linear model (GLM). To implement GLM, we reduced dimensionality of household level variables through agglomerative hierarchical clustering to arrive at three homogenous households groups (HG's) namely; wealthy (HG1), poor (HG2) and the financially integrated households (HG3): also used in computing interaction terms. Results from both SLR and GLM supported hypotheses that households accumulate more livestock wealth and structural social capital as we move from wetter and dryer environments. However, results from SLR showed that rain was not important in explaining variation in cognitive social capital (trust) for all households as we move from wet to dryer areas. Nevertheless, GLM results showed that rain matters for CSC for the HG2 and HG3 but not HG1. The accumulation of CSC was therefore not generalisable but was rather contingent on household resource endowment. To improve households coping and adaptation capacity, it is therefore desirable to promote measures aimed at enhancing livestock wealth and SSC (*e.g.*, membership to community groups) as form of insurance for household in ASALs. The results also showed that measures (*e.g.* investing time in relationship to develop trust) aimed at enhancing CSC can help poor households as a social insurance to cope and adapt to climate risks.

Keywords: Climate change, cognitive, insurance, Kenya, livestock, risk, social capital, structural

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Weather Risk, Agricultural Investment Decisions and Farm Profits

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This paper aims to analyse the impact of weather risk on farm profits in the context of a developing country. Weather risk can impact farm profits both directly through its contemporary effect on crop growth and indirectly through its influence on the farmer's investment decision. In an extension to the existing literature, this paper seeks to separate the two effects and analyse their different policy implications. Therefore, both a measure of total contemporaneous rain in the respective cropping season and the first three moments of the rainfall distribution prior to the farmer's investment decision are included in the analysis. For empirical investigation, this paper uses six rounds from the Ethiopian Rural Household Survey and combines them with detailed geocoded monthly rainfall data. Testing for separability between the farmer's production and consumption decision confirms that risk considerations should enter the profit function. The farmer's profit function is then estimated by a benchmark fixed effects regression according to the Mundlak procedure to account for farmer-specific fixed effects. In a second step, the model is extended and estimated by a quantile regression to allow for varying effects of rainfall on different conditional quantiles of the profit distribution. Finally, also a dynamic panel model specification is used to take dynamic effects of profits into consideration. Results suggest that smaller low-profit farms are most affected by the direct impact of rain on crop yield and thus profits, whereas rainfall risk prior to the investment decision is most relevant in determining current profits of high-profit farms.

Keywords: Farm households, risk and uncertainty

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Food consumption, consumer preference and human health

Nutrition-Sensitive Agriculture for Rural and Urban Health

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A growing world population with 9 billion predicted by the year 2050 and rising numbers of malnourished people — currently approximately 870 million people undernourished and more than two billion people nutrient deficient, increasingly in urban areas — put pressure on our current global agrofood systems. Nutrition-sensitive agriculture aims to provide a framework to narrow the gap between available and accessible food and the food needed for a healthy and balanced diet for all people. Nutrition objectives are explicitly incorporated into agriculture and address the utilisation dimension of food and nutrition security, including health, education, economic and social aspects. Based on this concept, a study was carried out to take stock of existing innovative approaches to improve the positive nutrition-related impacts of agriculture and related food systems. An overview on specific cross-cutting themes relevant to nutrition-sensitive agriculture and examples from various countries on how nutrition objectives can be incorporated into rural and urban agriculture and food systems are provided which allowed the identification of commonalities and parameters that are cornerstones, within which local nutrition-sensitive agriculture approaches will have a realistic chance of succeeding. These cornerstones are seen as entry points into systems in which all variables are interlinked and contribute to a balanced nutrition of the population. By changing or fine-tuning one or more of these cornerstones, the entire system can be improved. The study also highlights the current fragmentation in approaches towards more nutrition-sensitivity in agriculture and concludes that, where collaborative approaches are undertaken, there is a greater likelihood that shared projects will be implemented and/or be successful. Recommendations have been formulated to aid the development of future nutrition-sensitive programmes for rural and urban areas.

Keywords: Agriculture, agro-food system, biodiversity, gender, health, marketing, nutrition, policies, processing, production

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Linking Agriculture and Nutrition: Dietary Diversity of Women and Children in Different Agro-Ecological Zones of Western Kenya

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The diversity of diets is crucial particularly in the developing world where diets consist mainly of starchy staples and lack nutrient rich foods. To improve dietary diversity and quality, the role of agrobiodiversity in nutrition and health needs to be better understood. The objective of this study was to assess the possible relationship between dietary diversity and on-farm agrobiodiversity in rural western Kenya.

A nutrition survey was conducted involving 596 randomly selected mothers with children aged 6–23 month in six different agro-ecological zones (AEZs). Semi-structured questionnaires were used to assess socio-economic factors and food intake. A wealth indicator and dietary diversity scores (DDS) were compiled for the household (HDDS), women (WDDS) and children (CDDS) according to FAO guidelines (2011). Anthropometric measurements of women and children were taken. Farm richness (crop species) was counted for a sub-sample of 60 farms during the short rainy season.

The CDDS (mean=3.7) was below the minimum for an adequate diet of four food groups per day for 45 % of children; HDDS (mean=6.8) and WDDS (mean=4.2) were rather low for the study population. Stunting was typical for the study area with 20 % of children being moderately stunted and 10 % severely, while 9 % of mothers were underweight, 13 % overweight and 5 % obese. Both the HDDS ($p < 0.001$) and WDDS ($p = 0.038$) differed significantly between AEZs with the transitional lower-midland 4 (LM4) zone having the highest values for HDDS and WDDS being highest in both LM4 and semi-humid LM3. Also farm richness (mean=16 crop species/farm) differed significantly between AEZs ($p = 0.033$) with the highest richness in LM3. All three DDS were not correlated with farm richness, yet, significantly correlated to the wealth index of a household (all ps$<$0.001).

In summary, a low diversity in individual diets in western Kenya is present within lower wealth households. While there is a trend for women's diets being more diverse

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in areas of high on-farm crop richness, on-farm crop diversity might be less crucial for dietary diversity than other food sources such as animal source foods and market foods in order to achieve a diverse and healthy diet for all household members.

Keywords: Agro-ecological zones, agrobiodiversity, dietary diversity score, Kenya

Consumer Preferences and Influencing Factors for Purchase Places of Organic Food Products: An Empirical Evidence from India

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The market for organic products in India is at the early stage of its development. There is no sufficient knowledge about organic consumers in India. In this regard the present exploratory study was conducted to gain knowledge about consumer preferences and factors influencing the degree of consumer preferences for purchase places of organic food products in India. The consumer preferred places of purchase and socio demographic characteristics of the consumers were collected by means of face to face interview with 201 consumers by using simple random technique at different purchase places. The analysis was carried out in two steps. In the first step, simple ranking procedure was applied to calculate a measure of preferences. In the second step consumer preferences were regressed upon the consumer specific variables to know the consumer specific characters influencing on purchase place preferences. The data obtained from the survey were analysed with descriptive statistics, Friedmen's test, Kendall's W test and seemingly unrelated regression. The results reveal that the most preferred purchase places for organic food products are specialised organic stores and supermarkets. The least preferred purchase places are local open market and conventional retail shops. Further the results from seemingly unrelated regression showed that the preferences about places to purchase organic food products are mainly influenced by gender, education, family size and family income. Policy makers in agricultural marketing, institutions who are involved in organic food marketing and producer should consider the differences in consumer preferences and socio-demographic attributes of consumers for determining and supporting efficient marketing channels for organic food.

Keywords: Products, consumer preference, organic food, purchase place, seemingly unrelated regression model

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Youths Awareness and Consumption of Functional Foods in Nigeria: The Case of Plantain Flour

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The rural-urban interface is creating life style changes such as the awareness and consumption of functional foods. This has the potential of generating sustainable income and reducing post-harvest losses for producers and processors but consumer attitude and response to such foods, hence the sustainability of the markets, needs to be examined. This study examined consumers' awareness and knowledge of plantain flour among youths in Ibadan. It also examined the factors which drive their decision to choose it as a main staple. A random sample of 150 consumers ranging between the ages of 18-31 was chosen and data collected with the aid of a structured questionnaire. The data were analysed using descriptive statistics and binary logistic regression. The results showed that young female adults were more inclined to try the product, but were not aware of its alternative uses. It also revealed that though plantain was regularly consumed in its fried form, the knowledge of its health benefits as flour was quite poor. The most prominent knowledge about it is its usefulness in controlling diabetes (by over 60 %). Logistic regression shows that the probability of consuming plantain flour is affected by the availability of other acceptable staples (cassava) and their relatively cheap prices. Young people consider it to be expensive and useful only for older and sick people. The results indicate that positive life style changes may not be occurring among young educated people, but more importantly the gap in knowledge implies that a large market for plantain flour is yet untapped. The gap can be filled by a broad based, consumer oriented marketing policy.

Keywords: Awareness, consumption, functional foods, youths

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Indigenous Knowledge and Practices Related to Food Preparation and Preservation in a Bedouin Community, Egypt

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Bedouin indigenous knowledge and practices systems are territorial treasures, generated by local people, that need both documentation, to assure their territorial rights, and innovative arrangement to maintain their socio-economic, cultural and environmental integration. These systems must be assimilated with contemporary research agenda and results to enable Bedouins, especially women, to face socio-economic challenges and mitigate and adapt to the negative effects of climate change as well. Women, who represent about 43 % of the agricultural labour force in developing countries, are increasingly recognised as important actors in these systems. Within the household, they are responsible for food preparation and food preservation.

The main objectives of this study were to: 1) Investigate and document the indigenous practices related to food preparation and preservation in the studied area, 2) Identify coping mechanisms used to overcome challenges 3) Identify challenges facing Bedouin women related to food preparation and preservation.

The study was conducted in Bedouin communities of Matrouh Governorate, located at the Northern Western coast of Egypt. A semi-structured check-list was designed and utilised during focus-group discussions and individual personal interviews with Bedouin women to collect the qualitative data related to the study objectives.

The study documented the plant and animal sources of foods and different practices of preparation and preservation which suit the dry weather and scarcity of water. Food preparation and preservation practices reflect the socio-economic, cultural and environmental conditions prevailing in the tough desert nature that Bedouin women live. These practices and conditions could provide researchers and development specialists with necessary guidelines to verify, develop the IKPs and support them with latest scientific developments to upgrade their capacities for better coping with the harshness of nature.

Keywords: Bedouin community, Egypt, food preparation and preservation, indigenous knowledge and practices

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Evaluation of Linseed (*Linum usitatissimum* L.) Collections from Ethiopia for Oil Quality Parameters

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Linseed (*Linum usitatissimum* L.) has multi-purpose role for human nutrition, animal feed and also for industrial purposes mainly as a source of drying oil and fiber. It is an important oil crop in Ethiopia because of its high nutritive value, though little is known about the quality of traditional genotypes grown by farmers. A total of 120 linseed collections from 21 districts in Ethiopia were grown at Holetta Agricultural Research Center/Ethiopia in 2011 for oil quality evaluation purpose and for producing uniform seeds for replanting in the next multi-location variety trials. The layout of the field experiment was an augmented design with three blocks and six check varieties (controls). Each plot contains two rows with two meters length and 0.2 meters inter-plot and inter-row spacing. Analysis of oil quality parameters including fatty acids (palmitic acid - C16:0; stearic acid - C18:0; oleic acid - C18:1; linoleic acid - C18:2; and linolenic acid - C18:3), iodine value compositions were conducted using standard procedures at the Grain Research Laboratory in the Canadian Grain Commission. The results showed that all saturated fatty acids except palmitic acid had highly significant ($p < 0.01$) variability amongst the accessions. Palmitic acid content was significantly different ($p < 0.01$) amongst the control varieties, but not in the accession and control-variety interactions. In contrast, all unsaturated fatty acids except linoleic acid depicted non-significant variability amongst the collections at 95 % level of confidence. Similar to linolenic acid, iodine values of the collections were not significantly different at 95 % level of confidence. Based on the findings in this study, a number of promising genotypes were identified for linseed oil quality improvement.

Keywords: Cyanogenic glycosides, Ethiopian highlands, linolenic acid, oil crops, traditional varieties

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Effects of Socio-Economic and Demographic Variables on Vietnamese Households' Expenditure for Dairy Products

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In this study, Vietnamese households' expenditure on dairy products for home consumption is analysed using the latest Vietnamese Household Living Standard Survey datasets from 2010 (VHLSS 2010). Vietnam is the 20th most important importer of dairy products in the world and it is foreseeable that the demand continues to rise. This makes Vietnam become a highly potential market for investors in the dairy industry. The aim of the paper is to analyse the effects of socio-economic and demographic variables on Vietnamese households' decision to purchase dairy products and how much to spend per capita on these items. Three double-hurdle models are estimated to accommodate non-normal and heteroskedastic errors for fresh milk, milk powder and yoghurt. The parameter estimates for the purchase and demand decision variables are presented. The results suggest that the effect of income on household expenditure on dairy products is positive and significant. Household characteristics are found to be significant in affecting dairy products' expenditure. For instance, urban households, female-headed households, and households that have children aged under seven years old, all have a greater preference than other households. Age and education have positive effect on the probability of consumption and quantity of products consumed. The results of this study help to understand how the changing socio-economics and demographics of the Vietnamese population impacts households' dairy products expenditure. This understanding may help policy makers to implement policies related to the dairy industry, nutrition and food security. The results also are useful for dairy product marketing, for planning and developing strategies, because they will understand the influence of household characteristics on the decision if products are consumed and how much is consumed.

Keywords: Dairy products, double-hurdle model, household expenditure, VHLSS, Vietnam

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Meat Consumption Patterns in Vietnam: Effects of Household Characteristics on Pork and Poultry Consumption

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This study relates socio-demographic characteristics of Vietnamese households to their consumption of meat. Tobit models are estimated drawing on the latest Vietnamese Household Living Standard Survey in 2010 (VHLSS 2010). Pork and poultry are the most important meat types consumed in Vietnamese households. Increasing pork and poultry consumption has strongly contributed to the total meat consumption growth. The analysis of demand for pork and poultry in Vietnamese households demonstrates that the meat demand in Vietnam is significantly affected by socio-economic and geographic factors. The effect of increased income and urbanisation on pork and poultry consumption is positive, as expected. The study findings also suggest that the per capita meat consumptions with different demographic variables of the household sample show a decreasing trend of meat consumption per capita with respect to household size, being ethnic minority people and female household head. The change in food consumption has occurred for the whole country which has implications for Vietnamese policy makers and traders. Understanding meat consumption patterns will help policy makers to implement measures to ensure food security. The policies may address food redistribution between rural and urban areas, ethnic groups, the poor and the rich. Improvement of infrastructure, especially the transportation system, can support production and exchanges between regions. In addition, food firms who wish to invest in the food market in Vietnam have to understand meat consumption patterns and meat demand to develop appropriate business strategies. The preference of Vietnamese customer for fresh (warm) meat has been an obstacle for frozen, imported meat. The growing shortfall in Vietnam's domestic supply of meat leads to opportunities as well as threats for foreign exporters.

Keywords: Household consumption, meat consumption, tobit model, VHLSS, Vietnam

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Fatty Acids, Health and Risk Indices of Organic and Conventional Produced Milk in Southeastern Mexico

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Changes of diet have released undesirable effects on human health related to a high ingestion of saturated fat and low consumption of fiber. The efforts to identify healthier food products to counteract this public condition are mandatory. Organic farming has probed to provide animal products with compounds that may help to maintain human health. However, in tropical conditions, scarce investigations have been carried out to demonstrate the advantages of organic compared to conventional products. We investigated fatty acid content, thrombogenic index and health promoting index of both organic (OM) and conventional (CM) milk from humid tropical southeastern Mexico. Cross-breeds (Cebu-holstein, cebu-american swiss), incluiding ages from three to ten years, with two and eight births and weights from 400 to 600 kg were employed. OM farms were characterised by grazing on pastures ranging from free tree areas to complete forested vegetation. CM grazed on similar conditions but using standard management incluiding grain supplement. Milk was collected manually once in the morning from Januray to June of 2009. Three samples were taken monthly after milking on the bulk tank. Fatty acids were quantified by GC. Thrombogenic (TI) and health promoting index (HPI) were calculated: TI=(C14:0+C16:0+C18:0)/[(0.5 MUFA)+(0.5 n-6PUFA)+(3n-3 PUFA)+(n-3 PUFA/n-6 PUFA)]. HPI=(n-6PUFA+n-3 PUFA+MUFA)/[(C12:0+(4xC14:0)+C16:0)]. The results were analysed using SAS (α=0.05). CM had larger values of SFA (63.7 %) than OM (61.48 %), whereas OM had larger values of MUFA (34.3 %) than CM (31.7 %). PUFA showed an inverse trend for SFA and MUFA *i.e.* PUFA was larger in CM (4.6 %) than in OM (4.1 %). However, for CLA (C18:2 cis-9,trans-11) no differences were observed (1.09 and 1.14 % for OM and CM, respectively). SFA in OM increased from January to June. In contrast, PUFA and CLA in OM tended to be lower as the year advanced. MUFA were steady throughout the sampling period. TI was higher (less healthier) from March to May. In agreement, HPI had the smallest (less healthier) value in April and May. Both OM and CM provide considerable amounts of desirable fatty acids; however it would be prudent to increase their concentration in both milks for human health benefits.

Keywords: CLA, fatty acid, human health, organic milk, sustainability

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Vulnerability of Residents in Southern Benin (Western Africa): Settlement Risks, Levels of Income and Access Ability to Health Care

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Exponential demography, overexploitation of natural resources, frequent floods: today, there are numerous reasons which explain the fragility of the coastal area of Benin, already weakened by climate changes. The most exposed part of the population contains various branches of business of the primary sector, particularly small traders, craftsmen, farmers and fishermen.
This study is related to the analysis of the existing aquatic ecosystems within coastal areas and to the evaluation of vulnerability of the population in this area. Specifically, it quotes various pollution sources of surface water. It also evaluates the impact of water quality on the health of the population and their capacity to satisfy their elementary needs.
The samples of 162 households, 17 village councillors and 17 hospitals were the basis of the investigations.
The results indicate that the frequency and the extent of diseases such as malaria, diarrhea, dermatosis, and cholera confirm the various forms of water use in the localities situated in the border area of coastal waters. The relations between the sanitary situation of the population and the quality of used surface water are elucidated by the factorial analysis which reveals a weak dependence ($p = 0.5$) considering households and a clear independence (p=1.0) for hospitals. While imposing new research on water of domestic use, these results partly explain financial limits of the populations in the frame of real sanitary care because of the low incomes which they collect from their activities already affected by the degradation of coastal space. To relief the distress of "vulnerable people", it is essential to cleanse the coastal zone and simultaneously to disburden it. In this context, it is strategically important to determine the causes of migrations, to analyse the modes of land use, to appreciate the local development plans and to stimulate mobility (according to a national distribution of virtual solutions to migratory movements).

Keywords: Activities, Benin, coastal area, health, income, pollution, residents, surface water, vulnerability

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Fruit Intake and Nutritional Status of Young Children and their Mothers/Caregivers in Rural Western Kenya

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In Kenya high prevalence of malnutrition (stunting, wasting, and underweight) and micronutrient deficiencies including vitamin A exist, particularly in rural areas. Increased cultivation and consumption of fruits may help farming households to address malnutrition, but little information is available on the current on-farm fruit tree diversity and use. This study aimed at assessing fruit intake and nutritional status of children under five years of age and their mothers/caregivers in rural Western Kenyan households.

A descriptive, cross-sectional two cluster study was performed including 96 children under five and their mothers/caregivers from 96 randomly selected rural households in Busia and Kakamega counties, Western Kenya. Mothers/caregivers were interviewed on basic socio-economic data, household food security, household dietary diversity (HDD), and dietary intake (24-hour recall). Weight and height/length of children and mothers were measured and z-scores of weight-for-age (WAZ) for underweight, height-for-age (HAZ) for stunting, weight-for-height (WHZ) for wasting and body mass index (BMI) of mothers calculated following WHO 2006 standards.

Out of the 96 children, 2 %, 25 % and 9 % were wasted, stunted and underweight, respectively, with slightly higher prevalence in boys than girls. Of the mothers, 5 % were underweight (BMI <18.5) and 22 % overweight (BMI 25.0–29.9). The mother's BMI had a significant weak positive correlation on weight, WAZ and WHZ of the child. While number of food groups consumed had a significant weak positive correlation on the child's weight, HDD-score had no significant correlation with any measured anthropometric indicator of the child. Regarding food security, 67 % of mothers/caregivers did not produce enough food and 97 % not enough fruits at their farms to last them until the next harvest season, partly due to lack of agricultural inputs *e.g.* seeds. A total of 39 % mothers/caregivers reported that fruits often are not available from local farms and shops. Only 18 % of respondents consumed one vita-

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min A-rich fruit such as mango or papaya the day preceding the interview and only 34 % consumed any other fruit such as lemon or guava during that period.

There is need to create awareness on the importance of fruit consumption in western Kenya to improve nutrition and health of children and mothers.

Keywords: Anthropometric indicators, dietary diversity, food security, malnutrition

Natural Means of Rectifying the Micronutrient Deficiency Problems in Africa

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A test of nutritional adequacy of the diets in Africa indicated a deficiency of calcium in all countries, and poor levels of vitamin A, Fe and folic acid in some countries. In view of the composition of the diets which predominantly (>70 %) consist of staple food, it is not surprising to encounter micronutrient deficiency problems. The levels of vegetables and meat in the diets of East Africa (80 g and 30 g per capita and day, respectively) are markedly lower than the world average (280 g vegetables and 112 g meat per capita and day).

African indigenous legumes excel staple foods by an average of 360 % in both calcium and iron. Rich sources of calcium are rice bean (200 mg Ca/100 g), soya bean (186 mg Ca/100 g) and leafy vegetables (kale, baobab leaves and cabbages with average Ca content of 185 mg/100 g). The leaves of pumpkin, sweet potato, cassava and moringa with their calcium content of 246, 272, 403, 584 mg/100 g, respectively, have great potential of complementing the staple diets. Rich sources of iron include pigeon pea (15 mg Fe/100 g), bambara nut (12 mg/100 g) and a variety of beans ($\sim$ 10 mg/100 g). The daily consumption of 100 g kale, cabbages or musk pumpkin can satisfy the requirement (4 mg day^{-1}) for beta carotene, the precursor of vitamin A. The leaves of sweet potato, pumpkin, cassava and moringa with their beta carotene content of 18 mg, 21 mg, 101.4 mg and 118.2 mg per 100 g, respectively, are rich sources of vitamin A.

The legumes and vegetables used as supplements for calcium, iron and vitamin A are also rich in folic acid. The fermentation of cereals and their products prior to food preparation can still raise the folic acid content to a level which when served with legumes can satisfy even the requirements of pregnant women.

A supplement of most pulses to a level of about 200 g d^{-1} and that of fresh leafy vegetables to a level of about 400 g d^{-1} can potentially meet the daily requirement for the critical micronutrients. Draught resistant leguminous plants (bambara beans, cowpea and lablab) are not only useful in enriching the daily diet but they can also be intercropped with cereals restoring nitrogen in the soil and repairing the degraded farm land.

Keywords: Africa, calcium, folic acid, iron, legumes, nutritional adequacy, staple food, vegetables, vitamin A

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Spatial Pattern of Human Water Contact Activities and *Schistosoma haematobium* in Owalla/Erinle Reservoir, South-West Nigeria

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Schistosomiasis is one of the major parasitic diseases in the world in terms of people infected and those at risk. It is acquired by swimming or wading in freshwater bodies harbouring the snail intermediate host of *Schistosoma* spp. Research has shown that the disease is endemic in Osun State and remains unabated. Schistosomiasis infection, landuse/landcover (LU/LC) change detection pattern of the five communities and human water contact activities (HWCA) were thus essentially linked, and more knowledge about their relationship will help us to develop appropriate control measures. So far, only few studies have employed the use of geographic information systems and remote sensing (GIS and RS) in mapping and prediction of diseases in Nigeria. This study pioneers such and will serve as a reliable baseline data for intervention planning in the state. A detailed observation of HWCA in the study communities was carried out in six sites once every month from 0700 hr. to 1900 hr. for 24 months. A global positioning system (GPS) was used to locate the HWCA sites. Information was collected on age, gender, activities performed, time spent and parts of the body exposed to water. The frequency, duration and relative index of the HWCA in the study communities varied according to individual community. The study assessed the relationship between HWCA and LU/LC change detection to further explain the contribution of exposure to the transmission of schistosomiasis. A total of 2372 exposures involving four HWCA fetching, fishing, swimming, and washing utencils, for a total of 85,898 minutes. Mean duration of contacts ranged from about 2 minutes of fetching to 35 minutes of fishing. Frequency and duration of HWCA were age and sex dependent, a peak between 10–14 years (36.3 % of 2372). The average number of water contacts per person per day in this population was 2 minutes of fetching and 42 minutes of washing utencils. The observed patterns of HWCA in this study resulted from poor socio-economic status and proximity to such contaminated water bodies from the reservoir. There was a link between LU/LC and HWCA in the study communities.

Keywords: Geographic information system, HWCA, remote sensing

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Health Risks Associated with Waste Water Irrigation in Urban Vegetables Production in Ghana

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Urbanisation has consequently led to an overhaul of restaurants, hotels and fast food vendors in Ghana, These hotels, restaurants and fast food vendors serve vegetable salad as part of their menu thereby serving as a ready market for vegetables production. Therefore, fresh vegetables consumption has increased in Ghana and it has been found to be one of the food contamination pathways. Retailers of vegetables demand vegetables that are accessible at the farm gates and are not too far from the markets where most of them are consumed. This is due to the high cost of transporting the vegetables from the rural farm areas and the limited storage facilities in the country. As a result, urban and peri-urban vegetable production is on the increased Meanwhile, with the increasing urbanisation and the population growth, there has been pressure on fresh water supply and hence fresh water is unavailable for vegetable irrigation. Waste and polluted water are therefore used for vegetable irrigation since more waste water is generated which exceeds the country's capacity to treat, and also most of the available fresh water sources are polluted with domestic and industrial waste materials as a result of poor sanitation and improper waste management in the country. The polluted and waste water, when used by the urban vegetables farmers for irrigation contaminates the vegetables with pathogens. Many diseases particularly water related diseases have been linked to the contact of the waste water by the farmers and the consumption of the contaminated vegetables. However, the practice is known to have many benefits when used with safety safeguards such as initial treatment of the waste and polluted water before use. Over the years, fragmented efforts have been made to address this issue in Ghana by placing a ban on waste water irrigation in the country. This approach has failed in the context of Ghana. This paper uses qualitative research method to identify the health risks involved in waste water irrigation, the benefits, stakeholders perceptions and how the country can minimise risks whilst maintaining the benefits of the waste water irrigation in Ghana.

Keywords: Ghana, health risks, irrigation, urban, vegetables, waste water

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Perception of Water Quality and Health Risks in the Rural Area of Medellín (Colombia)

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In Latin America and the Caribbean, approximately 50 million people lack even basic access to drinking water, most of them living in rural areas. This uneven spatial distribution of the drinking water supply poses a continuous public health risk, results in low economic productivity, low prosperity and thus contributes to the enforcement of regional disparities. As to the successful implementation of drinking water systems, the focus is still on technical factors and on measures to improve the knowledge of the target groups. Using the example of three rural quarters of Medellín (Colombia), this study shows how the perception of water quality and health risks by different social target groups may influence the implementation process of drinking water systems. A social area analysis was carried out to determine the socio-economic framework of the study, followed by 125 face-to-face interviews with drinking water consumers, complemented by additional expert interviews.

Within the study area, 36 % of the households use exclusively drinking water from the provided drinking water infrastructure. 10 % of the respondents still consume only raw water and 54 % are connected to both the raw water and drinking water supply system. The main factors influencing peoples' water quality perception are its colour and appearance, which form a sort of "quality standard" used to evaluate the water quality, even of raw water. The use of raw water for hygiene practices and irrigation is not perceived as a potential risk. This even applies to the group of people who only partially consume raw water. Although clearly increasing the hazard of disease transmissions, about 50 % of these households use the same single pipe circuit for both the selective transport of drinking and raw water. A relatively small group of consumers of drinking water seem to have a suitable risk perception with a link between the river pollution and waterborne health risks and diseases.

The study showed that the implementation process of drinking water systems must consider the target groups' socio-economic and cultural context forming their perceptions. A realistic risk perception should be prevalent among the target group prior to the introduction of drinking water supply systems.

Keywords: Health risks, Latin America, Medellín, quality perception, risk perception, rural areas of large cities, South America, water quality

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Food Standards Are Good — For Middle Class Farmers

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The impact of food standards on the wellbeing of farmers in developing countries has been debated intensively in recent years, as the effect may be both positive and negative. In analysing the impact of food standards on farmers' livelihoods, most of the literature has focused on mean impacts. While the average gain from standards is surely interesting, there is, in our view, a strong case for believing that the gain is unevenly distributed among households of different socio-economic status. Moreover, we argue that a positive impact of standards is only attributable to farmers in the upper segments of the wealth distribution. And this is what we show, empirically, for Vietnamese pangasius famers in the present study.

We estimate the distributional impact of food standards on consumption expenditure using an original dataset of 277 farmers from the Vietnamese pangasius (catfish) sector and, to enrich our understanding of the farmers' situation and decision problem, we complement the statistical analysis with insights from 52 qualitative interviews with key stakeholders. To overcome the endogeneity problems with substantial self-selection, we use an instrumental variable quantile regression.

Besides observing that farmers who apply standards obtain higher farm-gate prices, we find that the overall average impact of food standards on household wellbeing is positive in the Vietnamese pangasius sector. Applying standards increases the monthly per capita expenditure by 56 % in our most conservative specification. Moving to the models with varying effects across the expenditure distribution we find that the average impact is driven by large effects primarily for the middle-class, defined as households from around the median of the distribution and upwards, but excluding the upper 10–15 % tail. The gain for the middle-class is 119–143 % evaluated against the per capita expenditure. The variation in the gain from standards is reflected in the share of adopters across the expenditure distribution whereby non-adopters are either relatively poor or relatively well off.

Overall, our results point to exclusionary role of standards for the poorest farmers who cannot finance the necessary investment, while for the wealthiest farmers, the added gain is too small.

Keywords: Asia, food standards, instrumental variable, pangasius, quantile regression, Vietnam

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An Assessment of Wear Elements in Food Products by Wet Milling using Atomic Absorption Spectroscopy Technique

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This research was carried out to determine the levels of wear elements introduced into food consumed by humans after being wet milled. Samples were collected from a selected milling house in Yelwa area and were taken to the laboratory for analysis.Heavy metals such as cadmium (Cd) and lead (Pb) as well as trace elements; copper (Cu) and zinc (Zn) contents in milled beans, tomatoes, pepper and onions collected were analysed using atomic absorption spectrometry. The wear elements detected ranged from 0.008 to 0.017 mg kg^{-1} for Pb and 12.42 to 17.63 mg kg^{-1} for Fe, and Cd went undetected being lower than the detection limits of 0.003 mg kg-1. However, the trace elements ranged from 6.75 to 11.84 mg kg^{-1} for Cu and 9.35 to 81.25 mg kg^{-1} for Zn. The highest values of Pb, Cu, Zn and Fe in the milled products were observed in onion paste (0.017 mg kg^{-1}), tomato slurry (11.84 mg kg^{-1}), beans paste (81.25 mg kg^{-1}), and onion paste (17.63 mg kg^{-1}), respectively. The level of Fe and Zn in most of the samples was found to be above the permissible level of 15 mg kg^{-1} and 60 mg kg^{-1}, respectively, as set by WHO (2003). Further wear elements were found to be within the safe levels. It reveals that there is a potential danger of high level of wear elements in some of our milled basic food stuffs. These levels are unknown to the consumers which calls for a better awareness.

Keywords: Absorption spectrocospy, heavy metals, wear elements, wet milling

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Satisfying Sugar Cravings in Obese and Diabetic Patients with *Synsepalum dulcificum*

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Managing the dietary intake of sugar has been found to be one of the most cost effective ways of coping with obesity and diabetes. However, this means of preventing and coping with diabetes and obesity has been found to be difficult for both adults and children since the need to satisfy their cravings for sugar is paramount. *Synsepalum dulcificum*, an underutilised and neglected indigenous Ghanaian fruit has been used for centuries in Ghana to satisfy sugar cravings. The fruit is unsweet with a mild taste. However, after eating this fruit, any sour food subsequently consumed, turns extremely sweet. The sweetening effect can last for about one hour. This research was conducted to find out if *Synsepalum dulcificum* can serve as an alternative means of managing sugar craving in people especially those with obesity and diabetes. The research used literature review to determine the essential analysis of this fruit and the possibility of serving as a sugar substitute. The results indicated that the sugar content in the fruit has been found to be insignificant. The sweetening effect of the fruit is attributed to the presence of Miraculin, which is used as a sugar substitute. The fruit has been tried in obese and diabetic patients without side effects. Cancer patients with unpleasant metallic taste in their mouth had it masked after eating the fruit. It can be concluded that the fruit can serve as a means of satisfying sugar cravings in many people whilst managing their dietary sugar intake due to the insignificant sugar content. It is recommended to cultivate the fruit on large scale. Also the consumption of the fruit must be promoted among people who are obese and diabetic.

Keywords: Diabetes, Ghana, obese, sugar, *Synsepalum dulcificum*

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Development

Development within the rural-urban continuum

Does the Development of Urban Agriculture Fit or Disrupt the Rural-Urban Continuum?

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The fast-growing interest in urban agriculture around the world has captured the attention of people with a range of backgrounds, including those focused on strengthening farming systems in rural areas. As a result, a variety of contrasting outlooks have been emerging as to the place of urban agriculture within the future of agriculture – as well as in the future of cities. Some view urban agriculture suspiciously, in terms of insignificance as a serious food production source at best, or competition with "real" agriculture at worst. Others regard urban agriculture in positive terms, but see its greatest potential when integrated seamlessly into farming systems in peri-urban and rural areas. This presentation reflects on the various outlooks towards urban agriculture and considers how viewing it within the urban-rural continuum can illuminate its potential place within urban development as well as agricultural development.

Keywords: Farming systems, urban agriculture, urban rural linkages

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How to Benefit the Upland Poor in Central Vietnam from Forest Devolution

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The research focuses on the practice of forestland property rights in the process of forest and forestland transfer from state to community and household property after reforming the state forest enterprises. The research community is one upland commune in Aluoi district of Thua Thien Hue, Vietnam. The population is constituted from the Kinh people who migrated from the lowland of Thua Thien Hue province, and of neighbouring Paco. Household interviews, key informant and group discussions were applied for data collection. Qualitative and quantitative data were explored, and statistical analysis included bivariate correlation, t-test, cross tabulation and binary logistic regression to determine the effect of independent variables on the dependent variable. The results showed that the two ethnic groups showed differences in land use and market access. The process of nationalisation of land in previous times had not recognised the management rights of the local people on forestland and natural forests. In fact, people have practised crop cultivation on the forestland since long time ago. These rights are recognised by the community and it exists in parallel with the legal rights. The process of transferring forestland from the state forestry agencies to the community, combined with the impact of the market, has spurred the process of strong and increasingly complex land possession in the area. With the slow and weak enforcement as well as capacity of the local authorities, impact of policies on forestland allocation and regional economic development is not large. The forest continues to be destroyed and converted for other use purposes. Therefore, the process of land use planning and land allocation needs to be promoted because with weak implementation this process will be more complex, and forestland allocation policies of the state will not fully be enforced. Simultaneously, it will be increasingly challenging to work towards poverty alleviation and protection of the remaining forest resources in the region.

Keywords: Common property, forestland allocation, forestland encroachment, non-timber-forest-products, property rights

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Investigation Study of Demographic Changes Impact on Rural-Urban Continuum in Semi-Arid Region

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Forest is an essential part of ecosystem services, not only as a resource but as a contributor to biological systems as well. The pressures imposed at any one place or point in time resulted to the complex of spatial and temporal interactions within topographical systems, can be propagated through the system and may have implications for future ecosystem functions over a wide array of various spatial and temporal scales. The aim of this study is to raise understanding of the relations between patterns of local-level economic and demographic changes, the nature and value of local ecosystem services, and the role of such services in an increasingly interlinked urban/rural livelihood systems of South Kordofan State of Sudan, specifically of those systems in poor condition. The focus particularly on forest-based ecosystem services and uses forest as an entry point for an investigation into the relationship between urban/rural development and ecosystem services. The methodology applied in the current research is two-pronged; formal literature reviews and field survey conducted on the study area. A tradition of intensive interactions between the rural and urban places has long been acknowledged, but recent changes in global political-economy and environmental systems as well as local dynamics of the study area such as: war, drought and deforestation, have led both to a new rapidity and depth in rural transformation, and a significant impact on urban area as well. Like most environmental problems, the effects of particulate matter are complex and stressed differentially across varied geographies by the socio-political processes that underlie recent economic and cultural globalisation. These interactions and processes have brought increasingly rapid changes in social, institutional and livelihood transformation across broad areas of the state. The study showed also, high rates of migration and mobility for the indigenous population as well as market-centric livelihoods now dominate in many villages that were once dominated by rural agricultural and natural resource based on socio-economic systems. More information exchange needed to inform actors and decision makers regarding specific experiences, capacity gaps and knowledge to address poverty through maintenance of ecosystem services.

Keywords: Demographic changes, forest, poverty, rural-urban continuum, semi-arid region

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Urbanisation, Crop-Livestock Intensification and Rural Development: The Case Study of South Asia

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Urbanisation in South Asia has been gaining momentum over the recent years through rapid changes in economic activities and migration from rural areas to urban centres. UN projections suggest the world's urban population will grow by more than a billion people between 2010 and 2025, while the rural population will remain stable. This will increase the population share not producing food and may increase food prices putting pressure on the livelihoods of rural as well urban poor if total food production does not continue to grow. On other hand, urbanisation through the accompanying income growth is increasing the demand for high-value products such as fruits, vegetables, milk, meat and fish. In addition, increasing demand for labour from other sectors has also led to higher wages in the primary sector. This calls for urgent attention to examine the sustainability of the primary sector in South Asia, where poverty remains widespread and rural livelihoods dominate. This paper would like to study the role of crop-livestock farming systems in a changing economic space and the livelihood impacts of these changes. We have selected three sites (two from India and one from Bangladesh) based on their farming intensification level (high, medium and low) as examples.

The preliminary results discovered that increasing demand for high-value crops from urban dwellers as well as for labour has brought considerable changes in farming practices in all three study sites, being most pronounced in the high intensity site. Here, the scarcity of labour in agriculture has brought in modern technologies such as tractors and combine harvesters. However, small farmers benefit only marginally from such productivity improvements due to their considerable economies of scale. The greatest benefit to small farmers appears to be the extraordinary rise in land prices due to urbanisation. Nevertheless, the intensification of crop-livestock production is highest where there is an easy access to urban markets. In regard to system sustainability, the low intensity zone appears to be most threatened when assessed by the pressure on biomass resources. However, in regard to ground water use it is the systems in the high and medium intensity zones which are facing severe challenges. Non-farm income plays a major role in financing the intensification of farming for home consumption in the low intensity zone, while in the other sites small farmers prepare their future exit from agriculture through producing for urban markets.

Keywords: Crop-Livestock, intensification, small farmers, South Asia, urbanisation

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Smallholder Farming in Kenya: An Evaluation of Livelihood Dynamics

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The rural population of semi-arid lands in Kenya face multiple challenges that result from population growth, poor markets, land use and climatic changes. In particular, subsistence oriented farmers face various risks and opportunities in their attempt to secure their livelihoods. In light of recent calls for more effort on understanding livelihood dynamics this paper contributes to comprehend long-term change and poverty dynamics with an inter- and intra-household comparison over the last fifteen years. A longitudinal livelihood survey was conducted in Laikipia County, Kenya, based on standardised questionnaires and semi-open questions with 150 smallholder households in 1997 and 2013. A participatory well-being index was developed and livelihood portfolios compared.

The results show persistence in low asset endowment for the majority of smallholders from an aggregated perspective, while transitions into and out of better livelihood conditions become apparent from a household perspective. The investment in, and accumulation of, conventional buffer or productive assets, such as grain stocks, livestock or land, does not shield households from adverse shocks as smallholders are shown to easily slip back into poverty. The study analyses the lack of sustained graduation out of poverty and highlights correlations between livelihood strategies, assets and the well-being pathway of households. The paper further explores the reasons for a significant reduction that was found in livestock keeping and identifies livelihood strategies to cope with a reduction in common grazing areas. Water projects in the area were found to be partly ineffective; ways to counter management problems to better cope with water shortages are discussed.

Keywords: Kenya, Laikipia, livelihood, longitudinal, rural development, smallholders

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Farm Forestry in Lugari District, Kakamega, Kenya

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This study was conducted to establish the factors influencing the development of farm forestry in Lugari District, Western Kenya. Data was collected between December 2007 to January 2008. Structured questionnaires/schedules, key informant interviews, and secondary sources of data were used to collect data. All collected data were entered in SPSS 13.5 for descriptive statistics such as frequency distributions and cross tabulations. Significant differences between expected and observed attributes were analysed by non-parametric Chi-square tests.

Farm sizes, species preferences, end use of tree products, access to and availability of preferred germplasm and planting materials, availability of resources for raising seedlings, access to extension services, and marketing constraints as well as biological and technical factors such as diseases, pests and planting techniques were established as important factors influencing farm forestry development and tree planting in general, in the district.

This study also demonstrated that farm forestry can be a useful tool for enhancing the livelihoods of many people and contributing to rural development in Lugari, and can be readily adopted if identified challenges can be comprehensively addressed.

It is recommended that tree propagation techniques and distribution networks should be developed to enable affordable access to a wide range of appropriate germplasm. Small scale farmers should be assisted, through extension services, to manage and enhance the value of their tree crops.

Institutional support through incentives such as credits, subsidies, technical support and creation of market opportunities including forest policy and legislation sensitisation and implementation would boost farm forestry activities in Lugari.

Keywords: Farm forestry, livelihoods, Lugari district, rural development

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The Socio-Economic Impact of German Development Services in Shiekan Locality, North Kordofan State, Sudan

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The current study was conducted in Shiekan locality, North Kordofan State during 2008–2010. The main objective of the study was to identify the socio-economic impact programs of the German development agency DED, on local communities. Specifically, the study aimed to find out the services offered by DED and how these were delivered to local communities. It also examined how beneficiaries perceived DED services and how they are involved in DED activities.
The study based on two types of data: primary and secondary. The primary data was collected from the field survey through questionnaires which were distributed to 60 respondents and direct interviews with 6 key informants, while secondary data was collected from DED documents, reports, relevant previous studies and references. To analyse the data, the study used SPSS software programme and further used Chi-square test to find the association between the variables.
The output of the study revealed that the main services provided by DED organisation are social services in term of capacity building programs, consultancy services, establishing community based organisation (CBO) and lectures in economics and savings. The economic services represented financial supports while health services focused on first aid programs and fighting harmful traditional practices. The results showed also that the majority of the respondents (98.3 %) participated in DED activities, particularly in planning, implementation, follow up and evaluation of the activities. CBO members have a positive role toward their communities and they are able to continue their activities after the DED project finished. Finally, the study formulated recommendations which could help community development and particularly the rural communities.

Keywords: Community based organisation, extension services, German development services, socio-economic impact

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Planning of Rural-Urban Continuum Towards a Sustainable Relationship between Agricultural and Energy Production

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Renewable energy production has strongly increased in order to achieve the European Union 2020 goals. According to the European Union Green Paper 2030, the reduction of distance between production and consumption sites is a key issue for sustainability. In 2050, 80% of the world's population will live in cities, where almost all of energy consumption will take place. Thus cities will be a focus of energy policies. The peri-urban space constitutes a high potential area around the city but has so far been ousted from planning and sustainable development. It is therefore high time to overcome the separation between "urban" and "rural" in sectorial planning, otherwise necessary changes cannot take place.

This article discusses the relationship between the urban built environments and the peri-urban non-built-up areas, the so called rural-urban continuum, as a key driver for sustainable development. To identify how to plan and manage these spaces, it is analysed which type of tools, not in contrast with the law in force, can help the construction of sustainable policies for wise management of the rural-urban continuum. The challenge is complex, because the promotion of short production-consumption pathways for energy and food near urban centres, the factors to consider beyond the mere economic and environmental evaluations are numerous. Therefore, working towards the perspective of the distributed generation model of energy and food, it is indispensable to also analyse the social impact. Urban planning has adopted only recently sustainable energy action plans, but clearly separated energy generating areas from urbanised areas. Agro-energy production, the link between energy, food and society; is one of the most promising energy chains for European cities. The proposed analysis takes into account the energy and agricultural potential of peri-urban areas within a holistic energy planning. Through efficient proximity logic, it is possible to evaluate the bio-energy potential of these areas and the relationship with urban economics. The article explores the case study of the district of Rome, the first agricultural community in Europe, to demonstrate the extent of the impact of various factors and the compatibility of the planned actions at metropolitan level.

Keywords: Bioenergy, energy planning, SEAP, sustainable agriculture, urban planning

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Assessment of Non-Governmental Organisations (NGOs) on Poverty Reduction in South Darfur State

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This study was conducted in 2010; the objective of the study has been to assess the NGOs role on poverty reduction in South Darfur State. A random sample of 200 households was interviewed using a questionaire. The study used DAD software for analysing data, in addition to inequality and poverty measurements. Cost of Basic Needs approach and Foster, Greer and Thorbecke measures have been employed to set the poverty line and compute the magnitude of rural poverty. Accordingly, three poverty lines were used: 2.60, 2.65 and 3.8 SDG/adult/day, respectively. The incidence of poverty (the proportion of people below the poverty line) stood at 74 %, 76 % and 94 %, respectively.

On the basis of the objective poverty line, with expenditure as a welfare indicator, the incidence poverty for two groups, beneficiaries and non- beneficiaries, were estimated at 0.41 % and 0.76 %, respectively. Using income as welfare indicator the Gini-coefficient and income share for beneficiaries and non- beneficiaries are 0.157 %, 0.685 % and 0.224 %, 0.315 %, respectively. IIrrespective of the welfare indicator or the poverty line used, the cardinal measures of poverty were lower among the beneficiaries compared to the non-beneficiaries. Accordingly, the intervention programme had led to significant reductions in all poverty measures for the beneficiaries.

Keywords: Household analysis, Sudan

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Increasing Fuel Demand in District Towns in Northern Togo: Economic Opportunities for Farmers and Ecological Risks

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In northern Togo, district towns, especially Dapaong and Mango, registered in the past three decades a continuous increase of inhabitants and therefore a growing demand for fuel. Because there are not state or NGO initiatives to promote the use of gaz or electricity on the one hand and low income of the majority of the citizens on the other hand, charcoal and firewood remain the most widely used energy sources, which are produced by North Togolese farmers and brought to the towns by the regional traders. While this creates additional income opportunities for rural populations, there are however at the same time environmental risks, particularly in the form of deforestation.

This paper examines first in a multi-level analysis the incentive and profit structures of the charcoal and firewood production in northern Togo. Second, by using the livelihood approach, it analyses the living conditions of the farmers and the importance of charcoal and firewood production in their income strategies by using qualitative and quantitative survey data collected in several villages. The case study aims to demonstrate that the charcoal and firewood production neither are farmers' survival strategies nor governed by interests of profit maximisation of powerful regional or even national actors. Rather, by the example of northern Togo it can be illustrated how urbanisation processes in peripheral African regions generate new economic opportunities for rural populations and regional traders which create, however environmental risks. Therefore charcoal and firewood production and trade, demand intervention and supervision by state agencies and NGOs.

Keywords: Charcoal, district towns, firewood, peasant income strategies, regional trade, Togo

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Assessing the Potential of non-Farm/off-Farm Enterprises in Spurring Rural Development in Uganda

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Rural-non-farm-activities provide supplementary employment to small and marginal farm households, and reduce income inequalities and rural-urban migration. The rural non-farm sector (RNF) is a poorly understood component of the rural economy of developing countries and little is known about its role in the broader development process. Our objective was to assess the potential contribution of the off-farm sector to rural development. A desk study was conducted through review of varied literature sources including government policies. We found that of the 3.8 million persons who worked outside the agriculture sector, 2.2 million (58 %) were in the informal sector. The proportion was higher for females (62 %) than males (55 %). Differentials by residence show that 54 % of the urban work force was in the informal sector compared to 61 % of the rural work force. A lower proportion of the work force in Kampala was in the informal sector (52 %) as compared to the Central and Western regions (60 %). Poverty remains higher in rural areas than urban areas. The poor in rural areas represent 27.2 % of the population as compared to 9.1 % in urban areas. The rural areas with 85 % of the population constitute 94.4 % of national poverty whereas the urban areas with 15 % of the population constitute 5.6 % of the national poverty. Similarly, wage costs are lower in rural areas where the marginal costs of migration, housing, transport and higher living expenses do not have to be incurred. Rural industrialisation could stop the skills drain from the countryside if it provides a sufficiently lucrative alternative for employment through utilising local surplus human and material resources which may not be used in urban industry. New enterprises could simultaneously generate modern skills in the rural workforce. The social costs of these are extremely low, and the benefits quite high, as in the case of various waste-recycling activities. The RNF sector increasingly plays an important role in the development of rural areas in sub-Saharan Africa and Uganda. It should be noted, however, that rural non-farm enterprises are not a substitute for employment in agriculture but rather as a supplementary measure.

Keywords: Agriculture, development, enterprise, income, off-farm, rural

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The Masipag Approach: Food Security and Sovereignty, Sustainable Rural Development and Farmers' Empowerment

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MASIPAG is a national network of farmers' organisations, agriculturalists, scientists, academics and NGOs promoting farmer-led sustainable rural development through the promotion and practice of the MASIPAG agro-ecosystems conversion program. The MASIPAG development approach aims to create change not only in farming techniques but through a holistic transformation of people and society. One MASIPAG farmer describes this approach: Even if one is practicing a full organic system with MASIPAG seeds, if he has no concern for other farmers and society, then he cannot be considered a true MASIPAG farmer.

The poster will focus on the main aspects of the MASIPAG approach which is: Bottom-approach; Farmer-scientist-NGO partnership; Farmer-led research; Farmer to farmer mode of technology and knowledge transfer; Advancing farmer's rights and genuine agrarian reform. The MASIPAG agro-ecosystems conversion programme includes: Diversified and integrated farming systems; Bio-fertiliser development and use; Alternative pest management and upland development program.

At the same time, a critical element in building sustainable and resilient communities is being able to empower farmers' organisations so that they are capable of addressing conditions that intensify the 'greenhouse effect', depletion of fossil fuels, and other conditions that adversely impact the ecosystem and biodiversity in rural communities.

In different partnerships at different levels (community, provincial and regional level) experiences are shared to strengthen the sustainability and resiliency of local communities. For instance faculty members and students of the Community Development do fieldwork in MASIPAG member farmers' organisations to help strengthening popular/community education on sustainable agriculture and resiliency to climate change. They are working together to assist local farmers' organisations in effectively practicing the agro-ecosystems conversion program, promoting adaptability and resiliency to climate change and effective advocacy work in order to address issues arising from destructive and large scale mining, illegal logging, land use conversion/crop conversion and other issues that negatively impact ecosystems and biodiversity. To ensure the sustainability of the farmers' organisations and their efforts to promote sustainable agriculture, programs for organisational development, leadership development are also being institutionalised at various levels of the MASIPAG national network.

Keywords: Empowerment of farmer organisations, farmer-led rural development, food security, sustainable agriculture

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Impact Assessment of Good Agricultural Practices on Rice Production, Food Security and Rural Livelihoods in Myanmar

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Rice productivity in Myanmar has stagnated in comparison with other rice producers in the region. Once the world's largest rice exporter, Myanmar is now a relatively minor player exporting an average 631,000 Mt annually over the past 4 years. However, the nation's export potential remains high because of abundant land and water resources, recent indications of progressive policy reforms, increased agricultural investment, and constructive international engagement. The Ayeyarwady Delta is known as the main rice bowl of Myanmar and approximately 80 % of the families in this region, primarily farmers, fishermen and farm laborers are engaged in agriculture. Rice is the major crop and there are about 5 million acres of rice production area (monsoon and summer) in Ayeyarwady region. Rice production in Ayeyarwady region is vital for the production of high quality fragrance rice for both domestic consumption and surplus rice for export markets. After the giant cyclone "Nargis" devastated Ayeyarwady Delta in May 2008, the rice production and productivity in this area decreased due to various factors such as lack of infrastructure for irrigation and water control (embankments), poor knowledge on nutrient management, lack of quality agricultural inputs (seed, fertiliser, pesticide) and poor post-harvest and storage technology. Many international and local non-governmental organisations provide farmers education on good agricultural practices. Cornell University researchers carried out a field study in the Ayeyarwady Delta region in May, September and December 2012. The study focused on farmers' adoption of new technologies and good agricultural practices, rice production, productivity and marketing and distribution. Group discussions and individual interviews were conducted with field extension agents of local and international NGOs and the ministry of Agriculture, farmers, rice millers, local traders and other stakeholders. The majority of interviewed farmers reported to have no access to good quality seed (salt, stress, submergence tolerant variety), fertilisers and pesticides. The key findings are nutrient management problems (wrong application, wrong type); water management problems (need embankments, group management); little agricultural extension (government has no funds); few profits at all levels of the value chain; need for incentives for improved quality seed; and need for demand-driven and market-driven extension and advisory services.

Keywords: Food security, good agricultural practices, Myanmar, rural livelihoods

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The Trap of Industrialisation: Rural-Urban Discontinuum in Vietnam's Mekong Delta

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The deterministic ideation of modernisation and industrialisation by 2020 has in several respects shaped the recent socio-economic development of both rural and urban Vietnam. Under and through the centralised planning apparatus, the translation and implementation of the national development strategy at local levels however have largely fallen in a reductionistic approach biased towards economic growth, industrialisation and urbanisation. Against this background, the present paper, relied on empirical data collected from one year field research (2010–2011) in the Mekong Delta, discusses agricultural and rural development practices in this largest and most active agricultural development area in Vietnam.

This paper analyses how modernising the agriculture sector is conceptualised and realised in the delta and to what extent industrial zone development becomes pro-agriculture. It delineates agricultural development in "administrationally-urbanised" subdistricts through examining (human and financial) resource allocation for agricultural management and extension as well as local farming model shifting strategies as adaptation, including in project-pending areas. The discussion also scrutinises rural vocational training programs as alternative possibilities of farm-based livelihoods or factory employment.

It is concluded that development planning and practice of the region have basically ignored the rural-urban continuum, which creates developmental vacuums where policy making and implementing are unmet and urban and rural inequalities widened. As a result, agricultural and rural development is increasingly kept in a trap of "shortcut" and simplified modernisation and industrialisation ideas. In the same manner, the deployment of the new integrated agriculture-rural-area-farmer policy (called Tam nong) can hardly be successful unless rural-urban dynamics are reflected.

Keywords: Industrialisation trap, rural-urban discontinuum, Vietnam's Mekong Delta

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From Demanding to Delivering Development: Challenges of NGO Led Development in Rajasthan, India

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The NGO sector in India has seen unprecedented growth in the recent past. A whole range of NGOs are not just 'demanding' development from the state but also 'delivering' development in the Indian countryside. While popular interest in the role of the non-governmental development sector is growing, it is not complemented by empirical studies which explain how do local NGOs evolve and change over time? What happens when grassroots NGOs expand their activities, capacities, resources and power to consolidate their position in the development regime? This paper addresses these questions on the basis of organisational life history of a local NGO in the desert state of Rajasthan in India. The evidence presented in the paper derives from qualitative research undertaken during a three-month stay with the NGO, involving semi-structured interviews and open-ended discussions with a broad range of stakeholders including NGO functionaries and villagers, direct observation, participation in NGO meetings and local documentary sources. Applying the life history research to NGOs is an innovative approach used by the author for understanding why do local NGOs follow particular strategies in their field of action, and what are the repercussions of their actions in terms of developmental outcomes?

Based on new data on NGO practices in the arena of natural resources development over a span of four decades, the author argues that grassroots organisations working without the constraints of tight budgeting schedules and time-plans do alter local power relations and caste-based discriminations, and have the potential of ending exploitative relations of patronage. Furthermore, the expansion of the organisation indeed brings in more resources and funds for development in Rajasthani villages but the long and complex tasks of transforming local power relations, which created goodwill for the organisation in the initial decades, have come to be replaced by meeting the targets of land treatment and budgetary allocations. The paper concludes that in their quest of 'delivering' development services 'professionally' and fast-track, grassroots organisations face the challenge of increasing 'bureaucratisation' of the organisational structure and functioning, creation of new relations of patronage, and of losing touch with the grassroots.

Keywords: Grassroot organisations, natural resources management, NGOs, Rajasthan, watershed development

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The Effects of Village Renewal on Quality of Rural Life: Evidence from Eskikaraagac, Bursa, Turkey

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Developing technologies and industry based on using of modern agricultural instruments and techniques have led to structural changes in agrarian economy. Due to the emerging developments, the employment that based upon conventional agriculture, has decreased its efficiency in economy. Local people who lost business opportunity, has begun to migrate from rural to urban in the hope of finding employment.Farm lands operating has became infertile because of the migration. As a result of these negative conditions, Villages that have been individual settlement unit of rural area have grown to lose their specifically social, cultural and physical structure. Turkey has need village renewal studies in order to prevent the migration to maintain specifically structure of rural and to provide improvement of rural.

The village renewal is a comprehensive process that determines potential in rural area, as well as providing proper use of the resources. Land fragmentation is major problem due to reducing to operate effective farm land in rural areas, so this condition can be solved by land consolidation. Land consolidation is a part of the village renewal studies. Natural and cultural properties preserve, thus making an environment planning and alternative living spaces can be created near the cities through the village renewal. These adjustments can be created new business opportunities, so creating more dynamic non-farming sector in rural areas. If these opportunities were provided for local people and made village renewal, People wouldn't migrate to urban/city and due to increasing the quality of life, local people would stake a claim on their own region.

Village renewal studies have been important because of increasing migration rate since 1970 and Turkey has needed a new construct in order to provide rural development and to sustain it. The aim of this study the effects of village renewal on the quality of rural life and rural developments in Eskikaragac-Bursa/Turkey.

Keywords: Rural development, village renewal, Turkey

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Integrating Biofuels into Simulation Models: How Does it Influence the Results of World Agricultural Market?

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Over the last ten years biofuels production has increased dramatically. This strong increment in production has been fostered mainly by governmental interventions, like mandatory blending targets, tax exemptions and subsidies. Since commercially available biofuels employ almost uniquely food crops as their feedstock, *i.e.*, mostly sugar cane, corn and oilseeds, concerns have been raised about the economic, social and environmental impact of biofuel production. Therefore, simulation models have gained increased attention for their capability to analyse the linkages between agricultural and energy sectors, and to measure the impacts of biofuel production on the world economy.

Based on that, this study aims first to provide a literature review of the evolution on how biofuels have been introduced into the frameworks of simulation models. Secondly, it seeks to analyse the empirical results implementing agricultural trade liberalisation shocks by developed countries using the Global Trade Analysis Project (GTAP) model. Here we employ two different structures of the model. The first structure resembles the standard GTAP model where biofuel production and consumption is only modelled implicitly. The second structure of the GTAP model employs an extension with separated biofuel sectors as well as a differentiated production and consumption structure, so that biofuel is modelled explicitly. From the first result of the empirical analysis, it can be concluded that the different structures of biofuel modelling used have only slightly changed the results, mainly due to the lack of biofuel traded in the period analysed. Additional shocks, like biofuel mandates, could be tested in these and other structures including relevant specifications, *e.g.*, land use module, and by-products from biofuel production.

In general, these analyses can benefit future researchers with more coordinated modelling efforts about how to incorporate biofuels in simulation models. Additionally, this study also serves as a guide for future researches and to support policy makers in better understanding how distinct modelling approaches could possibly deliver different results for the world economy.

Keywords: Agricultural trade liberalisation, biofuels, modelling framework, simulation model

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The Impact of Land-Use Change on the Livelihood of Rural Communities: A Case-Study in South Darfur, Sudan

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This study attempts to identify and analyse rural people's attitudes, knowledge and perception of land-use change, and to examine the impact of land-use change on rural people's livelihood. The cross-sectional data were collected from 100 respondents using pre-structured questionnaires. The data were focused on respondents' socio-economic characteristics, drought and its affect on natural resources (for example agricultural land and crop production, land degradation, forest production and rate of deforestation). The narrative perception of the key informants was used to obtain a clear picture of different historical changes in land-use patterns from 1972 until 2008 in the Edd Al-Fursan area, South Darfur State. Additionally, they provide a beneficial description of the natural resources situation in the seventies and their degradation since the beginning of the droughts in the 1980s. The data were coded, entered in a computer and analysed using the Statistical Package for Social Science (SPSS). Descriptive statistics and correlations were used to present the study results. The findings illustrate that the respondents are aware of changes in land-use patterns over the course of this period. The sampled population indicates that the driving forces of this change included environmental degradation, conflict and war, recurring droughts, human and animal population growth and human activities. This was based on their perception and interpretation of indicators such as the reduction of soil fertility due to over-cropping that led to lowered crop production, overgrazing that has resulted in the change in some grazing species and pasture degradation. The results of the study also indicate that deforestation caused by charcoal production, brick making and building materials ultimately led to land degradation and soil erosion. Moreover, the study illustrates that land-use issues in the study area were directly related to land tenure systems. However, the inability of land ownership and land management systems to cope with the demand for farms and pastures due to increased human and animal population resulted in land degradation caused by overuse, which hinders the sustainability of rural livelihood in the area.

Keywords: Land use change, livelihood, rural communities

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GIZ experience in the field of agricultural development within the urban-rural continuum

Urban Agriculture – Promising Option for Sustainable Urban Development

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Urban agriculture is not a new phenomenon but has since ever been part of urban settlements and urban life strategies. In times of rapidly growing cities combined with increasing poverty, food insecurity, social fragility and environmental hazards, urban agriculture has the potential to minimise these challenges by its multifaceted character. This puts it in the centre of the so-called "Food-Water-Energy-Nexus" which could be strengthened by appropriately designed projects.

The term "urban agriculture" describes very different phenomena of agricultural production in and around cities, from highly commercialised farming in the periphery to smallholder activities within cities.

The presentation will focus on the latter, but also highlight the potential of highly commercialised farming for poverty reduction.

Challenges for urban agriculture differ from those for rural agriculture and have to be addressed properly in urban policy and planning. New trends of urban agriculture like "rooftop farming" and "sky farming" or "vertical farming" will be presented in the light of their potential for developing countries.

Projects to promote urban agriculture should improve the frame conditions to achieve the multiple impacts and – at the same time – minimise potential risk factors like hygienic or environmental problems due to unsustainable agricultural practices.

Keywords: Poverty reduction

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Linkages in Rural-Urban Continuum, Focused on the Vegetable Value Chain: Mali

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This study examines linkages between rural and urban areas in vegetable value chain activities in the southern part of Mali. The value chain is characterised by a complex and informal network of farmers, middlemen, wholesalers, processors, vendors and customers.

The rapid growth of Bamako, Mali's capital and largest city with nearly two million inhabitants can be attributed in part to the temporary and permanent migration of people from villages. This movement has increased urban food demand, yet malnutrition remains an issue for many.

Methodology Primary data on horticulture activities and food consumption from rural, urban, and peri-urban areas in southern Mali was collected in 2010–2011 from 80 households at four randomly selected sites. Collection methods included individual interviews, focus group discussions, observations and secondary data.

Most villagers engaged in vegetable production sold about 80 % of their vegetables directly to traders and consumed the remainder. Rural populations involved in agriculture maintained gardens as a secondary activity to generate some income; women also tended small vegetable plots to produce food for their families in town, and to give as gifts. Small-scale traders, mostly women, collected vegetables directly from farmers' fields. They transported their crops to the nearest local or urban markets by public transportation or bicycle. Input vendors operating in towns, peri-urban and urban areas played an important role in the transmission of crop production information and publicity for new seed, fertilisers, pesticides and equipment.

Land insecurity is the main factor limiting vegetable production inside the capital city. Small amounts of vegetables were processed by rural and rural household members following traditional methods.

Bamako offers a large market for rural producers of vegetables and vegetable products, providing income opportunities for rural people, mainly in the informal sector and in gardening activities. Further research questions should focus on how rural-urban vegetable value chain can be developed to enhance the accessibility, availability and use of vegetables to sustain food and income security.

Keywords: Informal network of actors along the value chain, rural-urban linkages in the vegetable value chain

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URBAN NEXUS – An Approach for Sustainable Development and Example for Urban-Rural-Linkages

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Urbanisation is one of the defining characteristics of the 21st century. Over 90 % of the anticipated global urban growth is taking place in metropolitan regions of developing countries. Urban agglomerations therefore represent important living environments of the future and are central to the aims of poverty reduction, economic growth, sustainable use of common resources and provision of services and food. Within urban agglomerations urban-rural-linkages are becoming increasingly relevant. A truly integrated approach to development must go beyond intra-city policy coordination and traditional rural services. The integration with surrounding areas, both urban and rural, needs also to be considered. The benefits of stronger urban-rural cooperation include more efficient land use planning, better provision of services (*e.g.* basic services, public transport, health) and better management of natural resources.
Maintenance of the "status quo" and "business as usual" approaches to resource extraction and consumption will undoubtedly lead us down to path of exceeding planetary boundaries , particularly with regards to urban water, energy and food consumption. The severity of the environmental, social and political implications of these resources cannot be overstated. In response to this threat, URBAN NEXUS presents a new approach to understanding the interdependencies of these resources and linking rural and urban areas by overcoming "silo thinking" and supporting mutually beneficial responses and the potential cooperation of different levels of action and policy.

Keywords: Peri-urban agriculture

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Development policy issues

Economic Freedom and Perceived Corruption and Agriculture: Evidences from Soybean Exports in Brazil and Argentina

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The objective of this study was to explore the relationship between soybean exports (values and quantities), exchange rates and Economic Freedom of the World Index (EFWI) for Argentina and Brazil, as well as the importance of institutions on economic growth and perceived corruption. These exports are affected by changes in exchange rates, albeit to different degrees. Issues such as Sound Money and Legal System are identified as weak areas for Argentina, whilst Brazil seems to have problems with their Legal System and Regulations. We looked for long term relationship between the variables export quantities (EXPQUA), export values (EXPVAL), exchange rates (EXCHRT) and Economic Freedom of the World Index (EFWI) for both countries for the period 2000–2010 only, as complete data available was for that period alone. Results suggest an increase in currency rates affects the industry, especially Argentina, where exchange rates affect soy exports, potentially allowing for loss of power in the international market should the situation not improve. In Argentina's EFWI, scores on Sound Money experienced a decrease and a great issue seems to exist within their Legal System. On the other hand, Brazil is also affected by exchange rates, but to a lesser extent, reflected in the scores for Sound Money in the EFWI. In most countries the government controls resources and producers seek to attain privileges within the economic activities, condition which leads to greater levels of corruption. Pairing weak institutional quality with increased corruption, the effect on economic growth is negative. This responds the question on why institutions play a vital role in a country's economic growth.

Keywords: Economic freedom of the world index, institutional framework, legal-system, sound money

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Analysis of the Brazilian Governmental Regulatory Agencies of Sugar Cane Production – Food or Energy?

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The research analyses the evolution of the Brazilian government agencies behaviour on issues related to the sugar cane culture and production in Brazil in the XX and XXI centuries, especially the change model of food regulation production to urban centres to energy production for urban mobility. The survey has found a temporal cut line in the functioning forms of the government sugar cane culture regulatory agencies in the seventies of the twentieth century. (1) From 1930 until the 1970s, the sugar cane culture involved the creation and operation of government agencies focused on: (1.1) the primacy of the domestic food supply of Brazilian urban centres, (1.2) secondarily, the export of surplus sugar production. (2) Starting in the 1990s, the sugar cane culture involves the creation and operation of government agencies focused on: (2.1) domestic supplies of the fuel market for urban vehicles – ethanol - and the attempts to export ethanol surplus (especially with the political transformation of ethanol into tradable goods – commodity - in the world market), (2.2) secondarily, the export of sugar cane production and the domestic food supply of Brazilian urban centres. The perceived variations in the period of analysis of the government agencies behaviour – 1930-2012 – coincides with the spatial displacement of the Brazilian population, and with the displacements of the dynamic sugar cane economic centres: first, the urbanisation and population migration from the countryside to the cities, and second, the displacement of dynamic centres of sugar cane culture, from Brazil northeastern coast to South-central and Midwest Brazil.

Keywords: Brazilian agencies, energy, food, sugar cane

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The Conversion of Rice Field into Oil Palm Plantation: People's Greed or Government's Mismanagement?

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Agricultural land-use change, especially from rice field to other uses, has been a major concern in Indonesia in the past years. The government has been trying to control this by introducing policies. From Spatial Planning Policy in 1989 that 'only' designate certain areas to be used as agricultural land until the newest Policy on Sustainable Food Crop Land in 2009 that specifically ban the conversion of rice field to other uses. Policy after policy were implemented without any sufficient effect. On the other hand, to improve farmers' welfare and to support the rice self-sufficiency program, the government launched various supporting policies, such as building irrigation systems, supplying subsided or even free seed and fertiliser, agricultural tools, agricultural advisor, and rice price protection. However, the implementation of land-use change controlling policies together with the agriculture supporting policies have not yet proven to be effective. With a case study at a former rice production centre in North Sumatera that has completely been converted into an oil palm plantation, this paper seeks to answer the questions, what has gone wrong in the past? Is it the inefficient implementation or does it lies in the policy content that is inapplicable? Is it true that landowners decided to change their land-use because of the high and stable price of oil palm?

Semi-structured interviews have been used to gather data and information from actors at different levels (local, regional, and national) in order to gain better understanding of the reasons underlying landowners' decision to land-use change. The exploration showed how inappropriate policy implementation could lead to a chaos at different governmental levels. At the surface, it seemed that the drivers for the land-use change are only of economic nature. However, the failure of the government to ensure farmers' welfare and to implement policies prohibiting land-use change are the main underlying causes.

Keywords: Agricultural land-use change, oil palm, policy, rice, role of actors

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China's Agricultural Policy Transition, Domestic Grain Production and Changes of Agricultural Trade

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China's economy has been developed very fast since the policy of reform and opening up was issued in 1978. China's economic structure changed greatly in recent years. The agricultural sector has lost its leading role in economic development and has been replaced by the other two sectors. With the labour transfer from agriculture to other sectors, China imports more and more agricultural products to satisfy the domestic demand. However, the Chinese government aims to maintain 95 percent grain self sufficiency to protect the livelihood of the two-thirds of its population residing in the countryside, despite the lower-priced imports. China's agricultural policy passed through agricultural taxes to subsidies; until 2006 the remaining agricultural taxes were totally eliminated nationwide. The investment into agriculture increased from 214.4 billion RNB in 2003 to 857.9 billion RNB in 2010 with annual growth rate of 21.9 %. The agricultural policy transition reflects the Chinese leadership's attention to the so-called San-Nong problem (*i.e.*, the three agriculture-related issues: agriculture, rural areas and peasants). The increasing subsidies to the agriculture year by year affect the domestic grain production in China. How the domestic grain production will change, and its impacts on grain imports are the focus of this research. After 2005, China's domestic wheat and maize production increased greatly with more and more subsidies from the Chinese government. The results show that the subsidy policy has a positive and significant influence on the wheat and maize area. Increasing subsidies could promote the expansion of the cropping areas, further reduce the imports of grains and promote exports of some commodities. The agricultural policy transition is crucial for China's food security and food self-sufficiency.

Keywords: Agricultural policy transition, agricultural trade, domestic gains production, subsidy

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The Influence of Insecure Land Tenure on Upland Agriculture in the Philippines

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In the Philippine uplands the government started issuing land tenure agreements to individual forest residents and to communities in the mid 1980's. These land use rights are aimed at increasing land tenure security amongst the farmers and thereby promoting the adoption of sustainable agricultural practices. This issue is of crucial importance in the Philippine uplands, where deforestation and agricultural expansion have led to environmental degradation. Using primary quantitative and qualitative data collected in the provinces of Leyte and Southern Leyte in 2012, this study investigates the influence of land tenure agreements on upland farming practices, especially on the extent of trees on agricultural plots. Furthermore, problems in land administration processes at the policy level are investigated.

A total of 104 farm households was interviewed. A plot-level econometric analysis of determinants and constraints of tree keeping suggests that, ceteris paribus, the possession of a tenure agreement nearly triples the number of trees on a plot. Other important influencing factors are the reception of material support and farmers' perceived access to extension services. The wealth level of the farming households, proxied by the calculation of a relative poverty index using principal component analysis, does not show to have a significant impact on the number of trees on a plot. Nonetheless, significant differences between the wealth levels of sampled households that have a tenure agreement and those households without any agreement exist. At the policy level, expert interviews revealed that unclear responsibilities between different departments involved in land administration lead to conflicts. Thus, although the issuance of land tenure agreements shows positive environmental effects, challenges at the policy level remain.

Keywords: Agroforestry, CBFM, forest land, land tenure security, sustainability

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Land Consolidation and Agricultural Sustainability in Turkey

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Land consolidation works are carried out in Turkey since the 1960s and only 10 % of agricultural lands have been consolidated. The main objective of land consolidation is to ensure rural development. Yet, in Turkey, due to the lack of monitoring and evaluation after consolidation practices, data to determine if the consolidation has resulted in expected socio-economic impacts is lacking. Land consolidation caused increases in productivity per unit area increasing size of land plots and changing the plot shape to become more suitable for modern agricultural techniques. In this context, the increase in productivity and the farmers' economic situation need to be investigated. The farm size is the key factor in the farmers' production capabilities and consequently their incomes.

The optimal size of the agricultural holdings should be known well in the region that is undergoing consolidation. Since there are different climate zones in Turkey, this size varies in every region. Mechanisms should be developed that will ensure optimum size for facilities. Insufficient facility sizes can cause economic problems in the long run.

In Turkey, lack of annual production planning causes for surpluses in some products and scarcity in others. In today's atmosphere where input prices increase more and more, farmers who lose money migrate to urban areas and find different sources of income or try to maintain production with agricultural credits. Farmers who continue to live in rural areas try to sustain agricultural production on lands that become smaller on account of inheritance laws. Therefore the survey results in villages that are planned to undergo land consolidation show that farmers request lands to be consolidated at sizes that are salable when needed, rather than combining all of the land plots.

Keywords: Evaluating, land consolidation, monitoring

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Did the Ethiopian Land Registration Improve Women's Land Rights and Increase Adoption of Soil Conservation?

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Increasing productivity and incentives to invest in soil conservation techniques are often cited as a rationale to strengthen and document land rights. An early study of a low-cost, community-based land registration effort in Ethiopia, based on a survey conducted three years after start of implementation, found that, while the registration process was not biased against the poor, its gender impact was limited, with low female participation and only a fifth of land administration committees having a female member, even if this was required. The study also found positive initial impacts on households' undertaking new land-related investments in the last 12 months.

This paper revisits this issue by analysing the medium-term impact of the Ethiopian land registration on household investment behaviour, particularly the adoption of soil conservation techniques and tree planting, using data from the 2009 round of the Ethiopian Rural Household Survey, six years after the start of the land registration effort. The survey covers 1500 households in 15 villages broadly representative of the country's agroecological zones. It examines whether households' knowledge of their property rights under the land registration (as measured by answers to a list of questions regarding the provisions of the registration) has an impact on these investments. We attempt to unpack the "bundle of rights" under the land registration into three categories: tenure security, land transfer rights, and rights related to gender equity and inheritance. We investigate whether knowledge about a particular part of the bundle of rights has a greater impact on land-related investments, such as soil conservation and tree planting. We then examine whether gender differences in knowledge of property rights within the same household and across different bundles of rights have a differential impact on tree-planting and soil conservation, differentiating by gender of the household head and the plot manager. Answering this question contributes to the growing literature on the role of legal knowledge in enabling women to benefit from interventions that strengthen their property rights.

Keywords: Ethiopia, gender, land rights, legal knowledge, soil conservation

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Uncovering Governance Challenges in the Implementation of Post-Conflict Agricultural Recovery Programs: A Case of NUSAF and NAADS in Northern Uganda

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Programs that promote agricultural development play an important role in post-conflict areas because virtually the entire population in the affected areas depends on agriculture for their survival. Yet there are major challenges in the implementation of such programs geared at post-conflict recovery, such as mismanagement of funds, targeting problems and elite capture. The large scale programs that are being implemented in the post conflict situation of Northern Uganda such as the northern Uganda Social Action Fund (NUSAF) and the National Agricultural Advisory Services (NAADS) programme offer an important opportunity to learn about the opportunities and challenges of different implementation and targeting mechanisms. The goal of the proposed paper is to study such programs in a comparative perspective with the objective of generating policy relevant information on promising strategies for achieving food security and agricultural development in post conflict areas. Taking the case of the two programs stated above, this paper analyses the governance challenges that occurred in the implementation of these programs and possible strategies to address these challenges. The examines "supply-side challenges" (lacking capacity and incentives of the implementing agencies) and "demand-side challenges" (*i.e.* lacking capacity of the beneficiaries to demand good programme implementation and to hold the agencies accountable). A "Process Net-Map" tool and qualitative research tools like in-depth interviews and focus group discussion were used to identify governance challenges in implementation process and actors involved. The influence level of each actor was determined based ranks given by respondents and problem areas in the implementation were identified. The main supply side challenges identified included lack of human resource capacity, lack of monitoring to control kick-back payments for staff and embezzlement of funds, and political interference in contracting, *e.g.*, of agricultural inputs. The main demand side challenges arise due to low literacy rates, loss of social capital during the conflict, and political patronage. The study concludes that a combination of demand-side strategies, such as increased transparency and community monitoring as well as supply-side strategies, such as improved monitoring, are required to overcome the implementation challenges of post conflict recovery programs.

Keywords: Governance challenges, NAADS, NUSAF, process net-map

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Governance Challenges in Legume Seed Systems: What Role can the International Agricultural Research Centers Play?

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Legumes make significant contributions to diets of the poor in developing countries, especially as a source of protein. At the same time, they play an important role in maintaining soil fertility. Improved legume varieties with higher productivity and disease resistance could make a significant contribution to the well-being of smallholder farmers. However, the self-pollinating nature and low seed multiplication ratio of most legumes lead to market failure as these factors render them non-attractive for the commercial seed industry. Hence, research and dissemination of improved legumes often rely on government systems, which face their own governance challenges such as low efficiency, shortage of funds, and lack of qualified staff. The paper deals with the question as to what role the international agricultural research centres of the Consultative Group on International Agricultural Research (CGIAR) can play in addressing these governance challenges. The first part of the paper uses a transaction cost approach to analyse the role that the international centres should play in relation to national agricultural research centres and national seed systems, considering attributes such as transaction intensity, asset specificity, economies of scale and potential for spillovers. The second part of the paper presents an empirical analysis of the programme for improved groundnut and chickpea varieties of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in three countries that differ with regard to the capacity of their agricultural research systems and the state of their seed systems: India, Malawi and Ethiopia. A participatory mapping technique called Netmap, key informant interviews, and a meta-analysis of adoption studies were conducted to analyse the role of the different institutions and actors involved in promoting improved legumes. The results indicate that international agricultural research plays an important role in breeding improved varieties, for which the centres have a comparative advantage. However, due to factors such as donor pressure to show impact, the international centres also engage in downstream activities of seed promotion, which are problematic from a governance perspective, because they either compete with national systems, or they reduce the incentives for national governments to overcome the governance challenges in their national systems.

Keywords: Agricultural innovation, CGIAR, seed systems, spillovers, transaction costs

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Resources

Resources within the rural-urban continuum: Communities and ecosystem services

Including Urban and Peri-Urban Agriculture in Developing Resilient Cities

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In 2008 the world's urban population outnumbered its rural population and it is predicted that 60 percent of the world's population will live in cities by 2030. Cities in developing countries are confronted with enormous challenges, while their resources are often rather limited. Cities moreover are highly vulnerable to the disruption in critical (food) supplies (many cities have only for a few days food supply) and the changing climate exacerbates this vulnerability. Urban economies may suffer, as rural agricultural production is adversely affected by storms, floods, shifting seasonal patterns, droughts or water scarcity.

Urban and peri-urban agriculture is defined as the growing of food and plants and raising of animals and fish in and around urban areas; by making use of urban resources such as land, labour and urban organic wastes, producing for urban citizens, influenced by urban policies and regulations, land availability and prices, and urban markets, and effecting urban food security and poverty, as well as the urban environment and health.

Over the past 15 years, urban agriculture has grown from individual project and research interest and interventions to interest by various local, national and international agencies in the contribution of urban and peri-urban agriculture, or increased local food production, to more resilient urban food systems.The growing interest for urban and peri-urban agriculture is triggered by recognition of its (potential) multiple co-benefits and contributions to not only improving food security and nutrition, but also to community organisation, city greening, waste management, income and employment generation and – more recently – city resilience and climate change adaptation (including flood mitigation and reduction of urban temperatures).

It is in this context that resilient urban or city-regional food systems increasingly are getting attention by both international as well as governmental actors. These are comprehensive strategies that integrally considers rural-urban food flows, food production, processing and distribution, sustainable resource use, health and nutrition. To develop resilient urban food systems, a holistic approach is required that integrates all aspects of the food system. This includes urban and peri-urban agriculture, but also strengthening the rural-urban interface to ensure connections between rural supplies and urban contexts.

Rural and urban farming systems exist in a continuum with multiple types of flows and interactions between them. It is essential to define in which cases urban and peri-urban agriculture has a clear comparative advantage over rural agriculture.

Keywords: Food systems, multi-functionality, urban and peri-urban agriculture, urban planning, urban resilience

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Plant Communities of East African Wetlands and their Relationships with Land Uses and Soil Properties

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In East Africa demographic growth, degradation of upland soils and inter-annual variability of rains is increasing the pressure on both seasonal and permanent wetlands for crop production. The duration and intensity of agricultural land uses differentially affect soil properties, leading to negative impacts on a number of regulating and supporting functions of wetland ecosystems and potentially on the long-term productivity of the soils. To determine effects of land use and changing soil properties on the composition of vegetation we carried out a survey in four agriculturally used wetlands of Kenya and Tanzania between 2008 and 2009. Tanzanian wetlands were represented by a lowland floodplain of the Pangani river and a valley bottom in the Usambara Mountains. Kenyan wetlands were represented by a highland floodplain on the Laikipia plateau and a valley bottom on the foot slopes of Mount Kenya. A rapid appraisal with key informants determines the characteristic land uses and the land use history. According to preferential sampling, 224 plots of 10 m^2, representing the dominant land use types were selected. In those plots we recorded all present species and estimated their abundance as percentage cover. In each plot topsoil samples (0–15 cm) were analysed for selected physical and chemical attributes. The vegetation was classified using hierarchical clustering. Relationships between species composition / plant community types and soil properties were assessed by canonical correspondence analysis (CCA). The vegetation was classified into 10 communities types (clusters), five of which were weed communities in arable land. Ordination analysis indicated that plant communities responded more to soil property changes than to land uses, with soil exchangeable K, electric conductivity and pH being the main determinants of species composition. Interactions between soil and land use attributes in determining species composition as well as the use of plant assemblages as indicators of the wetlands ecological status will be discussed.

Keywords: Land use, Kenya, Tanzania, wetland vegetation

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Trade-Off Analysis and Economic Valuation of Intercropping Teak (*Tectona grandis*) – Maize under Different Silvicultural Management

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With decreasing forest area and the recent logging moratorium in Indonesia, timber production increasingly comes from smallholder systems within which laissez faire tree management has often led to low quality timber and hence low revenues for farmers. We carried out *ex-ante* analysis to explore the effect of different management practices on growth and production of teak and maize when they are intercropping using the tree-crop interactions model (WaNuLCAS). We considered a three-treatment factorial: the initial teak density (1600 trees ha^{-1} (2.5 m x 2.5 m), 1111 trees ha^{-1} (3 m $\times$ 3 m) and 625 trees ha^{-1} (4 m $\times$ 4 m)), the thinning (light (25 %), moderate (50 %) and heavy (75 %) of tree density), and pruning (40 % and 60 % of crown biomass). We compared intercropping with both teak and maize monoculture to show the trade-offs amongst different management options. As expected, cumulative maize yield in the first years of teak growth was negatively correlated with tree density and 10 % – 38 % higher when the tree density was reduced. All intercropping practices produced higher wood volume when compared with monoculture, as trees benefit from crop management and fertilisation. Maximum wood volume (m^3 ha^{-1}) was provided by the system with initial tree density 625 trees ha^{-1}, 25 % of it was thinned at year 5 and another 25 % of it was thinned at year 15 and 40 % of crown pruned at year 4, 10 and 15. However, greater stem diameter per tree was provided by 50% of thinning at year 5 rather than 25 % of thinning at year 5. Although greater stem diameter is rewarded with higher market price per volume of wood, an economic evaluation taking into account the cost of labour (for thinning and pruning) and its effect on additional timber revenue showed that the highest Net Present Value and return to labour was provided by the system with the second 25 % thinning done in year 20 instead of year 15.

Keywords: Agroforestry systems, ex-ante analysis, silviculture, smallholder teak, trade-off analysis

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Resource conservation and Rice Production in Mangrove Forests of Yanbye Township, Rakhine State, Myanmar

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Agricultural encroachment in the mangrove forests in Yanbye Township has been witnessed for the last 10 decades and has been exacerbated by population pressure and misleading agricultural development policies during 1980–2010 to increase rice production at regional and national level. The policy of the agricultural department failed to address the environmental impact, and as a consequence the mangrove ecosystems are exploited at an alarming rate with a great loss of important environmental services and economic goods. Conservation of the regional mangrove ecosystem is urgently needed and an immediate envisaged policy is to relocate the existing farms outside the reserved mangrove forest.

This study aimed to assess farm level productivity and profitability, and the contribution of existing mangrove-dependent rice farming to local food security and employment opportunities to be considered in the mangroves reforestation and farm relocation program. Descriptive analysis, cost-return analysis and factor share analysis were conducted by using secondary and field survey data of 147 farmers for the 2011 - 2012 production year.

The results revealed that farming systems are profitable at a very low level with 1.49 tons per acre of average yield giving 37.36 US$ ac^{-1} net benefit with a benefit-cost ratio of 1.28. One acre rice farm offers seasonal employment to 41 labourers in the growing season. The total revenue comprises 36.49 % of farmer share while other cash and in-kind benefits contribute 63.5 % of total revenue. For the rice farm area in reserved forest of 1370 acres, where 620 households are currently working, to be aborted for mangrove reforestation, the minimum loss of rice production would account for 4.5 % of the township's total production amounting to 3579 t $year^{-1}$ with a simultaneous loss of 98482 working days for a rice growing season, leaving 1860 rural people unemployed. Although estimation was at the minimum level, rice production and unemployment indicate for the implementation of reforestation and farm management policy from decision level. There should be looking for alternative employment and income generation to conserve over exploitation of resources in the name of local food security and employment opportunity.

Keywords: Employment opportunity, food security, mangrove ecosystem

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Farmers' Perceptions of Agrobiodiversity in Western Kenya

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Policy makers, programmers and researchers see enhancing agrobiodiversity as an important way to improve nutrition and livelihoods of small-scale farmers. This study assessed the perceptions of farmers in Western Kenya on agrobiodiversity to develop recommendations on how to better integrate these perceptions in future agricultural interventions.

A total of twelve focus-group discussions (six with women and six with men) were conducted in six villages in Teso South and Bondo districts in Western Kenya, located in an agrobiodiversity-rich area just neighbouring a sugarcane-growing belt. In addition 30 farm households in the same villages were interviewed on their perceptions and level of agrobiodiversity using structured questionnaires.

On average, study households cultivated 22 food crop species on a farm of 0.9 ha. When asked to choose, 29 out of the 30 households preferred an agrobiodiversity-rich farm to a specialised one such as sugarcane. The five main reasons for preferring a agrobiodiversity-rich farm were given in the focus-group discussions as food security, income, a balanced diet, improving soil quality and saving money (by not spending it on buying food). The main theoretical and practical reasons given against high agrobiodiversity were land scarcity, insufficient inputs such as fertilisers and agrochemicals, and high labour needs. Respondents suggested that the best interventions to increase agrobiodiversity would be improved access to farm inputs, especially seeds, availability of labour force, and enhanced knowledge on managing the different species. However, some respondents may have confused 'agrobiodiversity' with 'farm productivity', which should be better explained in future studies.

The fact that farmers value agrobiodiversity should encourage key stakeholders in development programs to further promote diversification of farming systems for improving rural livelihoods and food and nutrition security. Capacity building and improving farmers' access to agricultural inputs should be integrated into future interventions on enhancing agrobiodiversity. Farmers also believe that higher agrobiodiversity needs more fertiliser and chemicals. In general it is assumed that diverse farms need less fertiliser and have fewer pest and disease problems.

Perceptions exist that enhancing agrobiodiversity can contribute to food security and income, as these present the strongest incentives for high agrobiodiversity from the farmer's point of view.

Keywords: Agrobiodiversity, food security, Kenya, perceptions

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Contribution of Forest Resources to Rural Livelihood of Local Community in Protected Areas of Vietnam – Case of Thuong Tien Nature Reserve, Kim Boi District, Hoa Binh Province

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The limited knowledge on livelihood and importance of forest to residents in protected areas is the reason why forest management practice has not yet achieved conservation and development objectives. It even sometimes causes conflicts between the protected areas and local communities. The research on contribution of forest resources to rural livelihood of the communities living inside or around Thuong Tien Nature Reserve, Kim Boi district, Hoa Binh province bases on two criteria: distance from the household to the forest and household type. The applied methods in the research include analysis of secondary data and survey using participatory rural appraisal (PRA) tools: household survey (one hundred sixteen households), group discussions and expert interviews.

The research results show that there are three approaches to livelihood of residents living inside or around the nature reserve: (1) People develop agricultural production including wet rice cultivation and livestock; (2) People find sources of livelihood in other areas or trading; (3) People collect products from forest and forest land. The household survey results reflect that the major livelihood source in the research area is the exploitation of the forest resources, namely timber, fuel-wood, bamboo and medicinal plants as well as raising animals in the forest. The analysis of the contribution of these forest resources to the total income of the households relates the distance to forest and the household types. The results show that the correlation between total income of the surveyed households and the income from forest and forest land is relatively strong to very strong with a R^2 between 0.375 – 0.787. The research findings also reveal that the nearer people live to the forest the more important forest resources are for their total income. This is especially the case for poor households. Recommendation for solution packages are given with the aim of helping the nature reserve and local communities to promote the implementation of both conservation and livelihood development objectives in the area.

Keywords: Forest resource, livelihood, local community, nature reserve, protected area, Vietnam

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Firewood Consumption in the Tamale Metropolis: A Case Study in Nyohini Community

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A study was carried out in Nyohini, a suburb of Tamale, Ghana, to ascertain household firewood consumption levels with emphasis on sources as well as preference for firewood species in the community. A sample size of 100 respondents was selected and interviewed using the constant skip method with semi-structured questionnaire. Out of the 100 respondents, 90 were households while 10 were firewood sellers in the study area. Firewood was revealed to be the major form of household energy in the study area, basically for cooking family meals and heating water. The study identified two natural woodlands in Tugu and Gimli communities where the firewood was obtained for use in Tamale. Households purchased firewood from retailers in the study area who also buy from wholesalers who go to these two communities to harvest them. The study revealed that 82.5 % of the respondents used an average of 15 kg of firewood per day which implies that each household consumed approximately GH¢ 60.00 (US$ 30.30) a month on firewood. The study further indicated that respondents preferred firewood as a source of energy compared to other forms of energy because it was considered cheap, readily accessible and needed no skills to use. On the preference for wood species, the study revealed most of the respondents (81.1 %) showed no preference for any species while 18.9 % have preference for some specific species. High calorific value, less smoke production, charcoal residue, less odour emission, ease of ignition among others were the qualities sought for in firewood by those in the preference class. However, it was noted that the use of firewood could cause problems such as swelling of eyes, coughs, burns, air pollution, and degradation of the vegetation, among others. Despite the rise in demand for firewood in the community, the supplies keep dwindling over time. The study therefore calls for pragmatic measures to avert any future firewood shortfall. This could be done by advocating for the establishment of individual and community woodlots in order to lessen the pressure on the natural vegetation.

Keywords: Consumption, firewood, sellers, woodlot

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Livelihood and Integration of Indigenous People in Natural Forest Management: Case of Dak To State Forestry Company, Kon Tum, Vietnam

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Most of the remnant natural forests in Vietnam are located in mountainous areas where indigenous communities reside. The majority of indigenous people are poor. They heavily depend on the forest for subsistence and livelihood. Forests in Vietnam are state-owned assets assigned to various forest owners for management, such as the State Forest Enterprise, or the so-called State Forestry Company (SFC). The management of natural forests by SFCs is currently facing three main problems: low profitability, forest degradation, and conflict over land and forest use by local people.

This research investigates the importance of forests to the livelihood of households, the levels of integration between the SFC and households, and the perception of households on forest management practices. The research is based upon a case study of Dak To SFC in Kon Tum province of Vietnam. Sixty-two households from five villages were surveyed. Key informants were also interviewed to gain an understanding of the local situation.

The research findings reveal that the income of the migrant group (Kinh and others) is 4.2 times higher than that of the indigenous group (Sedang). The main income source of the migrant group is from business and service (62.6 %), while the indigenous group gets their income more from agriculture (mainly of Cassava, constituting 48.9 %). By contrast, the indigenous and low income household groups have greater access to forest and depend on it as their source of income, accounting for 5.8% and 14.9 % respectively. The migrant and the high income groups show almost no income from the forest, 0.4 % and 0.6 %. The difference in forest dependence is of high significance ($p < 0.000$). The SFC acts solely in planning forest management without the participation of locals. The total land owned is not much different, an indigenous household owns 1.2 times more than a migrant household. However, conflict over land is reported by 38.5 % of the indigenous group members.

Another field of conflicts is the lack of consideration of local people in operation planning and the lack of trust in the SFC's management ability. Recommendations for conflict resolution are to involve indigenous people in planning and improve forest management.

Keywords: Dak To, indigenous people, integration, livelihood, natural forest management, state forestry company, Vietnam

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Developing Community Forestry Management Strategies for Multiple Ecosystem Services and Benefits in the Mid-Hills, Nepal

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The concept of community forestry (CF) in Nepal is to improve forest conditions, and to increase forest products and livelihood promotion through stakeholder participation. The community forest user group (CFUG) as a local institution is responsible to develop and implement the community forest management plan with technical support from the District Forest Office (DFO). So far within the community forest programme much emphasis has been placed on social processes and participation of various social and ethnic groups with the CFUG. Identification of production potentials regarding to timber and non-timber products as well as a variety of ecosystem services, the specification of management goals as well as sound silvicultural tools to achieve such goals have not yet received so much attention. As a consequence developed plans may not be technically sound and not fully implemented due to lack of technical know how regarding silvicultural operations and insufficient planning procedures. Addressing these issues the aim of the current research was to assess the currently practised operational forest management in specific forest areas and to propose management alternatives where deemed necessary. In this contribution we use Taldanda CF in the mid-hill region of Nepal as example to highlight major issues and to demonstrate potential alternatives to improve the utilisation of forest resources to the benefit of the CFUG.

DFO staff and 7 focus groups from the community were consulted to collect the local knowledge and develop a locally accepted set of criteria and indicators to assess forest management. An input-output analysis of forest management operations and a forest inventory provided valuable input for a thorough assessment of current management and the development of improved management alternatives.

The careful assessment of the forest resource should be done based on qualitative and quantitative data, users' expectations to achieve multiple products and ecosystem services that enhance livelihood of local people while maintain or improving forest conditions.

Keywords: Community forest, criteria and indicators, input-output analysis, management strategy, Nepal

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Improved Charcoal Production for Environment and Economics of Blacksmith: Evidence from Nepal

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Blacksmiths in Nepal are marginalised and disadvantaged occupational caste, however, very popular for their handicraft works mainly in making iron tools and equipments. With the advancement of technology, there have been many innovative technologies in many other sectors but blacksmiths in Nepal are still dependent on their indigenous and conventional practices which have direct negative consequences for environment, biodiversity conservation and health. Recently, improved charcoal production technology has been implemented among the blacksmith households in Sindhupalchowk district as a pilot project. However, there is little research about the impact of improved charcoal production on forest resources conservation and people's livelihoods. This study therefore made an effort to explore the impact of improving charcoal production technology and firewood consumption on conserving the environment and promoting sustainable livelihood of marginalised households in rural areas of Nepal. Findings of the study revealed that improving charcoal production technology has positive impacts on forest tree conservation by reducing the fuel wood consumption up to 40 % with 60 % energy efficiency as compared to the traditional system. The improved charcoal production pilot project has reduced annual CO_2, CH_4 and CO emissions in the study area by 2.4 – 3.1 t, 3.3 – 4.3 t and 2.6 – 3.5 t, respectively. Furthermore, improved charcoal production system increases blacksmiths' welfare through generating social, human, and economic capital and quality attributes like environmental sustainability. Introducing improved charcoal production and controlling heavy firewood collection at rural villages of Nepal will help to increase carbon sequestration and reduce the sources of carbon emission in context of global climate change.

Keywords: Blacksmith, charcoal, climate change, Nepal

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The Value of Private and Public Goods from Agro-Forest Ecosystems and Native Pollinators - The Case of Selected Rural Communities in Northern Thailand

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The international community is showing increasing concerns regarding the continued decline of wild and managed pollinator populations worldwide, a phenomenon that has been recognised to be mainly caused by agricultural intensification, pesticide use and habitat loss. Animal-mediated pollination, especially as provided by bees, is responsible for about 35 % of the global food production.
Many native bee species of Europe and North America have been reported to be declining or threatened to disappear, making agriculture increasingly reliant on the pollination services provided by a single bee species, namely the European honeybee *A. mellifera*. Moreover, domesticated and feral colonies of this species have been driven to severe declines, to a large extent on account of an ectoparasitic mite that is native to Asia. This development should serve as a warning for agricultural systems in the tropics, where crop pollination is more susceptible to failure due to surrounding land use changes.
There is evidence that in some regions of Thailand deforestation and the overuse of pesticides have led to important declines of native bee populations, further causing losses in agricultural productivity. Thailand is endowed with a great diversity of stingless bee species and honeybees (with the exception of *A. mellifera*, all other 8 honeybee species of the world are indigenous to the Southeast Asian subcontinent). Nevertheless, Thailand's efforts to promote beekeeping have been mainly focused on the culture of the European honeybee, notwithstanding its prohibitive costs for smallholder farmers. Meanwhile, the potential to generate additional rural income offered by traditional beekeeping with native bee species remains underestimated.
This study attempts to estimate the value that local farmers of bee pollination dependent orchards place on different strategies intended to conserve native bees. The Discrete Choice Experiment (DCE) method is applied to elicit such value perceptions. The resulting stated choice data is analysed using econometric models, such as the conditional logit and the mixed multinomial logit, which allows calculating the willingness to pay for each conservation strategy. Thereby, the authors aim at finding potentials to integrate the economic incentives of rural smallholders into the global conservation goals for native pollinators and their habitats.

Keywords: Conditional logit, conservation, discrete choice experiment, mixed logit, native bees, pollination

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Payments for Ecosystem Service Schemes: The Case of Gender Inclusiveness

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Reconciling local livelihood development with national and global conservation needs is among the key challenges facing biodiversity conservation in Africa. Payments for ecosystem services (PES) have emerged as a promising approach to address this challenge, yet there are important knowledge gaps regarding effectiveness, and equity aspects, including gender equity, in such schemes. The study addresses this knowledge gap by conducting an empirical study of biodiversity PES schemes in Kenya. This paper analyses the extent to which different actors, including men and women influence the design and implementation of PES schemes. A conceptual framework is developed that follows evidence which shows that understanding institutional arrangements of conservation programs provides a useful entry point for the analysis of the extent of equity, and for the identification of feasible PES arrangements. One such institutional arrangement in Kenya is analysed empirically using a participatory mapping tool, called process-influence mapping and semi-structured key informant interviews. The results show that simple institutional arrangements amongst actors with diverse needs can enable the effective achievement of conservation without undermining the livelihoods of local communities. The voluntary nature of PES enrollment as well as the simplicity of contract design offers communities substantial influence over important aspects of program implementation, together with a significant incentive to retain ownership over land and sustainably maintain their livestock-based livelihoods. While the majority of PES contract holders are men, mechanisms to integrate gendered needs contribute considerably towards the attainment of household welfare outcomes and create the opportunity to systematically improve gender equity.

Keywords: Gender, Institutional arrangements, intra household decision-making, payments for ecosystem services

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Integrated Assessment of an Agroforestry System for Sustainable Land Management in Dry African Savannah

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There are several challenges faces the forest and agricultural sectors in Sudan which imposes the needs for well-designed information systems and management plans. Despite the land uses and its dynamics serve as one of the major input criteria for sustainable development programme, since 1970s the majority of the land areas (85–90 %)were managed weakly by the government, when the issued act disregarded land used by customary laws. Since then, large areas were leased to individuals for monocropping, which has clearly proved to be socially, economically and environmentally harmful. From that perspective, these challenges impose the need for efficient farming systems to integrate community participation in forest conservation and management plan, as well as to rise sedentary human civilisation for the both rural and urban communities. Therefore, the Tongya system has been introduced as an alternative solution, where farmers are encouraged to cultivate cash/food crops on deforested lands on the condition that they replant and maintain trees during the establishment years. Accordingly, this study is of great value to examine the effectiveness and vulnerability of the introduced system in the Blue Nile region. The adopted method in this research incorporates the utilisation of successive backward evaluation based on integrated multi-temporal satellite imagery and field data. The Earth Observation data were analysed with GEOBIA (GEOgraphic Object-Based Image Analysis), aided with oriented field samples for the identified recovered sites. For each investigated year, there were two periods in which different criteria were used: in the cultivated season the area, type, and number of cultivated years were defined, while in fallow season the growth and density in planted trees were estimated. Hierarchical multi-level segmentation thresholds were created and the targeted areas were delimited with semantic meanings by rule sets. Consequently, the dynamic changes were quantified and assessed for the periods 1995–2010 based on various segment's spectral layer values, ratios, and textural features. The present study exhibits a great capability of the adopted approach to evaluate the cropping systems. Meanwhile, the Tongya system persists to reveal its effectiveness in re-establishment of deforested areas and raising the farmer's income as a heart of antipoverty effort.

Keywords: Blue Nile region, GEOBIA, poverty alleviation, satellite image

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Economic Valuation of Access to Natural Resources in three South Caucasus National Park Areas

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Because of its exceptional conservation value, the German Federal Ministry for Economic Cooperation and Development (BMZ) initiated a multi-year programme on transboundarynational parks (NP) in the South Caucasus (Armenia/AR, Georgia/GE, Azerbaijan/AZ). Sheep and cattle herding on high altitude summer pastures is one of the most important income sources pressuring NPs and their buffer zones. In an interdisciplinary project on integrated conservation planning in the region, we conducted two twinned, transboundary case studies (Lake Arpi/AR-Javakheti/GE and Zaqatala/AZ-Lagodekhi/GE). Here we report on small famer preferences in Lake Arpi, Javakheti and Lagodekhi for access to natural resources in and around the NPs as well as for training measures for income alternatives. Following qualitative interviews (n=31) and a quantitative pilot study (n=120) a choice experiment (CE) was administered (n=3*100; clustered random sample). The CE was overall highly significant (P(chi^2, 9 df)<0.0001).

Regularly, households are allowed to collect plants and fuel wood for home consumption. Preferences for additional opportunities for commercial exploitation of these non-timber resources could not be found ($p = 0.133$) but a loss of current access is of major concern. To compensate for a potential loss of access for home consumption, respondents require, on average, a minimum payment of 12 % of their monthly income ($p = 0.001$; willingness-to-accept compensation: WTA). For each 1 % restriction of summer pasture area, WTA is 0.7 % of income ($p < 0.0001$). Training measures for bee-keeping ($p = 0.001$), cheese production ($p < 0.0001$), and tour guiding ($p < 0.0028$) are well-appreciated (positive willingness-to-pay, WTP); there are pronounced regional differences, though.

In view of the highly precarious economic situation of the population of the case study areas, we suggest that further restrictions of local land use (non-timer resources, summer pastures) in favour of conservation concerns need to account for the substantial associated economic losses. Buffer zone management should focus on regionally differentiated training measures that are able to increase local incomes.

Keywords: Buffer zone management, conservation planning, economic valuation, transboundary national parks

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Multidimensional Assessment of Food Security and Environmental Sustainability: A Vulnerability Framework for the Mediterranean Region

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Recurrent food crises and climate change, along with habitat loss and pollution, have put food security and environmental sustainability at the top of the political agenda. Analyses of the dynamic linkages between food consumption patterns and environmental concerns have recently received considerable attention from the international and scientific community.

Using the lens of a wide sustainability concept, this paper aims at developing a multidimensional framework for evaluating sustainability in food systems and diets applicable to the Mediterranean countries.

The Mediterranean region - a geographically interlocked and heterogeneous area including South European, North African and South-East Mediterranean Countries - presents several conditions of vulnerability to food insecurity and unsustainability. Furthermore the demographic growth, in urban and coastal areas of the Basin, leads to an increasing pressure on natural resources and widening disequilibria with rural areas.

Derived from natural disaster and sustainability sciences, a coupled domain / vulnerability approach has been applied to the analysis of the concepts of sustainable food security and diets. Within consensus-based preselected domains, the vulnerability methodology offers a coherent framework that disentangles exposure, sensitivity and adaptive capacities. A DELPHI method is applied to select the final set of indicators from the literature.

The main result is the elaboration of an innovative conceptual evaluation framework for measuring sustainability in the agrofood system. The framework draws upon two existing approaches: a vulnerability-based assessment method combined with an analysis of detailed empirical domains relevant for Mediterranean countries. The DELPHI selection process, involving several international experts, has reduced the number of indicators to a reduced pool of indicators.

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Use of the participatory approach of the DELPHI method helps move beyond subjective evaluation and reach consensus. Recognizing the systemic dimension of sustainability, the vulnerability approach enables to investigate the causal factors dynamics, instead of targeting exclusively the final outcomes. The domain-based framework reflects the region-specific attributes that necessarily need to be identified to link scientific concepts with metrics. Urbanisation is a main domain of vulnerability as it is a key driver of change affecting both market dynamics and consumers' behaviours, raising questions for food security.

Keywords: Food systems, integrated geographical approach, metrics, resilience, sustainable diets

Enhancing Conservation Units Management through Sustainability Indicators: A Case-Study in Combu Island, Brazilian Amazon

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In response to the high rate of deforestation observed in the Amazon Region, state and federal agencies have acted to regulate the Conservation Units (UCs) with the function of protecting areas with natural characteristics. Developing means of managing such areas, especially those where traditional people and communities are settled is therefore important to ensure the sustainable use of land and forest resources. This paper uses appropriate conceptual framework to propose the use of specific indicators systems for protected areas which could be useful to assess local sustainability as well as tools to determine weaknesses and strengths, and thus support the planning and execution activities related to the management. The paper shows the results of a research conducted at the "Combu Island" located in the Amazon Basin, an Environmental Protection Area (APA), a subgroup of Conservation Units of sustainable use, which allows the presence of residents. The island, with an area of 1.500 ha, has an estimated populations of 300 families distributed in four communities. A household survey using the participatory diagnosis was conducted on 100 households to collect data on economic, ecological and social aspects. The results were tabulated and transformed into indicators in the context of environmental, social, economic and institutional dimensions of sustainability. Weights and degrees of significance were adopted in order to determine the indices values by dimension of sustainability and the Global Sustainability Index (GSI) for the APA. The study proposed, taking into account achievable and verifiable criteria, the selection of 13 sustainability indicators for the APA. Each indicator has received significant degree interval between 0 and 1. Average indices for each sustainability dimension were evaluated and the results showed not satisfactory degrees of sustainability in the environmental, social and institutional dimension, and particularly low degree for the economic dimension, requiring attention and measures to be adopted to improve such figures. The GSI of the APA was thereafter calculated by the average of all dimensions and set as 0.437, which is very close to the minimum value for the average degree (0.400). Below this limit, the sustainability level reaches the stage alert.

Keywords: Brazilian Amazon, management of conservation units, sustainability indicators

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Dynamics of Carbon Sequestration in Areas with Historical Use of Agriculture in Northeastern Mexico

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Human activities produce land use changes in accordance to the needs of society. This leads either to a direct exploitation of the natural resources or to an agricultural land adaptation. The objective of the present study was to estimate the carbon content of former cultivated mezquital areas with a time of abandonment of 15 and 30 years. The study areas were located near the town of Linares, Nuevo Leon. For the estimation of the carbon content a systematic sampling design was used, in each area four sampling sites of 1,600 m^2 (40×40 m) divided into four quadrants were established. In quadrant I all trees and shrubs larger than 1 cm in diameter were counted. In the quadrants II, III and IV only trees over 5 cm in diameter were evaluated. The dasometric measurements made were total height (h) and diameter.

The for 30 years abandoned mezquital resulted in the largest value of carbon content in the aboveground biomass with 18.83 t ha^{-1}, followed by the primary mezquital with 14.76 t ha^{-1} and mezquital of 15 years abandonment with 5.24 t ha^{-1}. The carbon sequestration potential expressed in t CO_2e ha^{-1} $year^{-1}$ had a minimum value of 0.35 t C ha^{-1} $year^{-1}$ which is equivalent to 1.29 t CO_2e ha^{-1} $year^{-1}$ in the mezquital of 15 years. The maximum value was obtained in the mezquital of 30 years with 0.63 t C ha^{-1} $year^{-1}$ which equals 2.31 t CO_2e ha^{-1} $year^{-1}$. Recovering the initial state of primary mezquital in a geoform type of valley is possible, as can be seen with the mezquital of 30 years that bypasses the carbon content that was found in primary mezquital reserves. The abandoned valleys with former agricultural use showed a high level of natural regeneration that should be taken into account as an important ecosystem for carbon storage. Likewise these areas could be promoted for forest plantations.

Keywords: Aboveground biomass, carbon content, mezquital

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Habitat Degradation Shapes Biodiversity Patterns of Plants and Ants in Southwestern Madagaskar

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The Mahafaly plateau in southwestern Madagascar is part of a semi-arid region, characterised by a high level of local endemism in plants and animals (*e.g.* $> 90\,\%$ of the woody species are endemic). The natural vegetation of the area would be deciduous spiny forests. However, poverty and the fast population growth lead to an increased exploitation of the natural resources by the local population. The present extensive but non-sustainable land use practices for subsistence caused habitat degradation of forests (*e.g.* due to overgrazing, collection of firewood, logging and charcoal production) and the conversion of natural forests to cultural land (*e.g.* non-fertilised crop fields, hedges). Apparently, the land use type and land use intensity have pronounced impacts on biodiversity patterns of the natural assemblages, even in this remote area and even in the local National Park Tsimanampetsotse. The exact patterns of the biodiversity are, however, unknown.
Analysing composition of assemblages of plants and ants, we show that the effects of habitat degradation on natural communities differed among taxa. In n=137 plant communities, increasing habitat degradation lead to (1) decreasing local species richness, (2) increasing number of herbaceous neophytes and (3) decreasing species richness in woody species. Patterns of plant species occurrence were nested. In contrast, species richness in ant assemblages did not respond to habitat degradation. However we found considerable species turn-over along the degradation gradient. In both lineages we found a homogenisation of the assemblages with increasing degradation. We conclude that, although the ecologic mechanisms differ among groups, a substantial part of the natural communities are highly sensitive to habitat degradation. Thus, our findings emphasise the need for forests effectively protected and the establishment of sustainable land use practices within our study area.

Keywords: Beta diversity, community composition, land use, Madagascar, nestedness

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Land Rehabilitation and Female-Headed Households: Evidence from the Bilate Area Closure Project in Halaba Special Woreda, South Ethiopia

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Female-headed households in developing countries are particularly prone to poverty. They are structurally disadvantaged in terms of access to land, labour and other resources, and are often among the most food insecure. In 1995, the Halaba Special Woreda Agricultural Office in South Ethiopia has launched a community based Bilate Area Closure (hereafter Bilate AC) project with the aim to rehabilitate degraded lands and to sustain local people's livelihoods. Various land conservation measures were implemented ever since. The Bilate AC is managed by a community-selected Forest Committee (FC) in which women are represented with 50 %. This study aims to show the impact on and perception of the Bilate AC project with regard to female-headed households. The study is based on empirical field work conducted in 2012 using semi-structured household interviews, focus group discussions and key informant interviews. A total of 218 men and female headed households were interviewed. The result of our study show that female-headed households benefit comparatively more from the Bilate AC project than men-headed ones. 57 % of the interviewed heads of female-headed households said that the project substantially supports their households, compared to 20 % of the men-headed ones. This is mainly due to the fact that the Bilate AC provides food-for-work jobs and opportunities for cash income generation during off-season - such as selling grass fodder and firewood collected from the AC - which are particularly relevant for female-headed households. However, 100 % of the interviewed men stated that the representation of female-headed households in the FC is of no value for the overall project. In conclusion this study empirically shows the strong differences in impact and perception of a rural land rehabilitation project between men- and women-headed households, a fact which is often neglected or underestimated in project conceptualisation and implementation.

Keywords: Bilate area closure, female-headed households, men-headed households

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Drivers of Adoption and Impacts of Conservation Agriculture: Quasi Experimental Evidence from East Africa

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Conservation agriculture is a recent and evolving concept to land management that seeks to optimise crop yields and farm profits in a manner that balances economic and environmental benefits. The underlying principles include avoiding soil tillage. Maintaining soil cover and retaining crop residues, practicing crop rotations and improved fallows, precision placement of appropriate fertilisers, pesticides and herbicides (targeting of inputs), reliance upon integrated pest management (IPM) principles and avoidance of soil compaction, among others.

We use binomial probit analysis and propensity score matching (PSM) methods to investigate the drivers of adoption and assess the impact of conservation agriculture among smallholder farmers in Eastern Uganda and Western Kenya. We use data from 800 smallholder farming households collected in 2010.

The results show that the drivers of adoption are the same in both countries and that although both socioeconomic and biophysical characteristics drive the choice to use conservation agriculture practices, the latter appear to be more important than the former suggesting that increasing land degradation in East Africa will likely trigger increased adoption of conservation agriculture. Farmers whose main livelihood activity is either livestock or non-farm are less likely to adopt conservation practices whereas the relatively well off farmers are more likely to use conservation agriculture practices. Furthermore, results show that farmers in both countries are more likely to use conservation agriculture practices on degraded or soils prone to degradation. The results do not show any gender based differences.

Using both Kernel and Nearest Neighbour Matching approaches, the results suggest significant impacts on maize yield of over 1000 kg ha^{-1} on plots using conservation agriculture practices, negative impacts on the cost of inorganic fertilisers and result in labour savings of between 11–19 person days per ha per season.

We conclude that conservation agriculture has a future in smallholder farming in east Africa with great potential to boost farm productivity and profitability through reduced use of both inorganic fertilisers and family labour inputs.

Keywords: Adoption, conservation agriculture, East Africa, propensity score matching

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Assessment of Local Knowledge and Traditional Uses of *Acacia senegal* in Rural Areas of North Kordofan, Sudan

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This study was conducted in rural villages of North Kordofan State, Sudan in the year 2013. The study assessed the local knowledge related to the different uses of all parts of *Acacia senegal* (Gum Arabic tree). The study also investigated the role of this local knowledge in protection and conservation of *Acacia senegal*. Primary quantitative and qualitative data were collected from the social survey, direct interview and group discussion. Thirty questionnaires were randomly distributed among the rural community who produce and practised gum tapping and collection. The interview covered also those who use *Acacia senegal* for medicinal purposes and traditional uses as jobs. Content analysis and descriptive statistical analysis were applied. The main findings are: *Acacia senegal* is multi-purpose tree. Each part of this tree (roots, root nodes, bark, wood, leaves, flowers, gum, pods and seeds) is used in special traditional or medicinal use. There were more than forty uses for the *Acacia senegal* parts. People use different parts of *Acacia senegal* as food, drink, medicine, culture, believes and norms. Hundred percent of the people acquired their local knowledge from their ancestors and local environment. Poems, wisdoms and says related to *Acacia senegal* played an effective role in protection and conservation of the trees. It contributed to conservation of large areas of Hashab gardens. The study concludes that *Acacia senegal* in North Kordofan is the valuable tree due to its wide range of distribution and uses. It is recommended that this local knowledge should be documented and transmitted so as to assure protection and conservation of *Acacia senegal* by farmer generations.

Keywords: *Acacia senegal*, Gum Arabic, medicinal uses, traditional uses

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Analysis of Deforestation in Elain Area of North Kordofan State, Sudan: The Use of Buchanan Property Rights Approach

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Deforestation as a global phenomenon has been extensively studied, from many aspects using different approaches and methods. The novelty of this study is viewing deforestation as a property rights problem using Buchanan's property rights approach (BPRA) as a lens through which North Kordofan (Elain areas) was investigated. The approach was selected not only because it provides important insight on how deforestation problem developed but also it suggests a clear path of solving the problem. The study applied individualistic method and followed a deductive methodology in which theoretical framework of BPRA (constitutional contract and post-constitutional contract) with underling unanimity principle was clarified. Then, a conceptual framework to analyse deforestation in the study area based on the BPRA was developed. The analysis based on the approach reveals that the once emerged unconscious agreement on social right (social contract) from anarchy situation, between local people (sedentary farmer and pastoralist) in north Kordofan, has been eroded over time with continuous intervention of colonial and post- colonial state. Since then, no consensus or semi-consensus agreements on forest rights were recognised within local people or between local people and state. The discussion reveals how the enlargement of role of the post-colonial state coupled with other factors, resulted in many problems. The change in property rights rules serves the interest of legally enforced modern farmers and urban elites at expense local people interest, increases the efficient but short run agricultural investment at expense of the well adaptive and environmentally friendly traditional agro-forestry systems, created weakly enforced state forests at expense of locally protected communal forest. Overstepping its main task as a protective, impartial body to enforce constitutional contract, the state become the enforced referee as well as player. The legitimacy of unconstrained collectivity become at stake. The need to renegotiate constitutional contract, the rule of the game including the role of state, compromise between different interests to solve disagreement on forest rights, become necessary in order to solve the problem of deforestation.

Keywords: Anarchy, Buchanan, constitutional contract, deforestation, mutual agreement

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Wetland Ecosystems Services and Local Livelihoods: A Case Study of Malinda Wetland in Tanga Region, Tanzania

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In East Africa, wetlands play an important role in supporting the livelihood of rural people. In this study we analyse the provisional ecosystem services that the Malinda wetland in Tanga Region, northern Tanzania, provides to the local population in Kwasunga village. Empirical data was collected between July and October 2012 through 274 household interviews, five focus group discussions, and participatory observation. The results show how different provisional ecosystem services contribute to the livelihoods of different household groups in the village. These include crop production, fishing, livestock grazing, building and craft materials, fruits, medicinal plants, and various direct water services. These services provide subsistence and financial benefits. The village comprises seven sub-villages with different wetland use pattern. The importance of wetland resources also differs among households and sub-villagers; however crop production was equally valued, and contributed most to household income across all sub-villages. Cultivation was done on small fields, on average 0.7 ha. Yet, land shortage is the major limiting factor preventing many families from cultivating in the wetland.

To understand how different household groups benefit in different ways from the wetland, the households were grouped into wealth categories of "poor" and "better–off" which were distinguished based on two definitions, namely: a) one developed by the interviewees themselves, and b) Tanzania's national poverty definition. Findings show that, most households in Kwasunga village are poor and mainly depend on wetland-derived provisional ecosystem services for subsistence and income. We conclude that provisional ecosystem services from small wetlands play a decisive role particularly for the livelihoods of the rural poor; a fact that needs to be considered in wetland conservation strategies.

Keywords: Crop production, economic benefits, ecosystem services, livelihoods, poverty, Tanzania, wetland

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Integration of Innovations in Smallholder Farms Based on a Systems Analysis and Collaborative Learning Communities

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There is evidence that innovations of research and development in smallholder farms in developing countries did not survive the initial stadium. Even more, after researchers left, innovations were far too often disappearing. But does this inform us about the quality of the innovation or its' establishment in a complex farming system and environment? Following the latter, our research team analysed the implementation of Quesungual – a type of agroforestry with undersown maize, beans or pasture – as test plots and demonstration fields in 16 smallholder farms in the Northern Region of Nicaragua. In a first phase we employed qualitative interviews with farmers to understand the broader issue of their livelihoods. This analysis already sensitized us about several factors influencing the sustainability of any farm related innovation. Followed by a series of group discussions over 4 months which we call Collaborative Learning Communities, researchers, extentionists and farmers together studied and evaluated the farms and household performances from a holistic perspective added by women and youth specific group discussions. The process was concluded with an evaluation, which ended up with a list of recommendations to continue the approach and to extend the activities. Thus, the relevance of considering the farmers point of view was emphasised by the collaborative learning process, which gave the opportunity to the farmers, women and young people to be part of the decision-makers. It was seen as essential to establish an interface discourse in order to deepen the communication and the exchange of experiences between the stakeholders, but also between the researches and between both. Thereafter a research innovation should aim to offer more than only a technique and to provide also a "sensitivity" to identify the farmers themselves as subject experts in their own environment. This emotional and subjective characteristic will give them the strength to discuss their wishes, hopes and fears. After all the farmers and their families are the ones who must live with the technology. We conclude that the systems approach and the handing over of the initiative to the farmers, to analyse, reflect and criticise their own "cosmos", seems promising for sustaining the farm innovation.

Keywords: Communication, innovation, qualitative interviews, stakeholder

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Safe and productive urban and peri-urban vegetable farming (AVRDC + IWMI session)

Importance of Vegetables for Food and Nutrition Security in a Rapidly Urbanising World

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The high priority of increasing the availability, access, and use of adequate, safe and nutritious food in the United Nations Post-2015 Development Agenda is recognised by the World Bank and other development agencies. However, it is important to distinguish between having sufficient food and having adequate nutrition. Micronutrient deficiency or "hidden hunger" affects more than 2 billion people worldwide and can exist in populations even where the food supply is adequate in terms of meeting energy requirements. Poor nutrition causes physical stunting and mental impairment in children, leading to reduced potential to succeed in education and the workplace. Even in regions where significant progress has been achieved in reducing the proportion of malnourished children, such as South and Southeast Asia, malnutrition continues to persist, affecting large numbers of children. While these regions continue to deal with the problems of infectious diseases and undernutrition, they are at the same time experiencing an upsurge in non-communicable disease risk factors such as obesity and overweight, particularly in rapidly increasing urban areas. An increase in the availability, affordability and consumption of nutrient-dense fruit, vegetables and pulses is one way malnutrition may be reversed. The World Health Organisation and the Food and Agriculture Organisation of the United Nations recommend a minimum intake of at least 400 g of fruit and vegetables per person per day to achieve nutrition targets, but consumption far below this level is common in many countries. To improve accessibility and availability, local vegetable production may be the solution. Vegetable gardens can improve food and nutrition security, generate additional income, contribute to better health, and promote gender equity. Home gardens provide a variety of fruit and vegetables throughout the year, thus contributing significantly to a nutritious diet for family members and offering opportunities for income generation through sale of extra produce. School and community gardens encourage the production and consumption of a diversity of vegetables and fruit, which is particularly important when persuading children to favour a balanced and nutritious diet as part of a healthy lifestyle.

Keywords: Food security, nutrition security

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The Socio-Economic Impact of Urban Agriculture

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In recent years, food security has become an increasingly urgent concern in national and international policy debates. High and volatile global food prices and their effect on food access by low-income groups has been an important catalyst for this renewed attention.
Most of the projected increase in the world's population over the next several decades is expected to occur in urban centres of low-income regions, hence poverty in this century will become increasingly urban in nature, and so will food insecurity. Urban food security is about much more than the production of food, and requires policy frameworks that encourage rural-urban-linked development approaches.
Cities in developing countries are confronted with enormous challenges and their resources are often rather limited (especially so in sub-Saharan Africa). The growing interest for urban and peri-urban agriculture was and is triggered by recognition of its (potential) multiple co-benefits and contributions to not only improving food security and nutrition, but also to community organisation, city greening, waste management, income and employment generation and – more recently – city resilience and climate change adaptation (including flood mitigation and reduction of urban temperatures).
The effects of UPA on poverty alleviation vary with the type of participants involved, the products produced and degree of market orientation, amongst other things, but in developing countries, the proportion of the urban population that is involved in UPA or UPA-related activities is often quite substantial. These households benefit from UPA in various ways, such as savings, income and improved access to nutritious food.
A general overview of the impact of UPA on food security will be given, as well as main lessons from a RUAF/UN-HABITAT/IDRC study in five cities (Accra, Bogota, Colombo, Kitwe and Rosario) on food and nutrition security and the impact of a crisis. Lessons include the need for interventions in low-income areas that show the possibilities to reduce the costs of food without reducing its nutritional content, which need to be part of broader policies on urban food systems including urban agriculture.

Keywords: Food security, income generation, multi-functionality, urban and peri-urban agriculture, urban planning

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Vegetable Genetic Diversity Maintained by the AVRDC Genebank – A Cornerstone for Sustainable Production of Nutritious Food

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Crop genetic diversity, created through natural and human selection over millennia and complemented by the diversity present in wild relatives of crop plants, provides the raw material that can be employed by scientists to improve crop productivity and diversify production systems. But genetic variation, once considered unlimited, is fast eroding as modern breeding lines replace traditional cultivars over large areas, and natural habitats are destroyed through human intervention. This is especially the case for vegetables; high-yielding hybrid cultivars dominate the seed market and the value chain. AVRDC – The World Vegetable Center maintains a vast diversity of vegetable genetic resources comprising more than 60,000 accessions of 170 genera and 437 species from 156 countries. The AVRDC genebank is one of the world's largest international public genebanks. Since its establishment in 1971, AVRDC has distributed close to 590,000 seed samples of its vegetable germplasm collection to researchers and breeders in 200 countries. Each year the Center's Genetic Resources and Seed Unit distributes seed samples of 6,000 to 7,000 accessions and breeding lines to the public and private sector as well as to AVRDC scientists for crop improvement programs and related research worldwide, thereby contributing to global food and nutrition security. More than 466 improved vegetable cultivars and varieties developed from the germplasm held by AVRDC have been released to farmers around the world, helping them to produce good harvests and generate income despite pest and disease pressure or abiotic stress. One interesting example is tomato, with 169 cultivars based on AVRDC-developed open-pollinated, heat-tolerant and multiple disease-resistant germplasm released in 40 countries worldwide since 1978. About 75 % of seed companies in Asia use AVRDC-developed cultivars as parent lines in their breeding programs. This success was only possible thanks to the genetic building blocks conserved in AVRDC's diverse tomato collection of more than 8000 accessions, including 735 wild species, 595 genetic stocks and more than 6000 accessions of mostly traditional cultivars and landraces.

Keywords: Food and nutrition security, genebank, tomato, vegetable genetic resources

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Irrigated Urban Vegetable Farming in Africa: Options for Health Risk Management

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In and around three out of four cities in the developing world, crops are irrigated with raw or diluted wastewater without any noteworthy treatment. In this situation, the 2006 wastewater use guidelines of the WHO offer a variety of options for risk reduction which could complement wastewater treatment but also provide a reasonable protection where wastewater treatment is unavailable and irrigation already taking place. By providing this high degree of flexibility for various situations, the guidelines became rather academic with so far limited acceptance. Our research targeted pathogenic risks from domestic wastewater used raw or diluted for irrigation. Based on participatory action research between 'farm and fork' intervention measures were identified, tested and assessed for their effectiveness, costs and adoption potential. The studies covered farm, market and kitchen based interventions, applying the multi-barrier approach. At farm level, changing crops was not supported, while modifications to common water fetching and irrigation practices appeared promising. The studies showed that sedimentation ponds and filtration techniques could reduce the number of helminth eggs to acceptable levels but not fecal coliforms. Among various irrigation methods, drip kits achieved as expected high removal levels. Cessation of irrigation did not fit every type of crop and cannot last long without crop damage, at least in the hot climate of West Africa. Overall, farm based interventions were able to reduce bacterial contamination levels by 1–4 log units. Market-based interventions had generally less impact on the contamination carried over from the farm, like through the support of microbial die-off but they remain important to prevent new or additional contamination. At the consumer level, the removal of outer cabbage leaves and vegetable washing proved most successful. Washing lettuce, especially with recommended sanitisers and longer contact time, reduced bacterial contamination by 1 to3 log units.

To protect the consumer according to the health-based targets suggested by WHO, combining interventions from farm to fork appears most promising, but also a significant challenge as it requires a high adoption rate of the recommended practices. While the current WHO guidelines fall short in explaining how to facilitate and sustain their adoption, for example at the farm level, the presented research showed that it will require well targeted studies to understand the incentives needed for a lasting behaviour change.

Keywords: Urban agriculture

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Wastewater Irrigation in two South Asian Settings – Is the Negative Perception of the Practice Justified?

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Two of the physical links connecting cities and their surroundings are water and nutrients. Usually, they enter cities separately and – at least in the context of many cities in developing countries – exit combined: as wastewater. In areas downstream of urban centres, an estimated 200 million farmers worldwide use wastewater to irrigate their fields.

In an interdisciplinary international research project coordinated by the International Water Management Institute, risks and benefits of this practice were analysed from 2005 to 2008. Working in periurban areas of Hyderabad, India and Faisalabad, Pakistan, the project's particular focus was on health and environmental risks of wastewater irrigation. Our sceptical perception of the practice at the onset of our research reflected the predominant negative view of wastewater irrigation, which is shared by most planners, decision makers and scientists.

After three years of research, we were forced to reconsider this view: the data from the different project groups showed that neither health nor environmental risks of wastewater irrigation were as serious as expected. For instance, there was no clear evidence for a negative impact of wastewater use on parasite infections and on heavy metal contamination of soils. Benefits of the practice, though more difficult to assess, were however obvious. Examples for such benefits include higher returns on investments in agriculture and higher crop diversity in wastewater irrigated areas.

One possible interpretation of our findings is therefore that management of wastewater irrigation in cooperation with farmers might under some circumstances be preferable to highly centralised, technological and expensive approaches like wastewater treatment plants. This is particularly relevant for contexts in which other, competing infrastructure issues like provision with drinking water and basic health care are pressing.

Keywords: Water management

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Recovering Nutrients from Waste: Moving from Theory to Business

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Humans generate millions of tons of waste every day. This waste is rich in water and nutrients. Yet, waste is not being managed in a way that permits us to derive value from its resources. Meanwhile, millions of smallholders in low-income countries struggle with depleted soils and lack of water. Closing the loop through the recovery of water and nutrients from waste appears as a win-win situation for farmers, waste management and the environment. But despite a vast knowledge *e.g.* on treatment options, most examples, even of waste composting, have so far remained small in scale or life time. A common threat across failed attempts is the lack of any business plan, or market knowledge, and reliance on external support and subsidies. Another key imitation is the lack of operational and strategic partnerships. A better understanding of sustainable market-driven mechanisms and business models to support the development, viability and up-scaling of the productive use of waste is urgently needed. It is therefore timely to undertake research that analyses emerging waste reuse business models for further testing and dissemination in the public, private and educational sectors, but also to quantify economic and social benefits for the society at large to support private and public sector investment with facts on possible returns. In partnership with the International Fund for Agricultural Development, the Swiss Agency for Development and Cooperation, and the Bill and Melinda Gates Foundation – the new programme of the CGIAR on Water, Land & Ecosystems (http://wle.cgiar.org) is addressing the challenge. Its Resource Recovery & Reuse (RRR) Strategic Research Portfolio is identifying innovative enterprises that reuse domestic and agro-industrial waste resources, including fecal sludge, in low income countries and gather pertinent data on how their businesses operate. Based on this analysis a variety of scalable business models is being described and their feasibility tested in selected cities across Asia, Africa and Latin America.

Keywords: Business models, market-driven mechanisms, resource recovery and reuse, waste

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Man and efficient water use

Supporting Sustainable Water Resource Management along the Tarim River (China) until 2030

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Overexploitation of scarce water resources for irrigation agriculture is a key problem impeding a sustainable development in the extremely arid Tarim Basin in China's Xinjiang province. Therefore the SuMaRiO (Sustainable Management of River Oases along the Tarim River) project develops a Decision Support System (DSS) for integrated land and water resource management. To ensure credibility, relevance and acceptance of the DSS an inter- and transdisciplinary research approach is applied that includes local stakeholders' knowledge, perception, and preferences from the beginning of the project. The DSS-sub-models which are linked within the DSS include hydrological models (WASA, SWIM, and MIKE BASIN), quantifying discharge and irrigation water availability, bio-geophysical models (EPIC, APSIM), determining crop yields and actual crop water use, and farm optimisation models (Linear programming), deciding farmers' current and future cropping pattern. Furthermore the response of riparian forests along the river, on changes in groundwater level and flooding events is determined by self-developed empirical models. The actual land and water management measures that can be simulated through the DSS comprise improvement of water transmission and storage infrastructure, restriction of agricultural land expansion, improvement of agricultural extension service, subsidisation of advanced irrigation technology and others. Specific ecosystem service (ESS) indicators enable the DSS-user to judge the impact of potential water and land resource management measures under a range of future climate and consecutive river discharge scenarios. Socio-economic scenarios define future developments of agricultural input and output prices, which directly enter the farm optimisation model. The ESS indicators are then determined for every sub-region annually until 2030 and include among others the status of natural riparian ecosystems, farmers' income, production amount of food, feed and fiber, employment in agriculture, as well as ground and surface water status.

Keywords: China, decision support system, transdisciplinary research

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Welfare Economic Valuation of Sustainable Water Management and Land Use Strategies in Water-Scarce Regions: An Exemplary Study in NW-China

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The Tarim Basin in Northwest China is one of the most water-scarce regions in the world. Local ecosystems are extremely vulnerable and depend on water supply of the Tarim River, China's longest inland river. Due to unsustainable water use in the upper reaches the Tarim River dries out regularly in its lower reaches and the natural ecosystems have been seriously deteriorated. If the current water and land use scheme is not changed, the Tarim River might desiccate completely leading to the desertification of a region inhabited by 10 million people.

The Sino-German project SuMaRiO develops strategies for a more efficient water management and land use strategies in order to facilitate a more sustainable development of the Tarim area. Transfer payments from well-off regions, especially from China's megacities, to the relatively poor Tarim area will be needed in order to implement the measures under these strategies. However, it is not clear if such a public project is worth the costs. Therefore it is important to know the benefits accruing from the new water management and land use strategies to society as a whole.

Using the so-called Contingent Valuation Method (CVM) we assess people's preferences regarding the ecological consequences of a more sustainable water and land management in the Tarim area. In the paper proposed here, special attention is paid to the so-called nonuse values of natural ecosystems. Per definition, nonuse values can be perceived by people living on site and also by people living at a distance. We are therefore conducting CVM survey studies in the Tarim area (Alar) and in a Chinese megacity (Beijing). Results show that both groups of stakeholders appreciate environmental improvements in the Tarim Basin and that the majority of respondents is even willing to financially contribute to more efficient water management and land use strategies. We interpret willingness to pay in terms of the total economic value of the new strategies and suggest that for a rational decision on the practical implementation the overall social benefits should be considered and compared to the project costs.

Keywords: Contingent valuation method, total value, willingness to pay

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Effects of Goat Manure Enriched with Activated Charcoal on Leaching of Carbon and Nitrogen from a Subtropical Sandy Soil - A Comparison between Suction Plates and Ion Exchange Resins

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Leaching losses are often high in sandy soils that are low in organic matter. Additions of activated charcoal (AC) to soil are known to increase nutrient retention capacities and may thereby decrease such losses. We investigated (i) how AC affects manure mineralisation and leaching of dissolved organic and inorganic nitrogen (DON, NO_3) and dissolved organic carbon (DOC) and (ii) whether ion exchange resins and suction plates are equally suited to capture dissolved nutrients. To this end, a greenhouse experiment was conducted in which glass tubes were filled with sandy soil from Oman and fitted to glass suction plates at the bottom. As a comparison, ion exchange resins were mixed with silica sand (1:1:2 cation:anion:sand ratio), filled into glass cartridges, and installed below the soil columns. Five fertiliser treatments were compared, consisting of manure with: (1) 0 % AC (control), (2) 3 % AC, (3) 5 % AC, (4) 7 % AC, and (5) 9 % AC in goats' diet. Each treatment was filled into 65×65 mm^2 nylon gauze bags of 1 mm mesh and buried at 10 cm depth. The amount of nutrients applied was equivalent to 160–81-42 kg N-P-K ha^{-1}. Over a period of twelve weeks, soil water samples were collected weekly at -120 hPa after irrigation events equivalent to 450–500 mm. First results from two sampling dates (1st and 8th week after installation; WAI) show that NO_3 leaching was highest shortly after the onset of the experiment with 194 mg NO_3 l^{-1} lost across all treatments, while by the 8th WAI, mean NO_3 leaching was about eight times lower. Also, at the 8th WAI, NO_3 leaching was lowest for 7 % AC (18 mg NO_3 l^{-1}) and highest in the control treatment (28 mg NO_3 l^{-1}). One WAI, leaching of DOC averaged about 104 mg DOC l^{-1} and diminished to 81 mg DOC l^{-1} by the 8th WAI. Further analyses of soil water, manure decomposition from litterbags and microbial biomass indices are underway.

Keywords: Biochar, charcoal feeding, dissolved organic carbon, nutrient leaching

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Ammonia Sanitisation of Faecal Sludge for Use as Fertiliser

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Faecal sludge from pit latrines and pour flush toilets are often discharged directly into surface water, spreading diseases and causing eutrophication. Faecal sludge is rich in organic matter and plant nutrients, and has good use as fertiliser. However, there is a need to inactivate the pathogens in the sludge to reduce the health risk associated with sludge application on arable land.

One treatment alternative is the ammonia sanitisation, which utilise the pathogen inactivation by ammonia. The treatment inactivates bacteria, viruses and parasites. It is a simple technology which only requires uncharged ammonia and airtight storage for sufficient amount of time. In faecal sludge, urine is the main ammonia source, but in most current toilet systems, the ammonia from urine is either too diluted or ventilated away. For sludge with low ammonia concentration, additional ammonia in the form of the nitrogen fertiliser urea can be added to enhance the treatment. Preferably, by reducing the flush water volumes and using non-ventilated systems, faecal sludge could be sanitised without additional inputs.

To evaluate the sanitising effect of ammonia, the viability of *Ascaris* eggs was monitored during storage at lab scale at different ammonia concentrations and temperatures. At ammonia concentrations above 170 mM and 23°C, 99.9 % reduction of *Ascaris* egg viability could be achieved within 1.5 month, this corresponds to 2 L flushwater per person and day. For flush water volumes of 6 L per person and day, the ammonia concentrations were lower (44 mM) and 6 months storage was required at 23°C. At higher temperatures, the inactivation of *Ascaris* eggs was faster and the required ammonia concentration lower. This makes the system applicable to many tropical low-income countries where the need for fertilisers and faecal sludge sanitisation is crucial.

Ammonia sanitised faecal sludge can be used as a sustainable source of cheap fertiliser, especially for farming in or near urban areas. By implementing toilet systems which use airtight storage and low flush water volumes, the intrinsic ammonia may be sufficient to sanitise the faecal sludge without additional treatment.

Keywords: Ammonia sanitisation, *Ascaris*, faecal sludge, inactivation

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Irrigation Application Efficiency in the Lower Reaches of the Amu Darya Basin

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The problem of water scarcity in Khorezm region of Uzbekistan, situated in the lower reaches of the Amu Darya river basin, has been exacerbated by regional political decisions and mismanagement of irrigation systems. Previous studies revealed that despite there being temporal and spatial water scarcity in the region, there remains excessive water use for strategic cotton production. Excessive irrigation to cotton crop has led to overall inefficiency of the irrigation system. Moreover, there remains negligible information regarding the level at which the irrigation losses occur. Therefore, the objective of this study was to track the losses of irrigation at field level due to excessive irrigation. For this purpose, results of extensive experimentation during the 2010 cropping season were used to determine field application efficiency. For this purpose, soil moisture deficit was determined at 30, 60, 90, 120 and 150 cm depths before and after each irrigation event. The ground water level fluctuation was measured twice a week at 3 different locations per field (cotton and maize). Results show that the field application efficiency (FAE) during the three irrigation events for cotton at field 1 were 43 %, 21 % and 15 % respectively. Similarly the FAE calculated during the 3 irrigation events at another cotton field 2 were 48 %, 37 % and 22 % respectively. The FAE calculated at the maize field 3 was 42 %, 57 % and 23 % in the 1st, 2nd and 3rd irrigation event respectively. The standing reason behind the higher water losses at the farm lever were the poor irrigation management practices and poor canal infrastructure.

Keywords: Application efficiency, irrigation, water scarcity, water use

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Impact of Rainwater Management Strategies on Sustainable Rural Livelihood: Evidence from Azgo Watershed, Northeast Ethiopia

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This paper evaluated the potential use of integrated rainwater management practices on sustainable rural livelihood measured by household food security, poverty and willingness to participate in the management of watershed services. The study is based on a cross-sectional plot and farm household data collected in 2012 from a random sample of 354 household and 1011 plots in Ethiopia. The causal impact of the rainwater management is estimated using average treatment effect for the treated on crop income and measured differences in food calorie per adult equivalent, indicator based-poverty index and mean willingness to contribute labour. Propensity score matching is used to match households and plots with and without rainwater management. In addition, endogenous switching regression is utilised to estimate the true livelihood support of integrated rainwater management by controlling for the role of selection problems on production and adoption decisions. The result revealed that adoption of rainwater management practices has a significant positive impact on crop income and thereby on household food security and poverty status. The mean willingness to contribute labour for the management of the watershed service is not influenced by the prior experience of using the integrated rainwater management practices since non-users have also realised the benefits of rainwater management for watershed services. Wide spread use of the rainwater management practices were enhanced with the availability of location specific knowledge infrastructure, hard and soft institutional setup, market, and physical infrastructure. One of the innovative physical infrastructures is the use of different land management practices to collect run off and store in water harvesting ponds that allowed farmers to irrigate cash crops. The market and road network strengthened the rural-urban continuum thereby enhancing the demand for and successful use of rainwater management technologies through facilitating the input and output markets. The research calls for green water policy for sustainable intensification of smallholder agriculture by utilizing the unexploited two third of the global water resource rather than focusing on the over burden and conflicting blue water, which is only one third of the global water resource.

Keywords: Food calorie intake, payment for watershed services, poverty, rainwater management

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Integrated Water Management as the Main Mechanism for Future Survival in the Arid Zone

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Irrigation plays a very important role for the well-being, employment and food security of rural population in the arid zone and particularly in Central Asia within the territories of the five states: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Irrigated agriculture accounts for 25–35 % of GDP, but taking into account processing, marketing and services sector, the total share of the agrarian sector increases to 50 % of GDP. The restructuring of irrigated farming after independence and the shift from large agrarian entities (kolkhozes and state farms) to individual private and lease farms with small land use (from 0.5 ha in Kyrgyzstan to 60–100 ha in Uzbekistan) have caused huge problems for adaptation of irrigation practices and management to new economic and social conditions. Moreover, the economic weaknesses of new independent states plus fluctuations of agricultural production prices called for strong involvement of stakeholders in the formation and financing of new public-private forms of water organisations, such as water users' association (WUA), water canal committee (WCC) and Water-Land district commissions. All these innovations form a part of the so-called integrated water resources management (IWRM) that was implemented at first on an area of 136,000 ha in the Fergana valley within the territories of 3 states – Kyrgyzstan, Tajikistan and Uzbekistan. The new principles of integration of science and implementation, land and water, rural society and the nature, all types of water and different stakeholders plus hydrographic approach to management and public participation – all these were used for creation of a new system of water and irrigated agriculture management oriented towards increased land and water productivity.

As a result, water delivery to these lands was reduced from 1 billion m^3 in 2004 to 740 million m^3 in 2011, and the total volume of agrarian production increased by 35–42 % Andizhan and Ferghana provinces for same period of time. Many new institutional, legal, technical and managerial initiatives were introduced and demonstrated a good example for upscaling on an area of 246,000 ha in Uzbekistan.

Keywords: Central Asia, irrigated agriculture, IWRM, land and water productivity

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Enhancing Agricultural Production with Rainwater-Harvesting in Expanding Cities: Success and Potential in Burkina-Faso and Ghana

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More than 93 % of agricultural activity in West Africa is dependent on erratic rainfall and thus, vulnerable to climate variability and impacts of climate change. Climate change is expected to increase crop failures and livestock deaths. It results in increasing vulnerability of almost 65 % of the population living in rural area and depending mostly on agriculture for their livelihood. They migrate to urban areas causing an expansion of the urban population which is directly linked to an increased demand for food. It is predicted that, by 2030, almost half (48.3 %) of Sub-Saharan Africa's population will be urban and most of these people will be living, without access to adequate food, water or sanitation. Urban agriculture is a spontaneous response to this population growth. However, urban agriculture faces issues of legislation and land availability. Additionally, water resources are expected to become more scarce and vulnerable due to climate change and rapid urbanisation. In many areas of the world, water reuse, rainwater harvesting (RWH) and improved on-farm water management provide valuable additional water, rise agricultural yields and improve food security in urban areas. In West Africa, macro-catchment RWH methods like small or micro dams, artificial ponds and rainwater tanks are already used to reduce water scarcity. For instance, the use of water reservoirs for home garden by the farmers of Ouagadougou in Burkina-Faso has reduced the vulnerability of the home gardeners' household, since their yearly activity is usually limited to April by the amount of water available for irrigation. In Ghana, rooftop water harvesting is well developed and the water stocked in tanks is mostly used for cooking, washing and bathing. Promoting RWH practices can help increasing agricultural productivity and mitigate impacts of climate change. Hence, the food security in urban and peri-urban areas can be improved. The study analyses potential impacts of RWH, especially water reservoirs on agricultural productivity and small-scale farmers in urban and peri-urban areas of Ghana and Burkina-Faso based on literature research and reports.

Keywords: Burkina-Faso, climate change, Ghana, rainwater harvesting, small scale urban agriculture

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Use and Quality of Coastal Water in Benin (West Africa): Conflict between Sustainability and Resources Utilisation

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Stretching over about 125 km along the Gulf of Benin, the coastal zone of Benin hosts 1/3 of the population of the country. The largest economic dynamics as well as the most serious environmental processes are observed in that part of country. The ecological, economic and social problems inflict drastic conditions to the life in the region. The lack of special planning is attributed to the non effective control of land use by the territorial administration.

The daily life of the population depends on activities, which are tributary to geographical situation and to available natural resources. Ecological disturbances due to wrong use of surface water make the situation more alarming. At the horizon, important changes (degradation of water quality, siltation of lakes, reduction of biodiversity, etc.) profile in aquatic ecosystems. However the disappearance of certain activities supports the development of the most aggressive and polluting ones. So getting data on viability, usefulness of waters and also on aggressiveness of activities within the coastal area is an urgent need today.

Overall, 162 households equitably distributed in 18 localities (randomly chosen around the lakes Ahémé and Nokoué and along the coastal lagoon) were subjected to our investigations. Water pollution levels, revealed by the analysis of water samples, indicate that the coastal lagoon and Ahémé are affected through a "one-way hydroturbation" caused by soils erosion and by the strong exchange of high concentrations of phosphate and nitrogen compounds which lead to hyper-eutrophic conditions. Nokoué contains high nitrite and ammonium concentrations, reflecting impacts of waste water from surrounding urban areas,, resulting in eutrophic conditions of the aquatic ecosystem. Submitted to Agglomerative Hierarchical Clustering and Factorial Analysis of Correspondences, the results lead to the conclusion that the led activities in coastal area depend strongly on resources conditions, which, affecting them, are also submitted to them. It is about a pattern or a system of continuously, negative, spatial-distributed and interlaced changes, which concern several sectors of life. This inhibits the effectiveness of development efforts at the local and regional level.

Keywords: Benin, coastal zone, integrated management, sustainability, use, water quality

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Physicochemical and Bacteriological Quality Assessment of the Water Resources in the Mahafaly Plateau, Madagascar

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The Mahafaly plateau in southwestern Madagascar is subjected to a semi-arid climate with low precipitation. This region is known for the water scarcity and poor water quality. The objective of this research was to determine the physicochemical and microbiological quality of the water points in the Tsimanampetsotsa National Park and in some villages located at the plateau and the coastal plain. Sixty wells, 6 caves, 5 sinkholes and 2 resurgences were sampled during the dry and wet season. For physicochemical parameters, pH, dissolved oxygen (DO), temperature, electric conductivity (EC), ammonia, phosphorus, nitrate, nitrite and iron were assessed. Indicator bacteria namely, total count, *Vibrio*, *Salmonella*, *Escherichia coli* and fecal coliforms were assessed for microbiological analysis. There was no significant difference in phosphorus ($p = 0.175$) and nitrite ($p = 0.245$) among the water sources. A significant difference in mean values of temperature, electric conductivity, alkalinity, DO, nitrate, ammonia and iron among location ($p < 0.05$) was noted. The coastal plain has the poorest water quality, almost all the chemicals values and bacteria counts were above the recommended limits. Water has high EC (7181 ± 1091 μS/cm) and neutral pH (pH = 7.08 ± 0.05). The mean concentration of *Escherichia coli*, *Salmonella* and *Vibrio* were 4500 CFU per 100 mL, 3400 CFU per 100 mL and 3800 CFU per 100 mL, respectively. Water sources in the park has moderate EC (2344.57 ± 80.03 μS/cm) and slightly acidic pH (pH = 6.97 ± 0.049). The average concentration of *Escherichia coli*, *Salmonella* sp and *Vibrio* sp was 500, 300 and 200 CFU per 100 mL, respectively. Sampled water sources on the plateau had low EC (664 ± 73.27 μS/cm) and were slightly alkaline (pH = 7.39 ± 0.048). Bacteria mean count were 400 CFU per 100 mL for *E. coli*, 2500 CFU per 100 mL for *Salmonella* sp. and 2500 CFU per 100 mL for *Vibrio* sp. Water quality depended on the water sources type, the season and the local uses. Poor sanitary condition constitutes one of the principal causes of the water contamination.

Keywords: Bacteria, Madagascar, Mahafaly Plateau, sub-arid climate, water quality

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Water Regime in Paddy Rice Systems in Vietnam: Importance of Infiltration and Bund Flow

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In northern Vietnam, high population growth, resettlement programs and consequent land scarcity have led to an intensification of rice cultivation. Consequently, the amount of applied pesticides in paddy rice cultivation has tremendously increased. For paddy rice cultivation, however, there is concern that pesticides are lost from their target area possessing a serious environmental threat and contaminating surface- and groundwater. Both are used for domestic purposes. In northern Vietnam, many irrigated paddy systems include fish ponds. Especially in rural areas, fish can be considered as the main protein source for the local population. Therefore, main pathways of water losses should be identified and the significance of preferential flow for the translocation of pesticides should be analysed. Until now, water loss investigations from paddy rice fields in Northern Vietnam have not been carried out. The current study is filling this gap.

Four paddy fields were chosen meeting the following criteria: (i) direct adjacency to a fish pond, (ii) available information on the field and bund age, (iii) known management practice and (iv) the exclusion of intercropping. Double ring infiltrometer tests were carried out to determine vertical infiltration rates from paddy fields. To identify potential lateral pathways through the bunds,tracer tests were conducted using chloride and Brilliant Blue. After the experiments, the bund was dug up ten-centimetre-wise and water pathways were observed visually.

As already reported by Tuong et al. (1994), main water losses from paddy fields take place in dependence on macropores and consequentially on preferential flow. Via dye tracer tests, we proved that most lateral losses take place via macroporic bund flow. Bund flow occurred in all investigated bunds independent of the bunds´ age and morphology. The distribution of macropores was regulated by the amount of plant roots and the activity of animals. Within the fields no water or very sparse water was lost. The presence of a plough pan and very high groundwater levels inhibited infiltration.

Keywords: Bund flow, northern Vietnam, preferential flow, tracer

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Modelling Water Flow and Sediment Transport in Paddy Cascades in Northwest Vietnam

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Deforested mountainous watersheds in SE Asia under continuous maize cropping are prone to erosion. Erosion decreases soil fertility in the uplands and may have fertilising or silting effects on paddy fields in the lowlands. In paddies, ponding water and decreased flow velocity of run-off cause settling of suspended particles carrying nutrients and organic matter. LUCIA (Land Use Change Impact Assessment tool), a spatially explicit and dynamic model developed at the University of Hohenheim simulates water and nutrient cycles, plant growth and erosion on landscape-scale. However, paddy cascades, their specific topography and bunds and their influence on deposition are not part of the model up to now. The aim of this study was a) to develop a standalone model simulating water flow and sediment transport in paddy cascades that can be integrated into LUCIA, b) a first plausibility validation of the new model based on field data from Northern Vietnam.

In a paddy cascade in Chieng Khoi, Son La, inflow, surface flow between paddies and outflow were measured with water clocks. Additionally, turbidity measurements were conducted in all flows. These data were used for model calibration. During normal baseflow (no rain) the inflow was 49 m^3 per day resulting in an outflow of 24 m^3. Taking the same inflow, the modeled outflow was 20 m^3 day^{-1}. Modeled bund percolation, cross flow and percolation were in the range found in literature. Flows fitted simulated rain peaks.

Sediments eroded in the uplands are transported with the inflowing water into the cascade. Suspended particles in the water remaining in the paddy field are assumed to settle within one day. Sediment concentration changes from inflowing to outflowing water, while discrimination between particle size classes is not included in the model. A measured sediment concentration decrease (-85 %) from cascade inlet to outlet was also obtained with the model.

A next step will be the integration of the paddy model into LUCIA. In addition, more field data are needed for further validation.

Keywords: Hydrology, landscape modelling, paddy model

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Challenges in the Land Management of Public Irrigation Settlements in the Itaparica Reservoir Region – Brazil: The Case of Garbage Disposal in Petrolândia Municipality

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The Municipality of Petrolândia, located in the Itaparica region, was flooded in 1988 due to the construction of a dam, forming the Itaparica Reservoir. The Hydroelectric Company of the São Francisco River (CHESF) did these investments to supply electric energy to the semi-arid region of Brazil. About 40,000 people were dislocated involuntarily to new cities and settlements. CHESF built three settlements with irrigation infrastructure in Petrolândia: Icó-Mandantes, Apolônio Sales and Barreiras Bloco 2. In Icó-Mandantes and Barreiras Bloco 2 agrovilas (villages) were built with ca. 50 houses each. However, in Apolônio Sales, the farmers' fields are in the same place where they live, hence, agrovilas were not established. This paper presents first results of a study on the challenges in managing these newly established irrigation settlements - 25 years after the dam's construction. This work is part of INNOVATE, a comprehensive, collaborative project between Brazilian and German universities, aiming at a sustainable management of land and water resources in the Itaparica region. Based on literature, major actors were identified and approached in the study region. Using a guideline, in-depth interviews were held with the staff of the local farmers´ union, the extension service and salespeople of agricultural inputs, the major, a local NGO, and farmers living in the agrovilas. The number of houses in the agrovilas increased over time. Actually there are more than 150 houses in each agrovila, predominantly inhabited by descendants of the original settlers. In Apolônio Sales, a whole new, illegal settlement emerged. This disorderly urban growth, along with the ineffective waste collection, led to the random disposal of residential garbage and containers of pesticides. Part of the garbage was found in the preserved areas of the Caatinga biome, as well as near the reservoir in Barreiras bloco 2, where water is collected to supply the city. Leachate from garbage enters crop fields and people reported suffering from health problems. Petrolândia Municipality has an important role in monitoring the disorganised growth and developing alternatives to improve the situation in cooperation with the growing population of settlers.

Keywords: Irrigation

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Irrigation in the Tarim Basin (China): Farmers' Response to Changes in Water Pricing Practices

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The Tarim River is the longest inland river in China, located in the extremely arid southern part of Xinjiang Uyghur Autonomous Region. The Tarim River basin is an important cotton and fruit production base. However, extensive land reclamation combined with unreasonable water use over the last 50 years required a large amount of water to be diverted to irrigation. This resulted in a continuous reduction of water flowing to the mainstream of Tarim River with a negative ecological impact in the lower reaches of the river. Additionally water scarcity became the major factor to restrict the social and economic development of the region.

With water availability declining in many regions, it is becoming increasingly important to allocate and use this essential resource efficiently. Water pricing is an important instrument to improve water allocation and encourage users to conserve scarce water resources. Prices which accurately reflect water's economic, or scarcity value give information to users, which they use to make choices regarding water consumption and use.

To identify whether water pricing policies can lead to an increase in farmers' water use efficiency, 128 farmers were interviewed using structured questionnaires in different parts of the Tarim River. The results show that most of the farmers are willing to pay a higher price for better service. However, water pricing policies could not lead to a significant increase in farmers' water use efficiency without additional agricultural policies and regulations. Another major finding is that according to farmers' response water right tradings can be one option to reduce the severity of water shortages, but it could do little to raise farmers' income.

Keywords: China, Tarim river, water pricing, water right trading, water scarcity

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Cosmic-Ray Neutron Probe – A New Method to Monitor Soil Moisture Content

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The measurement of soil moisture content at large scale involves either taking large soil samples for gravimetric analysis or installation of large number of sensors such as TDR. However, these methods are tedious, time taking and destructive. In this study a novel, non-invasive and non-destructive technique named as 'Cosmic-Ray Neutron' probe was applied which can measure the soil moisture content at large scale. The theoretical framework of Cosmic-Ray Neutron(CRN) probe is that in the atmosphere, secondary cosmic rays are generated and after colliding with the land surface, they randomly scatter and distribute both below- and above-ground. As a results, neutrons are generated which after reacting with hydrogen molecule moderate their intensity. Cosmic-ray neutron probes detect neutrons at two energies, but use "fast" Neutrons for soil moisture detection because calibration is less sensitive to the chemistry and texture of the soil. Thus, the intensity of neutrons above the ground surface strongly depends on the water mass present in soil. The measurement depth of CRN probe is 10–50 cm (depending on water content) thus, provide observations within the root zone and average soil water content over a footprint of large area of 34 hectares (a circle with a radius of 330 m).

In this study CRN probe was installed at Korla, Xinjiang Province, China. The region has an arid climate with extreme shortage of water having an annual rainfall less than 300mm while the yearly evaporative demand is more than 1500mm. However, one-third of the country's cotton is produced in this region, which relies heavily on irrigation. The objective of this study is to develop a calibration method which can be used for longer monitoring periods to estimate the average regional soil moisture content. To calibrate CRN probe, soil moisture measurements were made using profile TDR probes with cotton crop growing in the field. In addition, meteorological data and aboveground crop biomass were included in the evaluation. About 50 profile TDR probes were installed at eight different directions around the CRN probe.

Keywords: Calibration, China, COSMOS, cotton, soil water content

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Postharvest, technology and product quality

Posters

Sweet Potato (*Ipomoea batatas*) Storage: A Review of the Present Status of Storage Practices and Losses

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Sweet potato (Ipomoea batatas (L.) Lam.) is a dicotyledonous plant which belongs to the family of Convolvulaceae. It is at present cultivated in more than 100 countries worldwide. Most of the producer nations are situated in tropical developing countries where a high proportion of the poorest people live. Being relatively resistant to pests and diseases and comparatively water-use efficient, sweet potato yields are better than those of most of the major root and tuber crops. The crop has been playing an important role as a life-saver during periods of food shortages and famine especially in sub-Saharan Africa. Depending on the variety, the crop has a relatively short harvesting time of 3–8 months from planting which is less than most other root and tuber crops. Despite the clear potential which sweet potato holds for combating food insecurity and malnutrition, particularly vitamin A deficiency, full exploitation is constrained by its bulkiness and perishability. Due to the short shelf life of the crop, it has to be cured and placed in stores immediately after harvest. After two to three weeks most of the crop is not marketable anymore. This often forces farmers to sell the crop at low prices immediately after harvesting. There have been studies documenting that under room temperature or in a ventilated yard. after two months the losses of fresh sweet potatoes are70 % and 50 %, respedctively. They appear to be due to natural metabolic processes, such as weight loss due to shrinkage, rotting of roots, sprouting and attack by moulds and weevils. Optimum storage temperature of between 13°C and 16°C and a relative humidity of 80–95 % has been recommended for long-term storage of sweet potato. Lower storage temperatures results in physiological damages whereas higher temperatures promote sprouting with an increase in water and respiratory losses. The authors present a review of the current knowledge status of sweet potato storage practices that are adopted in various parts of the world, and the losses that are found to occur during storage. A future research direction for long-term storage of sweet potato will also be presented.

Keywords: *Ipomoea batatas*, losses, shelf life, storage, sweet potato, temperature

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A Non-Gravimetric Approach to Tracing Changes in Water Activity during Convective Cobed Maize Drying

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Maize (*Zea mays* L) plays an important role in ensuring food security in Kenya. It is also significant for its starch and oil, which are used in adhesives, medicines, soaps, cosmetics and several other consumer products. Climate change, however, is putting a strain on its production and preservation. Yield losses due to aflatoxins are on the rise and natural drying is no longer an attractive option. Early harvest schemes have been recommended as a preventive strategy against the opportunistic agents of spoilage and waste, but these require provision of drying facilities customised to handle maize on the cob. Importing finished technology helps, but only a little and the development of home-grown capacity to design and fabricate drying solutions is the way to go. Moisture isotherms that describe the correlation between the moisture content and the equilibrium relative humidity at the surface (also called water activity) of hygroscopic materials, are developed gravimetrically using salts under primarily static air conditions. Tracking time related weight changes in products with long-term drying is tedious and prone to error even when automated systems are employed. An innovative in-process/dynamic water activity profiler that uses off-the-shelf temperature and humidity instrumentation was used to monitor the drying of dehusked maize ears at temperatures settings of 38°C, 45°C and 55°C, with air supply in the range 7–14 $m^3 h^{-1}$. Good consistency was observed comparing results with the traditional gravimetric drying curve analysis. The innovation has broad applicability and is an invaluable resource for technicians seeking to develop forced-air drying solutions for bulky products.

Keywords: Cobbed maize drying, water activity profiling

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Radio Frequency Heating for Biological Decontamination in Kariyat Herb (*Andrographis paniculata*)

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Kariyat (*Andrographis paniculata* (Burm.f.) Wall.ex Nees) is a herbaceous plant which is used in traditional medicine. The main active ingredients of this plant are andropraphólides and dehydroandropraphólide. The aim of this study was to investigate the efficiency of radio frequency RF treatment in controlling biological contaminates such as total bacterial count, total yeast and mold, enterobacteria; (*Eshericia coli*, *Salmonella* spp., *Staphylococcus aureus*, *Clostridium* spp.) and its effect on andropraphólides and dehydroandropraphólide contents. Milled herb with initial moisture content (mc) of 5 % was conditioned to 20 % mc. Then, the herb samples were exposed to RF at an operating frequency of 27.12 MHz with temperatures of 80, 85, 90 and 95°C for 3 and 5 minutes of application time. The percentage of biological contamination was detected by the use of the Potato Dextrose Agar (PDA) and blotter methods. After that the amount of andropraphólide(hRf) and dehydroandropraphólide were determined by ethanol extract methods. The result showed that total bacteria count from RF 90°C 5 min reduced from 3.5×10^5 CFU g^{-1} to 6.8×10^4 CFU g^{-1} lower than acceptance criteria (2×10^5 CFU g^{-1}), total yeast and mold from every treatment treatments were 1.5×10^4 CFU g^{-1} which less than acceptance criteria (2×10^4 CFU g^{-1}). The enterobacteria number was 8×10^2 CFU g^{-1} which lower than acceptance criteria (1×10^3 CFU g^{-1}). *Escherica coli*, *Salmonella* spp., *Staphylococcus aureus*, *Clostridium* spp. were not detected in most RF treatments. The amount of active ingredients as andropraphólide was detected from 62 - 65 hRf which were treated with RF from 80 and 85°C and it was not detected from 90 and 95°C treatments, and dehydroandropraphólide was not detected from RF-treatment temperatures of 80 - 85°C, but the RF treatment 90 and 95°C they were found at the number of 65 hRf. The experiment has shown that RF treatment at 90°C for 5 minute showed the best performance in biological decontamination with remaining their active ingredient. A high temperature (90°C) resulted to andropraphólide to dehydroandropraphólide by dehydration process.

Keywords: Andropraphólide, decontamination, dehydroandropraphólide, Kariyat herb, radio frequency (RF) technique

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Effect of Heating on Chemical Characteristics and Acceptability of Sudanese White Cheese made from Goat Milk

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Goats are an important animal for smallholders in the rural areas of the tropic. However, processing of goat milk never found much attention although goat cheese attains high prices especially in the western countries. In this study, Sudanese white cheese was processed with and without heating raw goat milk and the resulted cheeses were evaluated weekly during storage (8 weeks) for compositional quality and acceptability.

Cheese made from heated and raw milk contained 46.81 % and 46.31 % total solids, 22.13 % and 21.85 % fat, 15.02 % and 13.73 % protein and 2.44 % and 2.25 % ash, respectively. There was a significant ($p < 0.001$) difference in protein content between the cheese made from the heat treated and raw milk. A similar significant ($p < 0.001$) difference was reported for the acidity, which revealed 1.06 % and 1.21 %, respectively. Further, measurements showed highly significant differences ($p < 0.001$) during storage. However, the sensory evaluation of goat cheese revealed general acceptability for both cheeses with better scores for the cheese made from the heated milk. The cheese from the raw milk showed a higher colour score, while its texture was reported as rough and the flavour of goat milk was noticed to be intensive. Moderate salt was reported for both cheeses and the acidity was less at the beginning of the storage and it increase significantly during storage especially in the cheese made from the raw milk.

It is concluded that goat milk processing can be a promising activity for smallholders. There is however an urgent need to focus on improving goat production, processing of the milk and marketing of the products.

Keywords: Evaluation, goat milk, heat treatment, Sudanese white cheese

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The Feasibility of using Laser Backscattering and Digital Image to Monitor Physico-Chemical Changes of Osmotically Pre-Treated Papaya during Drying

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Non-invasive assessments are considered as an alternative method for evaluating quality attributes of agricultural products. This study investigated the feasibility of using the combination of a computer vision system (CVS) with laser diode emitting at 650 nm for predicting moisture content (MC), lightness (L*), hue (h*), chroma (C*), and shrinkage changes of osmotically pre-treated papaya (*Carica papaya* L.) during drying. Convective drying was conducted at four different temperatures (50, 60, 70, and 80°C) and the corresponding air velocity and relative humidity was controlled at $0.5\,\mathrm{m\,s^{-1}}$ and $10\,\mathrm{g\ water\,kg^{-1}}$ dry air, respectively. The illuminated area (AI) in pixel numbers and light intensity (IL) measured by grey values were used to monitor the photon migration profiles into the fruit tissue, while the segmented binary image area in pixel numbers (Aimage) was analysed from digital images. As expected, increasing drying temperature resulted to a decrease in MC and C* values, whereas L* and h* values increased as drying proceeded. The results also revealed that for each single AI, IL, and Aimage parameter obtained, can be used to describe all quality changes, except for C*-value. In addition, multiple parameter correlations of backscattering and digital image properties precisely yielded the best fit for MC, h*, and C* predictions because it showed the highest coefficient of determination (R^2>0.94). Therefore, the paper concludes that the use of CVS technique coupled with laser back scattering methods provide useful tools for quality control of fruit during drying. Moreover, they are multipurpose and non-intrusive methods for in-line measurements in food processing industry.

Keywords: Drying, image analysis, laser backscattering, osmotic dehydration, papaya

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Analysis of Assam Tea Processing in Small Scale Factories in the Highlands of Northern Thailand

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As a perennial high value crop Assam tea (*Camellia sinensis* (L.) var. *assamica*) contributes to the livelihood of many highland farming communities and helps to protect steep slopes from erosion. To evaluate the potential of broader market access for locally produced tea, three small-scale orthodox tea processing units in Chiang Rai Province (Northern Thailand) have been analysed on-site and evaluated according quality of their black and green tea.

Field observation of local tea processing units was done and interviews were conducted to analyse processing structures. To evaluate tea quality, three batches of samples were collected throughout each step of tea processing and analysed for moisture content, caffeine content and anti-oxidative compounds, including total polyphenol content (TPC), total catechin content (TCC) and eight individual catechin types.

In contrast to common practice, black and green tea are produced in a similar way. In both cases, fresh tea shoots are harvested, withered, heated, rolled and dried. For the production of black tea only, leaves are oxidised prior to final drying. The heating process, which deactivates tea-inherent enzymes in green tea, is unusual for black tea processing, as it inhibits the wanted enzymatic oxidation process later on. Because of intuitive process management, moisture contents varied greatly amongst sampling batches and processing units. Caffeine contents were lower than expected and significantly higher in black than in green tea.

Due to the heterogeneity of fresh tea leaves, TPC levels did not decrease steadily throughout processing. TPC in black tea was not statistically lower than in green tea. Further, black tea did not show the typical biochemical changes in individual catechin composition occurring during oxidation. Even during early stages of tea processing, the detected catechin structure showed characteristics of degradation, both in TCC and in configuration of individual catechins.

It was concluded that tea quality was not stable due to intuitive management of the tea producers resulting in poor quality tea products, which can only be marketed locally. Quality control of each processing step is necessary to improve tea quality for opening new markets for small-scale tea producers.

Keywords: Caffeine, catechins, product quality

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Optimisation of Solar Drying for Paddy Rice in the Philippines

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Paddy drying remains a main problem in postharvest production of rice. In the Philippines "highway dryers" are used, where wet paddy (rough rice) is spread out in sufficiently thick layers to dry alongside roads and highways. The paddy is raked during drying to continuously mix it to prevent the grain from prolonged exposure to the sun, which causes lower head rice yields and reduced product quality. Automation of rice drying is more difficult than mechanisation of production, because the use of mechanical dryers often requires adaptation of technology into existing postharvest systems. Furthermore, drying is a complicated procedure involving air and crop properties, which require in-depth knowledge of the process. As a response, the present study developed a low-cost solar dryer to reduce drying time during the rainy season and ensure a secure drying process. Field experiments were conducted in the Philippines during the peak harvest period during both wet and dry seasons. The work involved primary data collection and calculation of drying rates, which were then used to evaluate thermal performance of the solar dryer based on solar intensity, temperature and humidity.

Furthermore, there is high correlation between the dryer performance and the homogeneity of airflow distribution, as unfavourable designs often cause uneven drying. Then the arrangement of the inlet ventilators and the geometric design of the solar dryer influence the uniformity of airflow distribution. To achieve an optimised flow distribution, several simulations of the design was perform using FLUENT a Computational Fluid Dynamic software, where fluid flow was optimised without costly experimental repetitions. Results of the field experiments as well as the optimised solar dryer design are presented and discussed.

Keywords: Computational fluid dynamics, grain quality, paddy, rice, solar drying

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Performance Analysis of De-Shelling Process for *Jatropha curcas* Seeds

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De-shelling practices for *Jatropha curcas* L. seeds has become an essential process in the integrated production of biofuel and enriched protein byproduct. *J.curcas* seed de-shelling was reported as suboptimal since no specific machine was designed for the purpose but existing machines were adapted for the process. The objective of the study is to investigate the optimum conditions of the de-shelling process of *J. curcas* seeds via a disc spinning prototype. *J. curcas* seeds imported from Cape Verde, Africa with moisture content about 7 % (w.b.) were used. The seeds material was classified into four fractions according to their size using four different sieves (12, 11, 10, and 8 mm). In this study, a de-shelling prototype machine developed at Universität Hohenheim with constant motor speed of 750 rpm was used for performing de-shelling of *J. curcas* seeds. The prototype machine consists of two rotating parallel discs; the gap between the discs was varied from 5 to 10 mm. The de-shelling output was classified into different groups using a pneumatic conveyor which determines the terminal velocity of each group; (i) complete seeds, (ii) broken seeds, (iii) complete kernels, (iv) broken kernels and (v) shells. The efficiency was recorded between 38 and 51 %, and breakage capacity was obtained from 81 to 92 %. Terminal velocity to classify *J. curcas* material into groups broken seeds, complete kernels, broken kernels, and shells was obtained at 9.1 – 10.6 m s^{-1}; 6.8 – 10.7 m s^{-1}; 6.1 – 7.9 m s^{-1}; 3.5 – 3.9 m s^{-1}, respectively. The highest de-shelling efficiency was achieved at fraction III, gap opening 7 mm (51 %), and breakage capacity at fraction I, 6 mm (92 %). The experiments allow some optimisations which are used to investigate the optimum operating condition in the system.

Keywords: Breakage capacity, de-shelling efficiency, jatropha seeds, terminal velocity

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An Automated Peeling Machine for Large Scale Industries

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Cassava and other tuber crops form the major staple in sub-Saharan Africa and are very useful in agro and agro-allied industries. One major problem in the processing of cassava is peeling, which is occasioned by variation in tuber sizes, peel thickness and shape. Farmers often plant many tuber crops and may find it difficult to buy different peeling machines for each crop. In this study a multipurpose peeling machine was designed, fabricated and made ready for commercial production. The machine impacts rotary motion on the tubers and through shear and/or abrasion effect the required peeling of the tubers. Its major advantages include simplicity in design, utilisation and maintenance and relatively cheap procurement cost. The machine was fabricated from local materials which consist of a tuber inlet, trimming device, tuber metering device , peeling tool, 7 Hp engine, outlet and protective hood. Tubers were presented in three categories of both length and diameter. Length of 20 – 25 cm and diameter of 8 – 10 cm produced an efficiency of 79.5 % and a capacity of 95 kg h^{-1}, respectively, at a brush speed of 1200 rpm and auger speed of 150 rpm. The functional efficiency (Peeling efficiency) was highest in cocoyam but lowest in cassava. However minimum efficiency of 75.5 % was recorded with cassava peeling and a maximum peeling efficiency of 95.2 % was obtained with cocoyam. Other parameters affecting the performance of the machine include, auger speed, brush speed and moisture content of tubers. The speed of the metering device influenced the peeling process significantly at constant or variable speeds of the auger and brush. The speed of the metering device determines the residence time of the auger in the peeling chamber. Tuber damage and peeling efficiency were also influenced by the speed of the metering device. The machine is recommended for immediate commercialisation and utilisation for large scale entrepreneurs.

Keywords: Automated, cassava peeling machine, large scale industries

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Value Addition of Food in Drying Process: Design & Development of an Enhanced Food Dryer with Uniform Heat/Air Distribution

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This work focuses on the quality drying of food. Drying of a product is not an issue but to get a highly qualitative dried product quantitatively in farmer communities is a challenging task. These farmers dry food products in open sun drying (deteriorate quality), in small conventional dryers *i.e.* solar and biomass which are unable to contribute the society due to low drying capacity and low quality (due to uncontrolled drying conditions). High quality food drying requires two tricky things, consistent heat and uniform air distribution. Air drying is low-cost and high-speed, but expose the food being dried to high levels of uneven heat, reducing the quality of the overall product substantially by over and under drying. A new medium scale hybrid dryer has been developed with diagonally air flow pattern to establish uniform air distribution over the entire length (11 m) of dryer. It will strengthen the common assumption of isothermal condition in drying process which can be applied to deal drying modelling, where non-isothermal conditions are commonly taken.

Ansys-workbench13 (FLUENT) has been used to assess the working behaviour of proposed design. Design modelling and simulation have been done in both 2D and 3D format. Sample calculations are made for drying wood pieces as an illustration of the principle outlined. It has been estimated that how even temperature distribution avoids over and under drying problems with uniform drying rate. An amount of 0.327 ton wood was dried at controlled temperature of 44°C for 96 hrs. These samples were put in plastic buckets along the length of dryer. The measured temperature distribution and uniform drying rate of all wood samples illustrated the success of the design. Next experimentation will start for food (fruits and vegetables) to assess the uniformity of defined quality parameters.

Keywords: Air distribution, quality food drying, value addition

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Controlling Rancidity of Purple Rice Bran by using Radio Frequency Heating Technique

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A split split plot in complete randomised design (CRD) with 3 replications was designed in this experiment. The main plot was four cultivars of Thai rice bran which were 2 white rice (SPT1; KDML105) and 2 landrace purple rice (KDSK and KN), sub-plot was temperature of radio-frequency (RF) at 3 levels and sub-sub-plot was 4 storage periods. The rice bran samples were exposed to RF at frequency of 27.12 MHz at temperatures of 70, 75 and 80°C for 3 min. Then, the treated bran was packed in aluminum foil bag and vacuum sealed at a pressure of 80 kPa and stored at 25°C for 0, 2, 4 and 6 months. In each storage time, the bran were tested for contamination of microorganisms, moisture contents (mc), oil and protein contents and assessment of rancidity by thiobarbituric acid number (TBA) as well as anthocyanin content (in form of cyanidin^{-3}-glucocide: C3G) in purple rice was also determined. The results showed that RF heating technique significantly decreased ($p \leq 0.05$) the mc decreased more than 1 %, but there was no significant difference between all treating temperatures. After 2 months storage, the mc of bran increased significantly due to moisture equilibration in their airtight containers. The RF at temperatures of 70 and 75°C reduced microbial contamination significantly. Storage for 2–6 months significantly resulted in increasing number of oil content. The interactions between temperature and cultivar also affected oil content. Rice bran treated at 75 and 80°C showed higher oil content than untreated, especially in cv. SPT1, KDML105 and KN. The same happened in protein content. Storage of 2–6 months resulted in TBA value, which tended to increase during the first 4 months and decreased in sixth month. The methods also provided higher C3G content extracted from purple rice bran compared to untreated samples.

Keywords: Anthocyanin, purple rice bran, radio frequency technique, rancidity, storage

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Yield and Keeping Quality of Freshly Prepared Breakfast Sausage as Affected by Time *post mortem*

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Sausage meat was harvested at six hours *post mortem* intervals. The same sausage recipe was used for all times: Beef (65 %), lard (20 %), soybean binder (3.5 %), green spices (2.19 %), dry spices (1.5 %), ice water (4.5 %), salt (2 %), sugar (1 %), sodium nitrite (0.01 %), and phosphate (0.3 %). Sausage prepared was subjected to proximate analysis, physiochemical evaluation, sensory evaluation, microbial evaluation and Thiobarbituric acid (TBA). The sausage was stored for 14 days at 4°C.

There were significant ($p < 0.05$) differences observed in product yield, pH value, cooking loss and water holding capacity among the treatments. Product yield decreased as time *post mortem* increased. 99 % product yield was observed for 0 hour time *post mortem* compared to 86.87 % at 24 hours. The pH increase with time *post mortem*, the same was observed for cooking loss and water holding capacity. The proximate composition showed significant ($p < 0.05$) differences for freshly prepared sausage as affected by time *post mortem*. Variation was observed in the moisture, protein, fat and ash content.

Thiobarbituric acid (TBA) values significantly differed ($p < 0.05$), with greater values obtained from 0 and 6 hours time *post mortem*, decreasing as time *post mortem* increased. There were significant ($p < 0.05$) differences in total plate counts for microbial analysis, which increased as time *post mortem* increased.

Sensory evaluation score of sausage made 6 hours *post mortem* was highest for colour, juiciness, overall acceptability and tenderness, and significantly different ($p < 0.05$) from those of other treatments.

0 and 6 hour time *post mortem* were recommended from this experiment to harvest meat for best yield and for keeping the quality of sausage.

Keywords: Breakfast sausage, keeping quality and meat, time *post mortem*, yield

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Assessment of Quality of Raw Camel Milk and Increase of Shelf Life

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Camel milk is important to the human diet in many parts of the world. Fifty samples of raw camel milk were collected from different zones of eastern Saudi Arabia, analysed to evaluate their microbiological quality and the data were confirmed by PCR based methods. Furthermore, the presence of selected pathogens such as *Staphylococcus aureus*, *Salmonella* sp., *Bacillus cereus*, *E. coli* 0157:H7 and *Listeria monocytogenes* was detected. The following mean average of LAB and total viable counts were 1.1 and 2.6×10^6 cfu ml^{-1}, respectively. Thirty-two LAB isolated species were identified, while yeast and mould counts were relatively lower (1.8×10^2 cfu ml^{-1}). Low coliform numbers were 0.2×10^2 cfu ml^{-1}. *Staphylococcus aureus* was found in 30 % of samples while 0.4 % of samples were *Salmonella* positive. The detection rate of positive samples by using PCR was 35.6, 2.0 and 64.2 % for *Staphylococcus aureus*, *Salmonella typhimurium* and *E. coli*, respectively. All samples tested were negative for *E. coli* 0157:H7 and *Listeria monocytogenus*. Lactoperoxidase system (LPS), essential oils (EOs), isolated lactoferrin (LF), and lysozyme (Lyz) were used for improving the keeping quality of camel milk. Cold camel milk samples (4°C) treated with 15 ppm LPS and 0.2 ppm of marjoram or sage had a shelf life of 21 days. Use of 5 mg ml^{-1} of LF and Lyz had a higher antibacterial effect and improved the keeping quality of camel milk. The high content of antimicrobial agents in camel milk may explain its prophilactic potential against many diseases. The present study recommends further research on identification and molecular characterisation on the isolates from camel milk and its products.

Keywords: Camel milk, keeping quality, microbiological quality

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Meat Attribute of Domesticated Grasscutter Compared with Wild Grasscutter (*Thryonomys swinderianus*)

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To evaluate meat attribute of wild and domesticated grasscutter (*Thryonomys swinderianus*) forty eight (48) male and twelve (12) females grasscutter, 4–5 month old and weighing between 0.78 – 2.04 kg were used for the study, carried out at College of Agriculture, Osun State University, Ejigbo Campus in Osun State, Nigeria. The objective was to compare the carcass characteristics, physcio-chemical properties and mineral composition of grasscutter fresh and cooked meat of both grasscutters fed with same diets in a completely randomised design. Results showed that for carcass characteristic all parameters were significantly different except for the tail length, dress percentage and intestinal weight percentage with 18 ± 1.69, 80 ± 3.42 and 0.34 ± 0.02 for wild grasscutter and 24 ± 1.69, 79.4 ± 3.42 and 0.28 ± 0.02 respectively. Physico-chemical properties were ($p < 0.05$) for all parameters: cold and thermal shortenings, cooking loss, and share force except for water holding capacity with 64.7 ± 3.01 for wild and 71.7 ± 3.01 for domesticated grasscutter with no significant different. Mineral composition for fresh and cooked meat of wild and domesticated grasscutter were observed to have no significant different for calcium and potassium but ($p < 0.05$) were obtained for magnesium and iron. Significant differences exist among, moisture, protein, ash and ether extracts content of cooked and raw meat, with highest values observed for protein, ash, ether extract, but lower moisture content wild than domesticated grasscutter. Domesticated grass cutter had lower shear force, cooking loss, thermal and cold shortenings, protein, ash and ether extract but higher water holding capacity and moisture than wild grasscutter.

Keywords: Grasscutter, mineral composition, physico-chemical properties, proximate composition

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Managing and conserving forest resources

Posters

Conflicts in Natural Resource Management in Central Vietnam: The Role of Collective Action in Protecting Community Benefits

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The rapid growth in Vietnam over the last two decades has put a new face to the country's economy. At the same time, the pressure on the natural resources has been on the rise. Local communities that have been managing their surrounding natural resources for generations are now facing the challenge to maintain their rights and benefits from these resources.

This research presents empirical evidence from a case study in Thua Thien Hue province of Vietnam. The local community has managed an area of natural forest on inland sand area for over 400 years and has developed necessary institutions to protect the resource for community and individual benefits. Nevertheless, their tenure rights to the forest have not been legally recognised. Since the mid 2000s, conflict over this forest has emerged when a sand mining company with a legal license has started working on the community's forest. The conflict escalated when the main water resource of the community was used by the company for its own purposes and when the company encraoched its operations into the forest. Without legal rights to the forest, the community was put on the loosing end.

One-sample statistics and one sample-tests were used to explore the perception of the local people about the conflict and the impacts of companies on their lives and environment, and roles of actors in conflict management. Findings from the study indicate that the community has stood together to collectively protect their natural resources. Community members organised themselves and sent their request to the company to stop the operation on community's land. They also prepared their appeal to be sent to local authorities.

Our conclusion is that (legal) property rights play a central role in natural resource management, especially when the resource is in conflict. Customary practices, though maybe faded out during a long period of nationalisation of forest resources and economic growth, can still be revitalized to forge collective action to protect the resource for community interests. Economic development policy needs to take into account the rights of local communities in sustainably securing their livelihoods.

Keywords: And conflict management, collective action, community forest, property rights

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From Deforestation to Reforestation: Systematic Assessment of Smallholder Tree Planting Initiatives in Paraguay

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The forest area in Paraguay has declined at concerning rates. The country holds one of the highest deforestation figures in South America. However, the development of adoptable forestry management systems to address deforestation meets country's agenda not long ago. Therefore, research on tree planting by small farmers are crucial, especially to gauge their role in reducing the pressure on native forest and support livelihood. Several case studies were carried out to assess the success of tree planting initiatives; to identify the factors which influence its adoptability; and to determine the contribution of timber products to household income. Different stakeholder levels and tree planting schemes were selected to better depict smallholders participation in establishing and managing productive plantations. Results from logistic regression show that the pressure on existing forest resources can be diminished at a certain degree by tree planting initiatives. Most of established tree plots were readily adopted by farmers because they were compatible with farm production system (agroforestry) and they were easy to try on a limited scale and therefore it minimises risk. An influential determinant for tree planting seems to be the social organisation level, and technical and managerial support. It is also shown that farmers are willing to use farm production factors to guarantee the management of tree plots in the future, if they can count on market incentives. Plantation timber has notable potential for contributing to income generation. Managing planted trees at small scale farms requires little financial support and shows low labour input when comparing with traditional farm cash crops. Finally it is suggested that trees inherent advantages such as malleability to be combined as agroforestry system plus their potential for income generation are key factors to promote tree planting at small scale farms.

Keywords: Deforestation, income generation, smallholders, social organisation, tree planting

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Evaluating the Effectiveness of Protected Areas in Preventing Deforestation: Case Study of Evergreen Forest Colombia

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Evaluate effectiveness of protected areas PA(s) and indigenous reserves IR(s) in preventing deforestation is becoming more important given the crucial role of forest conservation in climate change mitigation. Monitoring deforestation using near real-time remote sensing is practical for detecting forest cover change trends and identifying protection levels. Information on how effective PA network in Colombia represent global and national conservation priorities is essential for developing and implementing policies for conserving forest habitats and development benefits.

Here, we evaluate the effectiveness of 80 Colombia PA(s) preventing forest loss under three forest conservation management strategies: 22/II—IV, 10/VI IUCN categories and 48/IR(s). We mapped annual forest cover change from 2005 to 2011 using Terra-i (250 m) joined to GlobCover 2005 (300 m) inside and in the 10-km buffers outside the PA(s). We used GlobCover re-classified to identify the extent of evergreen forest cover as base map. Based on these data we develop an effectiveness index including percentage of loss inside PA(s), the comparison of loss inside and outside PA(s), annual rate of loss inside PA(s) and the comparison of annual rate of loss inside and outside PA(s). The total forest cover area lost between 2005 and 2011 comprised 1.1 % nationwide and 0.3 % of the PA network, equivalent to 57.000 ha. Inside PA(s), loss of forest occurred in 20 % of those located in the category II—IV, 9 % in the VI and 55 % in the IR(s), while 23 %, 11 % and 60 %, experienced lost outside, respectively. Moreover, we identify four effectiveness categories: very-satisfactory, satisfactory, dissatisfactory and very-dissatisfactory. Nearly 51 % of PAs were effective, described as satisfactory and very-satisfactory protection level. Moreover, 60 % VI/IUCN, 54 % II-IV/IUCN categories and 45 % IR(s) were identified as effective.

These results suggest that loss of evergreen forest cover in Colombia PA network is substantially low in comparison with countries in Central Africa, South and Southeast Asia. The IUCN categories hardly explain the differences between effectiveness levels of protection. Hence, the application of another empirical method is recommended to control for landscape characteristics that can influence deforestation. Finally, forest protection strategies can contribute both to biodiversity conservation and climate change mitigation goals.

Keywords: Effectiveness protection, forest cover loss, indigenous reserves

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Conventional Logging in Natural Forests of Vietnam: Issues and Ways Forward

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Vietnam's total natural forest covers 10.34 million ha, of which 4.15 million ha are production forest, and State Forest Enterprises (SFE) manage about 26% of this forest for timber production. Conventional loggings are carried out by SFE or logging contractors. After logging, many forest areas have been degraded, non-commercial crops trees are left in the forest. Intensive logging happened in the period from 1976 to 1980 with 1.62 million m^3 $year^{-1}$. From 2005 up to date, logging quota are set down to 0.2 million m^3 $year^{-1}$. The study examined conventional logging techniques with machines applied by the SFE. Four SFE which mange natural forests were investigated, namely So Pai, Ha Nung, Dak To, Song Kon State Forestry Companies. A list of core elements in pre-harvesting, harvesting and post-harvesting activities was evaluated and compared with Reduced Impact Logging (RIL) standard. Moreover, key informant interview, group discussion and observation were complemented to have better understanding and evaluation. The results indicate that conventional logging practices by the SFE accounts for 61.5 % compared to RIL practice. Dak To showed the best demonstration of logging practice which reached 77.4 % of RIL standard as the result of RIL introduced in this case by a GIZ project. Compared to pre-harvesting and harvesting, post-harvesting activities appear to less satisfy the standard of RIL with only 53.9 %. The study also revealed that the conventional logging has some problems such as insufficient and unspecific mitigations of negative impacts; improper attention to exclusion areas; no development of proper harvesting evaluation of logging operations and its impacts; lack of well-trained workers; improper health and safety consideration; utilisation of out-of-date machineries; improper attention to harvesting monitoring; low rate of tops and branches salvage; and sketchy implementation of post-harvesting activities. For improvement of natural forest management towards sustainability, there is an urgent need to have a RIL code of practice for timber harvesting for the country that specifies and puts into mandatory regulations to nationwide performance. Moreover, higher level of mechanisation with suitable machines and equipment should also be considered.

Keywords: Conventional logging, natural forest, RIL, Vietnam

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Fire History of Conifer Forests of Cerro El Potosí, Nuevo León, Mexico

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Fire is one of the most important ecosystem processes contributing to biodiversity and health, so it is useful to study patterns and changes in fire regimes. The fire regime for the coniferous forests of Cerro El Potosí, located in the Sierra Madre Oriental mountain range in northeastern Mexico, was investigated using fire-scarred trees. The selected area for sampling was a part of the coniferous forests, between 2,900–3,450 m a.s.l., with a northeast aspect and a slope range of 22–38 %. The sampling area covered an area of $\approx$ 2 km. The forest in the sampling area was composed of species such as *Abies vejarii*, *Pinus strobiformis*, *Pinus greggii*, *Pinus hartwegii* and *Pseudotsuga menziesii*. To reconstruct the fire history in the area, we took samples from trees with at least one fire scar. We used chain saws to obtain the samples. We collected total and partial sections of stumps, logs, snags and living trees. In addition data were recorded for each tree such as diameter (DBH), status (live, snag, log and stump), slope, aspect and geographical coordinates. From the 22 collected samples, it was only possible to date 16, with a total of 35 fire scars. The samples used were of *Pinus strobiformis* and *Pinus hartwegii*. The oldest scar formed in 1807 and the most recent in 1998. The descriptive statistics calculated for the period of reliability (1888–2011) show that the Mean Fire Interval (MFI) for all fires was 11 years and 15.7 years for the larger fires or those that scarred $\geq$ 25 % of all samples. The trees recorded fires from the late 19th century through the late 20th century. Most of the fires corresponded to the 20th century; the last fire recorded was in 1998. We observed shorter fire return periods until before 1955, with an increase in these intervals for subsequent fire events. There was no significant relationship between fire occurrence and climate variables (precipitation and ENSO), suggesting that for our study area fire occurrence is mostly influenced by anthropogenic activities.

Keywords: Cerro Potosí, ENSO, fire scar, forest fire

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Does Corticular Photosynthesis Contribute to Carbon Gain in Green Stem-Succulent Plants?

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The African baobab (*Adansonia digitata* L.) and castor bean (*Ricinus communis* L.) are drought resistant green-stemmed succulent plants which grow in the arid and semi-arid regions of Africa. A common characteristic of stem-succulent plants is the presence of a green layer underneath the stem bark which contains chlorophyll and is capable of re-fixing CO_2 produced by stem respiration in the presence of light. Photosynthesis in the stems of green-stemmed plants is known to contribute to plant carbon gain especially during leafless periods. The contribution of corticular photosynthesis to plant carbon gain has, however, never been measured in stem succulent species. The aim of the study was to investigate the contribution of corticular photosynthesis to carbon gain in these stem succulent plants, and how this process is affected by drought, which is common in their natural habitats. The height and stem diameter of baobab and castor bean plants grown in the greenhouse were measured. The plants were completely defoliated and subjected to different treatments: watered with uncovered stems (WU), watered and stems covered with aluminium foil (WC) to achieve 100 % light exclusion, drought and uncovered (DU) and drought and covered (DC). The plants were allowed to grow for 3 weeks, while buds produced were harvested weekly. After three weeks, the dry weight of buds produced, the height and stem diameter and the ^{13}C composition of the buds and outer stem bark was measured. Stem coverage with aluminium foil resulted in a higher stem and larger stem diameter for drought exposed baobab seedlings with similar trends seen in castor bean. Light exclusion also resulted in a reduction in the stem chlorophyll content in both species. Light exclusion resulted in a significantly lower bud dry weight production and enrichment in ^{13}C in bud dry matter, demonstrating that corticular photosynthesis contributes to whole plant carbon gain in both species. Bud biomass production in drought stress plants was significantly lower compared to watered plants, showing that drought stress have negative impacts on growth. These findings confirm that the green stems of stem-succulent plants contribute to overall plant carbon gain.

Keywords: Bud development, corticular photosynthesis, defoliation, stem coverage, stem succulent

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Evaluation of Carbon Content in Forests of North–Eastern Mexico

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Our objective is to communicate some initial lessons about the practical challenges of designing and conducting measurements of carbon pools in Mexico. The acknowledgement of the importance of environmental services that forests provide and the need to count on reliable methods to assess them are the reasons to accomplish the actual study, whose objectives were to develop methods and practical tools to estimate the carbon content of some forest types. Better knowledge of carbon stocks and fluxes is needed to understand the current state of the carbon cycle and how it might envolve with changing land uses and climatic conditions. Aboveground tree mass is estimated using allometric equations relating diameter at breast height to total tree mass or component parts of bole wood, branch, and foliage mass. In the present work biomass equations as a function of the normal diameter were developed for *Pinus pseudostrobus*, *P. teocote* and *Quercus* spp. in temperate forests of northeastern Mexico. Likewise, the carbon content of the species was determined with an organic carbon analyser. The results allowed the construction of biomass and carbon content tarif tables and charts, through which contained carbon in tree species of mixed forests pine-oak, oak-pine and pure pine stands was evaluated. The carbon percentage in *Pinus pseudostrobus* was 50.4, in *P. teocote* 47.8 and in *Quercus* spp. 48.4. Carbon content tables for pure pine stands of the two pine species were built for different site indices. The results of the carbon content evaluation in different types of forest were: pine-oak forest 45.2 Mg ha^{-1}, oak-pine forest 64.2 Mg ha^{-1}, pure pine forest of *P. pseudostrobus* 73.2 Mg ha^{-1} and *P. teocote* forest 47.0 Mg ha^{-1}. Two inventory techniques for the estimation of forest carbon in different forest structures are discussed, and field measurement guidelines for mixed and pure stands are presented.

Keywords: Allometry, biomass, carbon ratio, carbon storage, environmental services

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Rainfall Partitioning in Tamaulipan Thornscrub at Species Level, Northeastern Mexico

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Throughfall and stemflow measurements in six thornscrub species plantations and in an undisturbed thornscrub plot were carried out in different periods between 2005–2013 in Northeastern Mexico, in order to investigate the rainfall partitioning of this plant community. Troughs and spiral-type stemflow gauges were used for throughfall and stemflow measurements. The analysis of rainfall events showed that net precipitation for *Acacia berlandieri*, *Acacia rigidula*, *Diospyros texana*, *Prosopis laevigata*, *Ebenopsis ebano*, *Helietta parvifolia* and the Thornscrub plot represented 82, 85, 78, 74, 65, 67 and 62 %, respectively, of total gross precipitation during the study period. Linear regression analysis between gross precipitation and interception loss in the seven canopy types showed correlation values from r=0.967 (Thornscrub) to r=0.61 (*A. rigidula*). Stemflow values ranged from 0.23 % (*P. laevigata*) to 3.29 % (*E. ebano*), and the canopy storage capacity values varied from 0.03 mm (*H. parvifolia*) to 0.24 mm (*A. berlandieri*). Interception losses of the canopy were estimated at 18, 15, 22, 25, 34, 33 and 38 % for *A. berlandieri*, *A. rigidula*, *D. texana*, *P. laevigata*, *E. ebano*, *H. parvifolia* and the Thornscrub plot, respectively. The results have indicated that the percentage of interception loss was in the following order: Thornscrub plot>*E. ebano*>*H. parvifolia*>*P. laevigata*>*D. texana*>*A. berlandieri*>*A. rigidula*. The higher interception loss in the Thornscrub plot and *E. ebano* may occur because the canopy cover of this plant community and plant species, respectively, is thicker and its storage capacity is greater than others. However, the architectural features of the canopy and leaf traits are different between species and may influence the interception loss. *A. rigidula* and *A. berlandieri* have the most permeable canopies and therefore the interception losses are lower. On the other hand, the *E. ebano* and Thornscrub intercept more than twice in relation to the *Acacia* canopies. Results suggest that the management of thornscrub, as a resource for water conservation, may play an important role in semiarid regions where water is a limiting factor. Also, thornscrub genera like *Acacia* could be used in reforestation programs for an efficient water management in this region.

Keywords: Northeastern Mexico, rainfall pertitioning, stemflow, thornscrub, throughfall

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Land Use/Cover Change (1997–2007) in the Protected Forest Sumaco, Northern Ecuadorian Amazon

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For effective and efficient conservation of a Protected Forest system in Ecuador, both realistic description of the local community's behaviour and regional land use dynamics need to be taken into account. Formulating policy requires good knowledge of what the community actually does. An understanding of the structure and dynamics of the population–environment relationship is a key for conservation and development efforts in tropical forests, aiming at mitigating deforestation and future land cover change. The present study focuses on the natural resource base, the institutional, infrastructural, and technological environment and community characteristics that drive land use and land cover (LULC) change in the Protected Forest Sumaco (PFS). In order to incorporate the spatial information into analysis, topographic and tenancy maps were digitalized into Geographic Information Systems (GIS) to use as input layers. Then these maps and satellite images from 1995–1997 and 2007 were used in GIS analysis to get deeper insights into the temporal and spatial variations in the land use dynamics of the areas. In addition, Participatory Rural Appraisal method was applied to 38 % of all communities of PFS, which collected socioeconomic information of local communities and biophysical conditions of the local resources bases. Between 1995 and 1997, at the community level, LULC pattern were principally influenced by the existence of rivers and flat land, but less by indigenous communities and sloping land. This changed in the period 1997 to 2007. Primary drivers of deforestation (LULC) were now indigenous communities and land titles, while number of hectares per community and rivers played minor roles. Hence, the important factors have shifted, which explain variation in deforestation in the Protected Forest Sumaco.

Keywords: Canonical function, colonist populations, GIS, indigenous populations, participative rural appraisal

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Structural Demography and Species Diversity in Dalang Natural Reserved Forest (Extension), South Kordofan, Sudan

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The present study was conducted in Dalang Natural Reserved Forest, South Kordofan Region in May 2012. The study aimed at identifying the structure and composition of the forest for management and conservation purposes. It studied also the demography of the species and its aptitude for recuperation in the near future. Data was collected from inventory work. Systematic sampling was applied. 20 square sample plots (200 m^2) were placed along the strips. Data such as tree species, diameter at breast height (DBH), and height were taken. Statistical packages for social sciences (SPSS) software 18.0 was applied for data analysis. The study recorded 11 families spread where *Fabaceae* is the dominant family. The forest is rich with diverse flora. 30 tree species were recorded. The dominant tree species is *Balanites aegyptiaca* while the highest density was recorded to *Albizia amara* and *Acacia seyal*. In the Gardud site of the forest, *Albizia amara*, *Acacia seyal*, *Acacia senegal* and *B. aegyptiaca* achieved the highest density while in low land of Valley and Mayaa sites 3 species scored the highest density; *Acacia nilotica*, *Acacia nubica* and *B. aegyptiaca*. Demographically, the percentage of new regeneration, young regeneration and mature trees (23.6, 22.2, and 11.1 %) in Gardud site is higher than its percentage in Valley and Mayaa site (20.8, 15.2, and 6.9 %), respectively. A recovery of the forest could be achieved in case of efficient protection. The vegetation recovery in Gardud site will recover more rapidly than in the valley and on the Mayaa site due to the highest proportion of new naturally and young regenerated species. The study recommended assisting enrichment of eco-diversity, conservation and achievement of sustainability in the forest and its surrounding buffer zone.

Keywords: Demography, diversity, Dalang natural reserved forest, structure, tree species

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Stand Structure and Spatial Pattern of Mangrove Regeneration in a Degraded Peri-Urban Coastal Forest

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Mangrove forests – notable for their global importance due to their high productivity and support for numerous ecosystem services – grow in a narrow range of the seashores and tidal parts of river estuaries in the tropical to subtropical coastlines. Their potential for carbon sequestration, nutrient cycling and coastal nutrient budgets are noteworthy; but they are threatened around the world by the conjoint impacts of human activities and natural factors. We conducted detailed field assessment of vegetation cover and the spatial distribution of trees in a degraded mangrove forest in Tudor creek, near Mombasa to describe the stand structure and spatial pattern of mangrove regeneration in degraded peri-urban mangrove forests. Modern point-pattern statistics including pair correlation and mark connections functions were used for the spatial analyses to investigate the spatial structure of mangrove regeneration in the study area. The results showed that the stand structure differed significantly across zones in the study area, with signature of some intermittent period of disturbance. Nonetheless, there was evidence of viable regeneration. Total juvenile density of all the four species found regenerating appeared to be sensitive to the influence of forest structural attributes and the degree of recurrent inundation. The juvenile density of *Ceriops tagal* showed a significant correlation with the number of harvested or damaged stumps. We found that the spatial structural pattern of *Rhizophora mucronata* population along tidal gradient showed a characteristic spatial aggregation at small scale but random distributed as the distances become larger. There was a distinct spatial segregation between recruits and adult trees, showing that juveniles tend to cluster in vegetation canopy gaps. The pattern was slightly different in the adult-adult relationship, and a rather completely opposite in the recruit-recruit associations as they showed clustering in space. Recruits were found spatially independent of the adult trees. We concluded that the effect of plant-plant conspecific interactions is more probable to inform the long-term structure and dynamics in a degraded mangrove forest. It is suggestive that successful restoration of degraded mangrove forests, especially through enrichment planting, would require consideration for the spatial structural patterns of mangrove species.

Keywords: Forest regeneration, mangrove degradation, peri-urban forest, point-pattern analysis, stand structure

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Litterfall Deposition and Leaf Litter Nutrient Return in Different Locations in Northeastern Mexico

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The study aimed to determine the litterfall production and macronutrients (Ca, K, Mg, N, and P) deposition through leaf litter in three sites with different type of vegetation. Site one (Bosque Escuela) was located at 1600 m a.s.l. in a pine forest mixed with deciduous trees, second site (Crucitas at 550 m a.s.l.) in the ecotone of a *Quercus* spp. forest and the Tamaulipan thornscrub and the third site (Campus at 350 m a.s.l.) was located at the Tamaulipan thornscrub. Litter constituents (leaves, reproductive structures, twigs and miscellaneous residues) were collected at 15-day intervals from December 2008 throughout December 2009. Collections were carried out in 10 litter traps (1.0 m $\times$ 1.0 m) randomly situated at each site of approximately 2500 m^2. Total annual litterfall deposition was 483, 706, and 495 13.4 g m^2/year for Bosque Escuela, Crucitas, and Campus, respectively. Of total annual litter production, leaves were higher varying from 72 % (Bosque Escuela) to 66 % (Crucitas) followed by twigs from 8 % (Bosque Escuela) to 21 % (Campus), reproductive structures from 5 % (Bosque Escuela) to 14 % (Crucitas), and miscellaneous litterfall from 3 % (Crucitas and Campus) to 13 % (Bosque Escuela). The Ca annual deposition was significantly higher in Campus (13.4 g m^2/year), followed by Crucitas (11.4), and Bosque Escuela (3.6). The K (0.98, 3.8 and 3.0, for Bosque Escuela, Crucitas and Campus, respectively), Mg (0.488, 1.298, and 1.165, respectively). The P deposition was 0.141, 0.260, and 0.237, respectively. On an annual basis for all sites, the order of nutrient deposition through leaf litter was: Ca>K>Mg>P; whereas, on site basis of total nutrient deposition (Ca+N+K+Mg+P) was as: Campus > Crucitas > Bosque Escuela. Ca, K, Mg, N, and P nutrient-use efficiency values in leaf litter were higher in Bosque Escuela, while lower figures were acquired in Crucitas and Campus sites. It seems that the highest litterfall deposition was found in the ecotone of a *Quercus* spp. forest and the Tamaulipan thornscrub; however, the Tamaulipan thornscrub vegetation alone had better leaf litter nutrient return. There were spatio-temporal variations in quantity of literfall collected and return of minerals.

Keywords: Litterfall, northeastern Mexico, nutrient deposition, nutrient use efficiency, pinus forest, quercus forest, Tamaulipan thornscrub

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Allometric Equations for Timber Stock and Stem Biomass Estimation of Phanerophytes in Dry Forests on the Mahafaly Plateau, Madagascar

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In the southwestern region of Madagascar, the dry spiny forests represent a unique and highly diverse ecosystem with an exceptionally high number of endemic species. However, deforestation rates increased drastically during the last 20 years and is mainly caused by slash-and-burn agriculture, logging, and the production of fuelwood and charcoal for cooking. To establish sustainable forest management strategies, the accurate and rapid assessment of timber stock is crucial, notably on the Mahafaly Plateau where local people are entirely dependent on natural resources to survive. The present study therefore aims at elaborating reliable allometric equations for phanerophytes on the Mahafaly Plateau, which permit to estimate wood volume and stem biomass from measurable dimensions such as diameter and height.

We inventoried diameter (diameter at breast height or diameter at 0.1 m), height, volume or biomass for the main tree and shrub species (22 species) used for charcoal production with a diameter ranging from 5 to 67.8 cm (n = 196). For 74 tree individuals, we applied a section-wise volume measurement for the stem and branch $\geq$ 2.5 cm diameter of already logged individuals (diameter and length of the section) using Smalian's formula and collected samples for wood density determination. For 122 individuals of phanerophytes, stem biomass was estimated by direct measurement of the weight of the stem from the soil level to the branches $\geq$ 2.5 cm diameter. Wood samples were collected and dried until a constant weight was obtained.

Five different equation models were developed and compared: a power function model with multiplicative error, a polynomial model, a combined variable model, a square-root transformed model and a power function model with additive error. Results indicate that the power function with multiplicative error and the combined variable models show a high coefficient of determination ($R^2 > 0.90$) and best describe the relationship of stem biomass and measured parameters. These equations will be used to extrapolate and map the results of ongoing forest inventory and satellite image analysis.

Keywords: Allometric equation, biomass, diameter, height, Mahafaly Plateau, wood volume

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Rhizogenezis of Leafy Stem Cuttings of *Calycophyllum spruceanum* (Bentham) Hooker F. Ex Schumann: Effect of Indol-3-Butyric Acid

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Reforestation and domestication of forest trees in the Peruvian Amazon depends especially on succesful propagation of partical species. Vegetative propagation may serve as a tool for selected genotype conservation, and is an alternative to propagation by seeds, which is often constrained. This study focused on determining effects of five different concentrations of Indole-3-butyric acid (IBA) on rooting parametres of leafy stem semihard wood cuttings of *Calycophyllum spruceanum* (Rubiaceae). This fast growing pioneer tree species is valued by local people not only for its relatively good quality wood with straight growth habit, but also for its medicinal purposes. After 21 days in sub-irrigated polyethylene polypropagator, rooting parametres of the propagules were measured. The number and percentage of rooting, callus formation, number of roots, total root length, and length of the longest root was significantly higher, while mortality and leaf abscission was significantly lower in group treated with 2000 ppm of IBA than in control group with untreated cuttings ($p < 0.05$). However no significant differences were found in these parametres between the group treated with 2000 ppm and groups treated with 4000 and 5000 ppm, respectively, except for the leaf abscission parametre. No significant differences were recorded in number of callusses per cutting between the five groups tested. These results shows that rhizogenesis of *C. spruceanum* was influenced by the application of IBA. The best concentration for successive vegetative propagation of juvenile leafy stem semihardwood cuttings of this species was 2000 ppm of IBA.

Keywords: Domestication of timber species, Indole-3-butyric acid (IBA), leafy stem cutting, subirigated polyethylene polypropagator

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Effects of Different Treatments on the Germination and Early Seedling Growth of Dawadawa (*Parkia biglobosa* (Jacq.) Benth.) from Northern Ghana

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Effective domestication and conservation of an important tree like *Parkia biglobosa* can be achieved when alternative ways of breaking the dormancy characteristics posed by the seeds of this plant is established. The experiment conducted at the plant house of the University for Development Studies, Nyankpala Campus investigated the most effective pre-sowing treatment to break seed dormancy and the assessment of early seedling growth of *P. biglobosa* seeds collected from the three northern Regions of Ghana. Matured seeds of *P. biglobosa* were collected from Wa (Upper West Region), Navrongo (Upper East Region), and Cheyohi near Nyankpala (northern Region), dried at room temperature and tested for viability by flotation method. The seeds were subjected to the following pre-treatments; soaking in 100 % sulphuric acid for one minute, soaking in hot water for two minutes, and soaking in cold water for 24 hours. The seeds were sown in polypots and after five (5) weeks, parameters measured included germination performance, number of leaves, seedling height and girth. The results obtained indicated that seeds from the three northern regions, treated with concentrated sulphuric acid had the highest germination percentage (60 %), recorded the highest number of leaves, the greatest height and also stem girths. For all the treatments however, the seedlings germinated does not differ significantly. This study revealed that seeds treated with concentrated sulphuric acid improved seed germination and early seedling growth. Thus we recommend to treat *P. biglobosa* seeds with sulpheric acid for early germination. Also soaking seeds in hot water can be effective where and when concentrated sulphuric acid is unavailable.

Keywords: Germination performance, pre-treatment, seedling growth

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Thermoregulation of Radiated Tortoises in an Altered Landscape in Madagascar

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The radiated tortoise (*Astrochelys radiata*) is an endemic species of southern Madagascar. It is classified as Critically Endangered according to the IUCN Red List of threatened species. Forest degradation, deforestation and subsequent livestock grazing or agriculture result in an increase of ambient temperature (Ta) in the species' native habitats. Ambaro, a degraded zone located at the North-eastern border of Tsimanampetsotsa National Park, was selected as a study site to understand the responses of tortoises to thermal stress imposed by changes in habitat characteristics due to changes in land use management. We studied the contributions of alteration in daily activity, behaviour and microhabitat utilisation for the regulation of body temperatures (Tb) in *A. radiata* in relation to changes of Ta. Our results showed a bimodal daily activity pattern of tortoises. The morning activity was characterised by frequent changes of burrows, while the afternoon activity was related to searching food. Throughout the day the tortoises maintained relatively stable Tb. Thus, animals limited their activity time and remained inactive in their refuges most time of the day. The tortoises preferred partially shaded microhabitats with a substrate covered by leaf litter and thus thermoregulated so that Tb stayed consistently below Ta, especially during the hot midday conditions. Since the rigid thermoregulatory behaviour suggests a vital role of Tb for proper maintenance, we suggest that conservation of the intact spiny forest ecosystem is important for the reproduction and survival of the species in the long run.

Keywords: *Astrochelys radiata*, body temperature, Madagascar, radiated tortoise, spiny forest, thermoregulation, Tsimanampetsotsa National Park

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Soils, environment and fertiliser

Posters

Soil and Soil Quality Mapping for an Extreme Relief Region using Detailed Fuzzy Slope Forms

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Slope forms at different positions along a slope are often gradual which reflects the nature of a slope. Some studies have computed different fuzzy slope positions for digital soil mapping. However, there has not been a system calculated for a large area with extreme relief conditions. This study examines all possible slope forms that can be achieved for a large area of 860 km^2 with extreme relief conditions and used later for fuzzy soil mapping. This fully achieved slope form system together with slope gradients can be used to rule out the variations of organic matter content at different slope positions and slope angles as a very important index for soil and soil quality mapping. Firstly, a classification of five major slope positions (ridge, upper slope, middle slope, foot slope, and valley) was defined. Nine basic slope forms (FAO guideline for soil description, 2006) were computed as nine fuzzy slope forms for each of the three middle major slope positions. This resulted in 29 fuzzy slope forms extracted for a single slope. Secondly, soil mapping was carried out using SoLIM software(Soil and Land Inference Model). To prepare for the model, calibration of different reference soil groups based on the environmental parameters as major soil-forming factors was carried out. The development of a soil database for the area based on 125 soil profiles resulted in 10 major reference soil groups. The soil information was collected with information of slope, elevation, geology, and land use types. Soil prototypes or distinctive combinations of soil-forming parameters to formation of soils were defined for every soil group. These prototypes were then set as fuzzy rules in SoLIM to derive a soil map of 10 major soil groups. Thirdly, soil quality indices were calculated for every soil profile in which slope form-dependent organic matter content played a very important role. From these calculations soil quality prototypes were then defined based on the available soil database and set as fuzzy rules. SoLIM was then applied to derive a map of different quality classes. This soil quality map tells us where the best soils are located and can be used for many purposes, such as land evaluation, land use planning.

Keywords: Extreme relief, fuzzy rules, organic matter content, prototypes, slope forms, SoLIM, soil mapping, soil quality mapping

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Decomposition and Humification of Soil Organic Carbon after Land Use Change on Erosion Prone Slopes in Northwest Vietnam

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Soil organic carbon decline after land use change from forest to maize usually lead to soil degradation and elevated CO_2 emissions. However, limited knowledge is available on the interactions between rates of SOC change and soil erosion and how SOC dynamics vary with soil depth and clay contents. The ^{13}C isotope based CIDE approach (Carbon Input, Decomposition and Erosion) was developed to determine SOC dynamics on erosion prone slopes. The aims of the present study were: (1) to test the applicability of the CIDE approach to determine rates of decomposition and SOC input under particular considerations of concurrent erosion events on three soil types (Alisol, Luvisol, Vertisol), (2) to adapt the CIDE approach to deeper soil layers (10–20 and 20–30 cm) and (3) to determine the variation of decomposition and SOC input with soil depth and soil texture. SOC dynamics were determined for bulk soil and physically separated SOC fractions along three chronosequences after land use change from forest to maize (up to 21 years). Consideration of the effects of soil erosion on SOC dynamics by the CIDE approach yielded a higher total SOC loss (6 to 32 %), a lower decomposition (13 to 40 %) and a lower SOC input (14 to 31 %) relative to the values derived from a commonly applied ^{13}C isotope based mass balance approach. Comparison of decomposition between depth layers revealed that tillage accelerated decomposition in the plough layer (0–10 cm), accounting for 3 to 34 % of total decomposition. With increasing clay contents SOC input increased. In addition, decomposition increased with increasing clay contents, too, being attributed to decomposition of exposed labile SOC which was attached to clay particles in the sand sized stable aggregate fraction. This study suggests that *in situ* SOC dynamics on erosion prone slopes are commonly misrepresented by erosion unadjusted approaches.

Keywords: Chronosequence, degradation, isotope, mineralisation, SOC dynamic, SOC accumulation, soil science

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Tracing Soil Organic Carbon Relocations in a Mixed Land-Use Agricultural Catchment in Northwest Vietnam

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Soil relocation (losses/deposition) processes at watershed scale are the key to understand the spatial fate and behaviour of soil organic carbon (SOC), a determinant for soil fertility and regional carbon balance and budget. It is essential to study dynamics of SOC movement and to precisely trace sources of SOC in upland areas at watershed level to adjust existing upland farming systems to more sustainable land use systems. The primary objective of this study is to test the applicability of a compound-specific stable-isotope (CSSI) approach and CSSI-based mixing models to identify and trace SOC source-and-sink relations in the Chieng Khoi watershed, Son La Province, Vietnam, where severe and accelerated land degradation and soil erosion is currently occurring.

The CSSI approach uses differences in the natural abundance signatures of plant-specific carbonaceous compounds (δ^{13}C) which emerge due to the different photosynthetic fixation pathways, genetic and environmental factors. The compounds of choice to be used as markers are long-chain length fatty acid methyl esters (FAME) originating in upland soils including a range of different crops, as well as natural and secondary forests. These CSSI-biomarkers were traced in the lowland soils (*i.e.* sediment deposition areas, lake sediments) to estimate the dynamics of landscape SOC stocks at watershed level and to assess how land use intensification has changed the spatial and temporal distribution of respective C from uplands to lowlands.

Results have shown that different land uses show different δ^{13}C signatures for identical FAMEs and multi comparison procedures have revealed that a variety of FAME marker with significant discriminatory power exists to describe distinct isotopic fingerprint profiles in source soils for selected sub watersheds. Therefore it was possible to trace the sources of lowland sediments, which improves the understanding of soil erosion and will help to adapt cropping systems which are prone to erosion and thus nutrient losses.

Keywords: Erosion, soil organic carbon, stable isotopes, Vietnam

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Agricultural Innovations in Cropping Systems of Semi-Arid Southwestern Madagascar under Multiple Ecological and Socio-Economic Constraints

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In the Mahafaly region, agriculture is constrained by low and erratic precipitation, by low soil organic matter and nutrient contents. Farmers cultivate cassava, maize, sweet potato, millet and legumes with hand tools, neither using plant protection agents nor chemical or natural soil amendments. Even though subsistence production is dominant, farmers are integrated into local market systems. To develop sustainable land use strategies that reduce pressure on remaining biological diversity, we seek to identify and promote promising agricultural innovations. Field trials are accompanied by social science surveys addressing knowledge and attitudes of local farmers towards agricultural innovations (ex ante survey: n=145 in 4 trial villages, n=123 in 3 control villages). An *ex post* suvey will monitor changes in innovation attitudes.

On-farm experiments and demonstration trials include the application of manure up to 30 t ha^{-1} in cultivation of introduced drought-tolerant maize as well as sorghum and millet varieties. Using a participative approach with seed donations, we test the feasibility of irrigated vegetable cultivation in house gardens. First results indicate that maize and sorghum emergence is better on manured plots under low rainfall conditions, and that yields may more than double. The participative vegetable cultivation with local women resulted in first successful production, and will be supplemented by a controlled field trial with manure and charcoal application as well as shading in the following season.

Survey results highlight that farmers had an extremely risk averse attitude towards innovations including manure application before the start of the trials. The wide-spread adoption of manure application may be hindered by lack of transport options. On the other hand, farmers involved in the "trials" experienced successful harvest this year, and we see increasing interest of additional farmers to partcipate.

Our study is embedded into a "markets for the poor" (M4P) approach, which regards agricultural production as depending on market-facilitated availability of inputs and of commercialisation options independent of donor support. To this aim, farmers are asked to pay for commercially sourced vegetable seeds in the next round of on-farm trials. Likewise, we started to explore options for small-scale, "entrepreneurial" seed multiplication of the drought-resistant maize variety.

Keywords: Drought-tolerance, input intensification, participatory experiments, sub-Saharan Africa

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Bokashi-Than Bach Ma: Charcoal Fertiliser for Improving Rural Living and Nature Conservation in the Bach Ma National Park, Vietnam

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Bach Ma National Park is located 40 km from Hue city, Central Vietnam. Central Vietnam is a very poor area, due to its extreme climate condition and poor soil productivity. Thus, urban citizens purchase food produced in remote areas, while rural farmers produce just enough for self-supply and cover their livelihood by invading into the national park and conducting uncontrolled timber harvests. To create alternative earnings for people living in the buffer zone of the urban area and Bach Ma National Park, a project was started to introduce the multi-purpose use of charcoal in that region. The charcoal was made not from natural forest trees but from agro-wastes such as branches of fruit or plantation trees, sawdust and rice husks. Our project contained 6 major activities: 1. Create an extension centre at the headquarters of the Bach Ma field station to organise surveys, workshops and follow-up activities; 2. Conduct of charcoal making workshops; 3. Establish organic fertilisers containing charcoal; 4. Grow vegetables together with farmers in on-farm experiments; 5. Introduce alternative methods for animal husbandry; 6. Raise awareness and conduct marketing in urban area. The project started in 2008 and was wrapped up in 2013.

Based on this activity, an organic fertiliser called "Bokashi-Than Bach Ma" was established, which is made from cattle manure, rice bran and rice husk charcoal. Its use remarkably increased the soil cation exchange capacity and led to higher yields. Organic fertiliser mixed with charcoal had much higher yield compared to chemical fertiliser only. The product could be sold to the city with additional value. Constant production with sufficient amount would be the task to establish the product as a brand in this area.

Keywords: Buffer zone, charcoal, national park, soil fertility

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Estimation of Methane Emission from Permanently Flooded and Alternately Wetted and Dried Rice Field Supplied with Rice Straw, Biochar and Mineral Fertiliser: A Greenhouse Study

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A study was conducted to estimate the methane (CH_4) emission from rice cultivation in a greenhouse setting. Two by three factorial design experiment was set in which each of permanent flooding (PF) and alternate wetting and drying (AWD) contained 3 treatments; i) Soil amended with rice straw and mineral fertiliser (RS), ii) Soil amended with biochar and mineral fertiliser (BC), and iii) Soil applied with mineral fertiliser (MF) alone. Each of 18 plexiglass base columns with area of 153.86 cm^2 were filled with 3 kg of soil and applied with respective treatments and gas samples were collected mounting a top column on the base column making a airtight chamber. All the columns were flooded throughout the season except draining of AWD plots for 7 days after 30 days of transplanting. Gas samples were collected once a week at the time interval of 0, 20 and 40 minutes during each sampling day and gas was analysed using gas chromatography through flame ionisation detector. High temporal variation in CH_4 flux was observed from all the treatments. CH_4 flux was significantly depressed in AWD-RS treatment due to midseason drainage while PF-RS showed continuously higher flux. All the treatment from both water regimes showed gradual increase in CH_4 flux after 52nd day after transplanting. PF-RS had relatively higher flux for the whole rice-growing season followed by AWD-RS. Biochar treated pots showed lower emission during the initial period but rise in flux was observed during the late season in both water regimes. Mineral fertiliser showed continuously lower CH_4 flux from both the treatment. Cumulative emission of CH_4 from PF-RS was highest among the treatment followed by AWD-RS where the values were 794.9 and 392.3 mg pot^{-1} respectively. PF-BC, PF-MF, AWD-BC and AWD-MF had cumulative CH_4 flux of 203.3, 131.1, 93.1 and 82.9 mg pot^{-1} respectively. Result suggested that organic matter and water management has determining effect on the amount of CH_4 emission. AWD reduced considerable amount of CH_4 emission from all the treatments as compared to that from PF.

Keywords: Alternative wetting and drying, biochar, methane emission, mineral fertiliser, permanent flooding, rice straw

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Indicators for Monitoring Soil under Secondary Forest in the Tropical Yungas of Central Bolivia

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Shifting cultivation is a common way of food production in many tropical forest agroecosystems. In the Yungas of central Bolivia, indigenous populations utilise this practice to produce maize, beans, chili, groundnuts and other crops for subsistence. Land is cleared with slash and burn, cultivated during a few years until productivity decreases, and then set aside in fallow for a long period. However, increased population pressure in this area has led to increased food production needs and thus fallow periods of secondary forest growth shortened, specifically near settlements and towns. In order to establish a sustainable rotation between cultivation and fallow, variables must be tested that are suited to monitor the rate of recovery of soil quality during fallow. We sampled 20 sites of secondary forest fallows of different age, ranging from 3 to 50 years. At each site 4 soil samples were taken randomly with steel cylinder to a depth of 5 cm. Samples were analysed for texture, bulk density, pH, cations and cation exchange capacity, total and labile carbon (C), total nitrogen (N) and available phosphorus (P) contents. Sites varied considerably in texture and total C, and within sites we also found high spatial variability. The variables that showed best correlation with fallow age were total C (R^2= 0.28), labile C (R^2= 0.33), and the quotient between total C and clay plus silt contents (R^2= 0.30). Other soil attributes did not vary according to fallow age, and within site spatial variability as well as differences in how fallow areas were used for livestock grazing and wood extraction might have caused this lack of relationship. The results indicate that soil recovery under secondary forest fallow can be monitored with soil C data. Specifically labile C and the relation between total C and soil texture (% of fine soil particles) might be more suited since some of the spatial variability is neutralized. In the range of fallow ages sampled, we could not find signs of declining rates of C sequestration or C saturation, indicating that even after 50 years of secondary forest these soils still accumulated organic matter.

Keywords: Labile carbon, secondary forests, shifting agriculture, soil carbon

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Soil Quality in the Iñao Mountains of Central Bolivia

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The Iñao Mountains have been very inaccessible until recently when massive immigration from the Bolivian tropical Andes and other landscapes increased population density. Population pressure led to more intensive land-use, where most accessible lands are being cultivated without traditional fallow periods. Some of this land has steep slopes and is very susceptible to water and wind erosion. We described and sampled soils of landscape positions that are continuously used for crop production in this area. These were identified as three distinct zones, valley river sides (V), plains at medium heights (P), and higher slope (S) positions. In all of these zones the predominant crops were maize, beans, chili and potatoes. Soil samples of each horizon of the respective soil profiles were taken by digging soil pits and auger sampling of 4 replicates in each zone, totaling 169 samples. Samples were analysed for texture, pH, conductivity, cations and exchange capacity (CEC), carbon, nitrogen and phosphorus contents. Results indicated that zone V was different from P and S due to more sandy texture, lower CEC, carbon and nutrient contents. Zones P and S were similar in their intrinsic soil properties (sandy loam texture, neutral pH, CEC 22 meq/100g soil), but S had significantly lower carbon, nitrogen and phosphorus. This indicated that S suffered more nutrient losses due to leaching and erosion. The best soils were found in zone P, with highest carbon and nutrient contents. However, most intensive agricultural use corresponded to soils in zone V, followed by zone S, while in zone P many soils are used for pasture. According to the results of this study, land use should be planned according to soil quality attributes such as texture, pH, carbon and nutrient contents. For the present case, soils in zone P could be used more intensively, while soils in zone S should be managed more carefully, preferably with permanent vegetation cover to reduce susceptibility to erosion. Zone V soils due to their extremely sandy texture are inherently less fertile, but support intensive use when appropriate fertilisation and organic amendments are used.

Keywords: Food production, landscape, soil quality, sustainability

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Assessment of Ammonium (NH_4-N) Adsorption and Fixation as Affected by Different Soil Salinity and Sodicity Levels in two Types of Sudan Soils

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This study was conducted to investigate the effect of different levels of salinity and sodicity on the adsorption and fixation of ammonium produced from waste ammonia in two soil types. The waste aqueous ammonia was obtained from Khartoum Refinery at El-Jaily, 50 km north of Khartoum city. The laboratory experiments were run in two soils Vertisols and Entisols. The rate of application was 80 kg N ha^{-1}. The aqueous ammonia was added to the soils at different levels of salinity: 40, 60 and 80 mmo+ l^{-1} and sodicity (SAR): 10, 15 and 25. The readings were taken every week for five weeks. The adsorbed ammonium was estimated using the potassium chloride method, and the fixed ammonium was determined using the mixture of hydrofluoric and hydrochloric acids.

The results showed that with an increasing salinity level from 40 to 80 mmol l^{-1} the mean adsorbed ammonium decreased from 331 to 263 mg kg^{-1} soil. An increase in SAR levels from 15 to 25 resulted in an increased adsorbed ammonium level of 256 to 324 mg kg^{-1} soil, respectively. The values of adsorbed ammonium were higher in Vertisol (up to 147 mg kg^{-1}) compared with Entisols (only 62.7 mg kg^{-1}). It can be concluded that aqueous ammonia produced from Khartoum Refinery, as a by-product of petroleum industry, can be used in saline soils as a cheap source of nitrogen fertiliser. As a potential side effect in such soils, high levels of salinity produce more soluble cations which will compete for the adsorption and fixation of ammonium ions into the exchange sites of clay, and this will increase vulnerability of N to be leached from such soils. Therefore, new policies and management strategies are needed for the efficient use of waste aqueous N fertilisers in such soils. Nevertheless, utilising aqueous ammonia as fertiliser in such manner will definitely decrease the hazards of disposing the ammonia onto the surrounding area near the refinery.

Keywords: Ammonium fixation, ammonium adsorption, salinity, sodicity

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Nutrient Uptake, Biomass Production and Quality of Soybean Grown on Technosols of the Gatumba Mining District, Western Rwanda, Using Different Fertiliser Combinations

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Mine soils are increasingly used for agricultural production in many parts of Rwanda. This study was conducted on degraded tantalum sites to (1) evaluate the fertiliser combinations that promote soybean growth on pegmatite versus a pegmatite-lixisol Bt mixture and (2) assess toxic element contaminations with soybean grains. The treatments used were (i) an unamended control, (ii) *Tithonia diversifolia* biomass (T:5t dry matter (DM) ha^{-1}), (iii) Tithonia+Minjingu phosphate rock (T+MPR:5t DM ha^{-1} +50 kg P ha^{-1}), (iv) Tithonia+triple super phosphate (T+TSP:5t DM ha^{-1} +50 kg P ha^{-1}), (v) Tithonia+MPR+Ammonium sulphate (T+MPR+AS:5t DM ha^{-1} +50 kg P ha^{-1} +50 kg N ha^{-1}), (vi) T+MPR+TSP:5t DM ha^{-1} +50 kg P ha^{-1}. The experiment was laid in a RCBD with 3 replications per treatment. The results indicated that soybean performed well on pegmatites than on the soil mixture. The T+TSP yielded higher ($p < 0.05$) nutrient in roots with 12.6 kg N ha^{-1}, 2.3 kg P ha^{-1}, 15.0 kg K ha^{-1}. In contrast, shoot nutrient accumulations averaged 20.6 kg N ha^{-1} and 19.4 kg K ha^{-1} in Tithonia. This was significantly more ($p < 0.05$) than in the other treatments, while P uptake was with 6.41 kg ha^{-1} significantly higher ($p < 0.05$) in T+TSP. Likewise, root (RDM) and shoot dry matter (SDM) was highest on pegmatites with 880 kg RDM ha^{-1} in T+MPR+AS, and 1,560 kg SDM ha^{-1} in T+TSP. This also explains the higher grain yields determined on pegmatites ($p < 0.05$) than on mixed soils with 975 kg ha^{-1} in T+MPR+AS and 910 kg ha^{-1} in T+TSP. Due to their higher pH H_20 which for pegmatites range from 6.7–7.3 versus 5.0 for the soil mixture Al toxicity was reduced and P availability increased. Pegmatites could thus be used as a valuable substrate to enhance soybean growth in tantalum mined sites. Toxic element concentrations determined in soybean seeds on pegmatite were: 16.7 mg Cu kg^{-1} DM, 64.4 mg Zn kg^{-1} DM, 0.03 mg Cd kg^{-1} DM, 0.03 mg Pb kg^{-1} DM and 0.10 mg Cr kg^{-1} DM. The respective values on the soil mixture were: 21.0 mg Cu kg^{-1} DM, 70.1 mg Zn kg^{-1} DM, Cd below detection level, 0.01 mg Pb kg^{-1} DM, and 0.10mg Cr kg^{-1} DM. These data were, however, below the threshold values and thus do not seem to present a risk to human health.

Keywords: Food safety, mined soil, mineral fertiliser, pegmatite, rock phosphate, soybean, Tithonia

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Effect of Organic Manure on Seedling Growth and Chemical Composition of *Treculia africana* var. Decne Seedlings

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A study on the effect of organic manure on seedling growth and proximate composition of *Treculia africana* seedlings was conducted to influence the growth and improve the nutritive quality of the plant as an alternative source of feed for dry season feeding. Three months old seedlings of *T. africana* were planted on the field containing samples of organic manure (poultry and cowdung) mix with topsoil and a control (without manure) in a randomised complete block design which was replicated thrice. The seedlings were assessed for plant height, number of leaves, collar diameter and number of branches. Samples of the seedlings foliage were collected across the treatments and analysed for proximate composition at the end of the experiment. Seedlings under cowdung application recorded a significantly ($p > 0.05$) higher values for number of leaves per plant (21.82), plant height (66.58 cm), collar diameter (12.96 mm) and number of branches (4.20) at 8 weeks after planting (WAP), followed by seedlings to which poultry manure was applied and lastly by the control. Proximate composition per seedling showed that the dry matter (DM) content values of the samples were high which ranged from 894.60–896.30 g kg^{-1} DM ($p < 0.05$). The crude protein (CP) content followed the same trend as the DM with its values ranging between 143.6 and 149.30 g kg^{-1} DM ($p < 0.05$) and the ether extract (EE) values ranging between 22.20 and 23.50 g kg^{-1} DM ($p < 0.05$) for the samples collected respectively. The ash content did not vary significantly between the different manure applications and the control. The crude fibre was quite significantly ($p < 0.05$) low in the samples ranging from 162.10 and 166.70 g kg^{-1} DM. This study has shown that cowdung is the most suitable for *T. africana* seedlings in terms of mineralisation and it is relatively fast when compared with poultry manure. The application of poultry manure has also positive influences on growth and development of *T. africana* seedlings and it improved the nutritive quality of the plant.

Keywords: Growth, nutritive quality, organic manure, seedlings, *Treculia africana*

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Value chains

Value chains and market integration within the rural-urban continuum

Crop-Livestock Research and Development - The Potential for Spillovers

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Crop livestock systems in developing countries play a major role in the livelihoods of millions of people through the provision of food, income, draught power and employment. These systems produce about half the world's food from both livestock and crop foods. Around 70 % of the world's population live in such mixed systems and a significant portion of their income is generated from diverse livestock-related activities through value chains of farmers, traders, market agents, processors, retailers and consumers.

Crop livestock systems have benefited from increasing research and development support during the past 30 years. However, research on crops has mainly been targeted at the food (grain) component with less attention given to the feed component. Furthermore, livestock scientists have not tended to work closely with crop scientists. During the past 10 years, however, integrated crop livestock research and development projects have made notable progress in improving the productivity and profitability of selected crop livestock systems, providing opportunities for using the knowledge and technologies more widely through spillovers.

Spillovers from agricultural research and development investments have been shown to account for more than half of agricultural productivity growth globally although this is largely unappreciated. Most studies of spillovers have been retrospective analyses of their value and impact, often many years after the knowledge, technology and/or methodology was developed. Identifying, selecting and promoting potential spillovers of best-bet knowledge and technologies in crop livestock systems could more rapidly enhance their productivity and contributions to food security and poverty reduction.

Selected examples of both successful spillovers and potential spillovers of knowledge and technologies in crop livestock systems in sub-Saharan Africa and Asia will be discussed, in the context of strengthening value chains, including food-feed crops, dairy and poultry systems, and fodder markets.

Keywords: Crop livestock systems, spillovers, value chains

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Spatio-Temporal Dynamics along the Urban-Rural Continuum - A GIS-based Analysis of two African Cities

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In the time of rapid urban transformation, urban and peri-urban agriculture has evolved as an important livelihood strategy for millions of urban dwellers in sub-Saharan Africa. Especially in small and medium-sized cities, cultivated areas can be seen as an integral part of the urban patchwork. Yet, little is known about the spatial extent of agricultural production in and around these cities and how the spatial parameters of this complex patchwork change along the urban-rural continuum. The purpose of this study therefore was to enhance the understanding of spatio-temporal dynamics of urban and peri-urban agriculture along the urban-rural continuum with a special focus on small and medium-sized cities in Africa.

Two cities were selected for this study: Moshi in Tanzania and Bamenda in Cameroon. Four transect polygons – 100 metres wide and up to 15 kilometres long – were laid out radially from the each city centre, building the spatial framework for the data collection and analysis process. Within these transects, all agricultural land use was mapped and with about 450 households per site, a representative number was interviewed. All data were digitised and geocoded, allowing for the spatial analysis of the two datasets. An urban-rural index (URI) was calculated based on building density and travel isochrones as the foundation of spatial analysis, ensuring that the process was not biased by the selection of conventional categories, such as urban, periurban or rural.

The results of this study revealed that almost all agricultural parameters showed significant correlations with the respective URI score. Even though correlations in land use data were usually larger than in household data, four characteristic patterns of spatial changes along the continuum could be identified. While the proportion of area under cultivation and mean patch sizes increased, building density or formal flat/house ownership steadily decreased with decreasing URI values. However, spatial changes in other parameters were less predictable. While construction activity and crop diversity were highest in periurban areas, the numbers on the duration of residence or land ownership were lowest in these areas.

Keywords: GIS, peri-urban, transect, urban agriculture, urban-rural continuum

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Following the Timber from Forests to Cities: Assessing Informal Market Networks in the Ecuadorian Amazon

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Most of the timber in Ecuador is consumed in the domestic market which has doubled in the past five years. Rural forested areas in the Amazon provide different wood products for construction and furniture in the cities. An important portion of timber supply operates informally through very vigorous market networks that extend from local markets located in key rivers or secondary roads passing through medium-size depots in local urban markets to relatively large-scale depots in the capital cities in the highlands. This study contributes with knowledge about actors' strategies in rural and urban market networks. Our findings draw on three main sources of information. First, a household survey (n=243) was carried out in the provinces of Napo and Orellana in the Ecuadorian Amazon to understand farmers' decision-making with regard to forest management and their interactions with markets. Second, structured interviews were conducted (n=130) to a diversity of forest actors to gather their strategies to link with the markets. Third, a one year round weekly data gathering in urban timber depot to describe the seasonality of timber demand. Main results show that the main strategy adapted by rural households is selling to informal markets through vigorous intermediation networks. These networks have a strong rural-urban separation. While rural markets are led by middlemen who have the capacity to legalise the timber through different means, in turn urban markets are led by big dealers that monopolise the supply. Thus, urban markets tend to shape the demand by dictating what rural areas should harvest. The increasing urban demand also contributes to informality since middlemen are not able to supply all orders with legal timber and state agencies in charge of authorising legal harvesting are not able to keep up with the pace of the demand. These market dynamics have strong influence on rural households, since timber-related income amount about 19 % of total household income. Thus, timber contributes with cash money to fulfil family's needs, and to cope with crisis as a safety mechanism. Since forests tend to degrade over time, policies should look beyond the farms to the market networks shaping farmers' decision.

Keywords: Actor network, Amazon, Ecuador, rural households, urban timber market

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Cow Based Minimum-Budget Rice Farming (Gō-Adharitha Krishi): A Sustainability Model within the Rural-Urban Continuum

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Rice wetland eco-system are highly fragile, the effects of high input intensive farming are prominent and far-reaching. In the present agricultural scenario ensuring food security and sustainability requires a shift towards low external input eco-friendly agriculture. This action research examines the possibility of developing a business model for organic rice by taking advantage of the rural-urban continuum in the Indian context. A farmer innovation developed by blending the concept of cow based farming and the indigenous wisdom of the local community from Palakkad district of Kerala, India has the potential for a paradigm shift from the input intensive chemical farming to a sustainable one along with efficient strategies for marketing through prospective customer linkages. Cow based rice farming involving Asian breeds of cattle has formulations made from cow dung, cow urine and other natural products and believes that every thing the plant need is in the environment we thrive and, we are mere facilitators for nature's activities. In the comparative study of the benefit-cost ratio for different types of farming, cow based rice farming was found to be quite high (2.2) compared to 1.7 for chemical farming and 1.4 for organic farming. It is obvious from this case study that nurturing environment does not restrict the farmers from making profits if there is an efficient and well thought out marketing strategy to explore the organic markets. After the success of this technique in vegetable cultivation, for the past five years the farmers have experimented it in rice, which was also found to be highly remunerative with an efficient and unique marketing system practised by these farmers. They have recently formed a group of interested farmers namely "Ditto" for promoting eco-friendly farming. Their activities include giving trainings to the interested farmers and procuring the organic food produced by them at a higher price, thus avoiding the middlemen. This technique can be replicated as an alternative business model at micro-level for organic products that can take the lead to a transformative change in the agricultural marketing arena.

Keywords: B-C ratio, cow based farming, customer linkages, eco-friendly farming, marketing strategies

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Technology Options for Agriculture in the Rural-Urban Continuum: The Sustainability of three Good Practices

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Sustainability is back on the world development agenda since the United Nations discuss the adoption of Sustainable Development Goals for the post-2015 era. Indicators to monitor development for sustainability at the global or national level have already been developed in the past. But little research has been conducted to develop indicators at the innovation level that help decide which agricultural innovation would be the more sustainable to promote or adopt in a developing country context. To address this question, this study presents a way to assess the sustainability of three agricultural innovations that are suitable specifically for poor and vulnerable people in urban and rural areas, respectively. In particular, the study examined ecological sanitation in rural areas of North Bihar, India, riverbed farming in the Terai region of Nepal, and vegetable production in sacks that is suitable in urban areas. The underlying data was collected from experts of the respective innovations based on a questionnaire that was sent out by email. More than 300 experts were contacted in three "calls for application" of the SATNET Asia project. Experts were asked to provide information on selected criteria determining the environmental sustainability, economic development, social inclusion, as well as technical sustainability of an innovation. Overall, thirty one innovations were described by experts of which three were selected for this study because of their relevance for rural and urban settings. Field visits were conducted to comprehensively validate the information provided by experts for two of the three innovations. Composite sustainability indicators were calculated based on the SATNET Asia analytical framework. Results are presented graphically and compared with reference technologies. The analytical framework is discussed in terms of its applicability to agricultural innovations with a data scarce background. Possibilities to accommodate other criteria like impacts on migration, health, and nutrition are suggested.

Keywords: Adoption, composite sustainability indicator, decision making, sustainable development, technology

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Crop Farming in Mpharane – Constraints and Opportunities for a more Market-Oriented Production

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The distribution of wealth in South Africa is still 20 years after Apartheid highly uneven. Governmental initiatives such as land reforms and several agricultural development projects have failed in trying to reduce rural poverty and boost agricultural production in the former homelands. The main objective of this paper is to investigate why smallholders are primarily producing for subsistence and what the constraints and possibilities are for a more market-oriented production.

Empirical data have been gathered in Mpharane village in the former homeland placed in the Eastern Cape of South Africa. A range of methods has been used including questionnaires, qualitative interviews, informal conversations, GPS geo-referencing, observations, participatory rural appraisals (PRA) such as income ranking and seasonal calendars. Furthermore, three soil quality samples have been analysed.

The gathered data indicate that the majority of the villagers mainly rely on other incomes such as government pensions or non-farm employment in the cities rather than agriculture. The primary function of agriculture is subsistence; few households cultivated their outfields, whereas the majority had a vegetable garden contributing to the household consumption.

The last couple of years a decrease in the number of outfields cultivated has taken place. Many constraints were identified and these included growth conditions, climate shocks, access to land and lack of liquidity to pay for a tractor to plough the field.

Those who managed to farm did not produce a big enough yield to be able to sell on a regular basis, and sale therefore takes place merely in good years. All farmers were apprehensive about the risk of hail storms, floods and periods with drought which make people in the village hesitant to invest in farming, since such shocks can threat the household's survival. Therefore, only a minority in Mpharane base their entire livelihood on agricultural activities; rather it is common that people engage in several livelihood activities in order to decrease their vulnerability to risks.

Keywords: Livelihood diversification, market-oriented production, smallholder farming, South Africa, subsistence farming

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Medicinal Plants Value Chain Intervention: Bringing Rural Communities Closer to Urban Buyers in Uttarakhand, India

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Geographical remoteness, lack of opportunities, small land holdings and scattered establishments results in rural-urban disparity and regional divide among hill and the prosperous plains of Uttarakhand, India. These conditions compel the high altitude farmers of kuth (*Saussurea costus*) and kutki (*Picrrorhiza kurroa*) to live in utter poverty. Addressing this disparity, GIZ in its Regional Economic Development Programme, in 2009–2010; together with the Uttarakhand State Government analysed the value chain of these medicinal plants for pilot intervention in Chamoli district. The methodology included desk research, roundtables, stakeholder consultations and value links approach. The paper presents the results of successful interventions. Bottlenecks identified at farmer end included insufficient market information, lack of aggregation of produce and little incentive to promote cultivation. The constraints from buyer side were; farmers in high-altitude regions were largely unorganised, scattered cultivation plots, small volume of the produce with no aggregation point and lack of infrastructure; which discouraged buyers from travelling uphill to buy produce from individual farmers. Change was introduced by project interventions at the interface of communities and urban buyers. Vertical coordination provided a platform for interaction between farmer representatives and buyers. The structured event/buyer-seller meet allowed one-to-one interaction between buyers and sellers. Negotiations were moderated by neutral and respected referees from Government side. Thereby, formal agreements for the supply of 2,000 kg and 1,500 kg of kuth and kutki at INR 150/kg and INR 425/kg were agreed, which previously were very low INR 40/kg and INR 120/kg respectively. By facilitating functional upgrading through partner organisation in harvesting, sorting and grading practices, the overall quality of produce improved. Chemical test reports were enclosed with every lot of produce transported. Through process upgradation the farmers' federation at village level were enabled and establishment of aggregation points for logistical facilitation were established. The results achieved were, an organised value chain, a strong farmer federation with reduced risks and better understanding of market demand. Presently, farmer federations are selling cultivated & certified kutki upto INR 1000/kg. Study by partner organisation (2013) showed an increase in overall household income by 13.33 % through increased prices after the intervention.

Keywords: Keywords: medicinal plants, kuth, kutki, market access, value chain intervention , vertical coordination

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Himalaya Nettle in Uttarakhand – Reflections on a Promising Business in Rural India

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In large parts of Uttarakhand (India) the rural economy depends on checks sent home by villagers who left in search for a better future in the city. With the ambition to preserve local cultures as well as to keep the huge Himalayan forest areas populated, the state government developed various schemes in the last years to enhance "business"-opportunities for the mountain farmers.

This paper describes one of the projects initiated in 2007: The production of textiles made from wild nettle. In consultancy with GIZ's regional programme for "Rural Economic Development", the value chain concept was implemented. State institutions and NGOs choose women of the Bhotia tribe as ideal weavers for the experiment since their knowledge out of a historical trading with wool seemed to ensure the envisioned outcome of the enterprise. The women were trained for a maximum participation within the nettle's value chain: From collecting and breaking the fiber to washing, drying as well as spinning and weaving. As a first step towards the professionalisation GIZ recently sponsored a motor-operated carding machine.

Nevertheless selling the final products of pure cloth and simple scarfs resulted difficult. Though of precious quality regarding the nettle's natural and handmade touch and causing curiosity among potential clients, the Indian market turned out "not to be ready" for the fiber. International customers claimed the results to be "interesting, but too scratchy". In the light of disappointment among the producers who felt overloaded with the extensive work process, the problem of "marketing" was diagnosed as the final problem to be solved in the value chain. Research in design to cater for urban tastes was announced as a solution.

Seen from an anthropological perspective the focus on elite conceptions of trade appears little fruitful. Using this case of nettle as an example, I will argue that for a truly successful "business"-approach an understanding of the rural work culture among the actors at the initial stage of any value chain is necessary. Studying and acknowledging conventional economic practices is a crucial step towards an effective implementation of the concept.

Keywords: Anthropology, India, natural fiber, rural development, value chain concept

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Characterizing the Patterns and Trends in International Trade Network of Gum Arabic: Implication for the Producer Countries

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Gum arabic is among the oldest internationally traded non-timber forest products. The commodity is extracted from *Acacia* species adapted to the drier agro-ecologies of tropical regions. It has wider industrial application in food, beverage, pharmaceutical, cosmetic and other industries. In order to fully understand the gum arabic value chain and its impact on the national economy and rural development of producer countries, a holistic understanding of the structure of the trade flow is crucial. This paper uses a network analysis tool to analyse the characteristics of gum arabic international trade network (ITN). The structure of the trade networks is compared to examine the trends to what extent the characteristics of the ITN changed over the last decade. The analysis reveals that the international trade of gum arabic demonstrates an expanding trend both in volume and trade connections from 2002 to 2011. A general increase in the size of the trade network in terms of the number of vertices and links as well as increasing trend in the density of the network was observed in the last decade. The gum arabic international trade is concentrated in certain industrialised countries including France, Germany, USA, and Great Britain. Their significance in the ITN is explained by the high in-degree, out-degree and the betweenness centrality indices. The increase in density of the network over the last ten years implies the increasing connectedness of countries in the gum arabic commodity trade. Overall the international trade flow of gum arabic is dominated by industrialised countries that controlled the processing and distribution of the commodity. This might have an implication for forward integration of the producer countries in value added processing of the commodity and in finding new partners and market outlets in developed countries. Promoting foreign direct investment and faire trade mechanisms can balance the benefit distribution between the producers and the international partners.

Keywords: Betweenness centrality, density, forward integration, gum arabic, ITN, vertex

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Contribution of Gum and Resin Commercialisation to Rural Livelihood in the Drylands of Ethiopia and Sudan

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Commercialisation of NTFPs has been widely promoted as a means for rural development and conservation. Gums and resins represent commercial NTFPs with wider cultural and industrial application, predominantly extracted from the drylands of sub-Saharan Africa. The commodities are traded for millennia in local, national and international markets. The global gums and resins trade accounted for more than 600 million USD in 2011. Sudan and Ethiopia are the principal suppliers of gum arabic and frankincense, respectively. The present study investigates the extent to which the economic gains derived from gums and resins commercialisation impact rural livelihood improvement under different resource management regimes. Primary data was collected through semi-structured interview from 240 randomly selected smallholder producers in four regions, in Ethiopia and Sudan, with different resource management regimes from wild resources with open access to domesticated resources on private lands. Moreover, the household survey was complemented by secondary data, group discussions and key informant interview. Data analysis employed both qualitative analysis and descriptive and inferential statistics with SPSS. In the four regions, the contribution of gum and resin income to smallholder producers' livelihood was significant constituting 15–28 % of the total household income. The results reveal that the value and contribution of gum and resin based activities is highly governed by the resource management regime. The households' absolute income from gum and resin was positively correlated with the resource management regime and commercialisation level. The absolute income was higher from the cultivated resources on private lands, followed by the regulated access of wild resources. In open access resources the producers' income was the lowest although accessed by the poor, women and children. However, the level of dependence on gum and resin income was higher in the open access resource area. Households' socioeconomic characteristics, resource access, production and marketing variables determining income from gum and resin was identified using multiple regression analysis and their variation across the four study regions discussed. Overall, gum and resin commercialisation in the drylands of Ethiopia and Sudan bears potential poverty alleviation role through their safety net role and helping producers to move out of poverty.

Keywords: Ethiopia, gums and resins, livelihood, poverty alleviation, resource management regime, Sudan

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Smallholder Farmers Market Participation in Rural-Urban Continuum to Improve the Livelihood Condition in Developing Countries

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The majority of the population in developing countries depend on agriculture for their livelihood. Focus of this research is mainly on smallholder vegetable growers in India participating in different chains for marketing their produce across rural and urban areas. The perishable nature of agricultural produces such as vegetables provides challenges to analyse the supply chains in order to estimate transaction costs and to analyse chain efficiency. A reduction of the transaction costs might encourage farmers towards resource intensification while increasing their family income. The co-existing market outlets with competing conditions include local markets where farmers directly provide fresh products to local traders who sell these products to rural or urban consumers. Co-operatives, APMC (Agricultural Produce Market Committee) and wholesalers serve as a clearing house between surplus and deficit regions. However, the individual small farmer is often a marginal participant in the value chains. Smallholders in developing countries like in India face numerous problems and constraints while marketing their produce. The limited access to physical and financial resources restrict their opportunities to increase production, resulting in high transaction costs. Also, these farmers lack bargaining power, and, as a result, there is an unequal distribution of value among the actors in the market chain, which is even more prominent for perishable seasonal agricultural commodities. The research objective aimed at identifying efficient value chains, analysing the transaction costs through socio-economic indicators and finally formulating recommendations for improving the livelihood condition of the small and marginal farmers of the developing world.

Keywords: India, livelihood, market participation, smallholder farmers

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Development of an Effective Quality Management Practice for Cocoa Beans before Export to the European Union for Processing: A Study on Ghana's Cocoa Industry

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Cocoa beans from Ghana are valued by most chocolate manufacturing industries around the world and have been the mainstay in Ghana's economy for many years. Ghana processes some of its beans for the local market and exports the rest especially to the European Union countries. Still, production levels and quality of the beans are not up to the expectation of stakeholders. The study used face-to-face interviews with semi-structured questionnaires combined with visual observation to collect relevant data from 98 cocoa farmers from four districts within the cocoa growing regions in Ghana. The study gave a description of the cocoa beans production processes in Ghana before export and indicated the quality criteria for cocoa beans and factors which influence the quality criteria. The study revealed that about 71 % of the cocoa farmers used cutlasses/machetes for cocoa pod harvesting while about 5 % used the cocoa sickle which is the appropriate tool for cocoa pod harvesting. Breaking up of cocoa pods should normally be done with a recommended tool such as the wooden mallet but about 65 % of the farmers were still using cutlasses and machetes for such activity. Also, fermentation of cocoa beans in banana/plantain leaves was found to be common representing about 85 % of the methods used for fermentation. During fermentation, cocoa beans should be turned twice every 48 hours and about 13 % of the farmers applied this. The results further indicated that about 20 % of the farmers had appropriated facility for dried cocoa beans storage while about 57 % stored their dried cocoa beans in their kitchens and about 19 % stored their dried cocoa beans in their corridors. Therefore, appropriate quality management practices were developed for the industry to ensure continual improvement to reduce the dwindling decline in the quality. Damage by pest, lack of credit facility, high cost of spraying, weed control problems, inadequate extension services and lack of storage facilities were seen as major constraints in cocoa production. Routine training programmes on quality management of cocoa beans were recommended for the farmers and all the stakeholders in the cocoa beans supply chain process.

Keywords: Cocoa, fermentation, harvesting, quality management, storage, supply chain

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The Role of Markets in Food Availability and Market Integration among Smallholder Farmers: The Case of Western Kenya

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Smallholder farmers produce food for both home consumption and for commercial purposes, but often they are also net buyers of food. Markets thus play a key role in ensuring year-round food availability and food security. This study assessed: (i) the link between food available in markets and what is grown and consumed at household level, and (ii) the factors influencing the level of farmers' involvement in market trading networks in two regions with good market access.

All present plant and animal species grown/reared for food were inventoried on 30 purposively selected smallholder farms in six villages of Mumias and Vihiga counties, Western Kenya. Purposive sampling of available food products was done on three and four markets near the surveyed farms in Mumias and Vihiga counties, respectively.

In the markets, food products of 59 plant and animal species were available, while 68 different plant and animal species were documented on the surveyed farms. Cereals and non-leafy vegetables were mainly sourced from markets, not own farms, during the surveyed post-harvest season. Various reasons shaped on-farm availability and consumption of these food groups at household level. While Irish potatoes (*Solanum tuberosum*) were readily available in markets, sweet potatoes (*Ipomoea batatas*) and cassava (*Manihot esculenta*) were more popular in farms and for home consumption. While cooking bananas (*Musa paradisiaca*) were unavailable in all markets, they were readily available for 60 % and consumed by 17 % of households.

Regarding market trading systems, a minor share of the 59 food products were either grown by the interviewed market trader or sourced from neighbouring farmers, while most products were sourced from within the district and other districts as well as from neighbouring countries. The food groups 'fruits', 'pulses/nuts/seeds' and 'starchy roots/tubers' were mainly sourced from neighbouring countries *e.g.* Uganda.

The present study showed that smallholder farmers can be integrated better in the local market system to improve rural livelihoods. This could be achieved *e.g.* by identification of local, diversified products that are otherwise sourced from other districts or even countries and then linking farmers producing these items to the local markets.

Keywords: Food diversity, food security, market trading systems, markets, on-farm availability

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Rural-Urban Interdependencies in Kyrgyzstan and its Impact on Small-Scale Farming Systems

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After the collapse of the Soviet Union, and the evolvement of some hundred thousand small scale agricultural farms, GDP contribution of Kyrgyzstan's agricultural sector decreased from about 50 % to less than 30 % today, while the commercial and trade-sector in urban areas, like in the capital of Bishkek, increased substantially. Nevertheless, a variety of ties exist between the two sectors which may influence economic sustainability and development of the small-scale agricultural enterprises in Kyrgyzstan. This research study, which is part of two PhD research projects, explores how, and to what extent small-scale agriculture in two typical rural mountain regions is exposed positively or negatively to urban development factors.

Little research has been done on the characterisation of family-based farm-household systems and their inter-dependencies to the urban sector in Kyrgyzstan. Hence, this research study classifies and describes farming systems according to their exposure to urban effects, resource availability and agricultural activities. Quality and extent of rural-urban inter-linkages are explored in terms of labour exchange, capital- and knowledge transfer, differentiated according to different groups of small-scale farming systems.

The research is based on two representative farm-household surveys in the district regions of Naryn and Chui in Kyrgyzstan with stratified random sampling. Multivariate classification of farm-household systems in regard to factors of resource-availability and urban exposure distinguish groups of farming systems. Exploratory and functional interrelations are tested by correlation, respectively regression analysis. Significance of differences between groups of farming systems are explored by 'Chi-Square-Testing'.

This presentation will show first results on quality, extent and impacts of rural-urban inter-dependencies and review the holistic and interdisciplinary research approach. Future research is expected to examine the economic success of heavily and marginally urban-linked farms-households, explain causes of obstructive and beneficial urban influences, and, finally, discuss possible impacts on national food security and economic development in Kyrgyzstan. Results are planned to feed into development-oriented research by identifying challenges to harmonise rural and urban development in the mountainous areas of Kyrgyzstan.

Keywords: Farm-household systems, mountain regions, urban-rural dependencies

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Agricultural Finance and Market Access: A Review of Emerging Innovative Models in the Kenyan Agricultural Sector

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Agriculture comprises the largest sector in most of the developing countries in sub-Saharan Africa (SSA) in terms of employment, income generation, industrial raw material generation, export earnings, trade volumes and food provision. In Kenya, the sector contributes 23 percent of Kenya's GDP and 57 percent of the total export earnings. Further, it indirectly contributes 27 percent of the country's GDP through manufacturing, distribution and service-related sectors. The Kenyan financial sector is one of the broadest and most developed in SSA, with 43 commercial banks and 2 mortgage finance companies. These banks make up Kenya's formal banking sector and serve 22.6 percent of Kenya's adult population. Non-bank financial institutions, including MFIs (microfinance Institution), SACCO's (savings and credit co-operative), and mobile phone service providers serve another 17.9 percent, bringing the total served by formal financial services to 40.5 percent. Another 26.8 percent rely on the informal sector, including NGOs, self-help groups, and shylocks, while 32.7 percent of the population does not use any form of financial services. Despite its importance, systematic and prudent financing of smallholder agriculture has been and continues to be a difficult goal for the country in spite of remarkable progress in provision of financial services over the past twenty years. The sector, with its non-uniform cash flows, rural bias, poor capitalisation, widely dispersed producers, seasonal cash flows, and price and market risks differs substantially from businesses conventionally supported by traditional financial services thus most financiers shy away. In fact, the total credit provided to the Kenyan agricultural sector is less than 10 percent of the total credit channelled through the domestic financial system. This paper uses conventional methodologies of data collection in order to establish the various innovations that are in practice. The results show that a number of innovative financing models have recently emerged and are being used to expand the agricultural finance frontier to the Kenyan smallholder farmers. These innovations are geared to address the various challenges as well as the risks associated with agricultural finance.

Keywords: Agricultural finance, innovations, models, risk

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Marketing, Production, Constraints and Opportunities in Rural to Urban Goat Value Chain in Uttarakhand, India

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The International Livestock Research Institute (ILRI) conducted a goat value chain analysis in three districts of Uttarakhand, a state in northern India, during December 2011 to February 2012 to inform key public and private stakeholders on the constraints and opportunities of production and marketing in the sector. This paper presents the key findings of the study. A long urban value chain was studied at Dehradun, the state capital, while two medium rural value chains were investigated in Tehri and Nainital districts.

Results show that irrespective of location, length of the chain and number of actors involved, the price achieved by goat farmers is more than 70 % of the consumer price which is higher than milk (65 %), potatoes (58 %), onions (46 %) and tomatoes (25 %) indicating that middle level agents were not exploitative. Across all goat value chains butchers receive the highest margin along the value chain (15 %), due to their comparatively higher expenses, in comparison to wholesale traders (10 %) and retail traders (5 %). Farmers sell 2-3 animals per month, while wholesale traders handle about 500 animals, retaining INR 150 000 as margin. Further, the local hill goat keepers are not able to benefit greatly from market demand as 90 % of the traded goats are sourced from the plains of neighbouring states.

Production is constrained by feed shortages, high kid mortality and the pricing of animals without weighing. Marketing constraints include butchers' lack of knowledge on hygienic and sanitary practices as well as the loss of animal weight after purchase because of health issues. Both traders and butchers face credit issues. Wholesalers in particular are challenged by an inadequate number of animals, improper facilities for buying and selling, high transportation costs and corruption. Consumers in the urban chain reveal that butchers sell chevon adulterated with mutton as consumers prefer chevon. Lastly, rural consumers prefer black goats and report a shortage, especially for religious sacrifices.

It can be concluded that breeding strategies targeted at consumer preferences, improved health care, credit provision, improved buyer-seller platforms, training on and introduction of hygienic slaughtering facilities with an appropriate support framework and an efficient collaboration between relevant stakeholders will enable the emergence of sustainable and efficient goat value chains in hill areas.

Keywords: Constraints, goat value chain, marketing ,production, opportunities

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Linking Small-Scale Farmers to High-Value Chains: A Case Study of Inclusive Business Models in the Costa Rican Pineapple Sector

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Global agri-food markets are undergoing a rapid transformation towards stricter requirements of food safety and quality. Small-scale farmers in developing countries face multiple barriers to upgrade their production processes and to access high-value export chains. To link farmers to high-value chains, innovative business models are required that help to reduce transaction costs and improve coordination between producers and buyers. In this research, we compare four business models in the Costa Rican pineapple sector with respect to their level of trust, commitment and inclusiveness. To assess the level of trust and commitment, factor analysis is used. In the inclusiveness case, the criteria ownership, voice, risk, and reward are used. We distinguish between a producer-driven business model, two buyer-driven business models, and one intermediary-driven business model. The buyer-driven models differ from the others with respect to their length of relationships with farmers and with respect to the services offered to farmers. We find that the producer-driven business model is the most inclusive model and gives farmers the highest level of ownership, voice and reward. The buyer-driven model that is based on long-term relationships between buyers and farmers is the second most inclusive model. Here, farmers value the services offered by buyers as well as the punctuality in payments and the respect of the prices that were agreed previously. Unexpectedly, the intermediary-driven business model does not have a high level of inclusiveness and farmers in this model suffer from high delays in payment and differences between the agreed price and the price received.

Keywords: Commitment, high-value chains, inclusive business models, ownership, pineapple, reward, risk, trust, voice

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Linking Genebanks and Farmers to Urban Markets: Native Chili Peppers in Peru and Bolivia

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Agricultural biodiversity has been on a steady decline for the last century at both the crop and variety level. This decline, which is still continuing today, started in the middle of the 19th century with the rise of international agricultural commodity markets and food industry. Neglected and underutilised species and local varieties of commodity crops have been particularly marginalised in such a process. Diversity can be a great potential source for income especially in those areas where conventional markets and value chains are not succeeding. Native chili peppers in their centre of origin in Bolivia and Peru have great potential for high-value product differentiation in urban niche markets and income generation for the poor, but multidisciplinary research is needed at all levels.

A BMZ funded project, coordinated by Bioversity International, with participation of three German Universities and several partner organisations from Peru and Bolivia, has been combining innovative germplasm selection and characterisation methods with participatory market research, value chain assessment and upgrading strategies facilitated and guided through multistakeholder innovation platforms to demonstrate how native chili pepper farmers' income can be increased by exploiting diversity that is currently underutilised. One of the largest and most diverse collections of chili diversity has been assembled in national genebanks in Peru and Bolivia. Taxonomic, agro-morphological, molecular, biochemical and sensorial characterisation plus the systematic screening for commercially valuable traits that meet market opportunities have been undertaken.

Innovations from environmentally friendly solar drying technology and the establishment of good practices for improved production, post-harvest and processing methods have been part of the research, as well as helping to forge mutually beneficial institutional and commercial alliances between small farmer organisations, processing companies, retailers, service and input providers, research organisations, local governments and development organisations. As a result, new and traditional products using native chili diversity have been developed and are now successfully sold in urban supermarkets.

This approach is applicable to other country contexts and crops including farmers growing underutilised native mangoes in India or sweet potatoes in Uganda - areas struggling with declining commodity prices and looking for diversity-based opportunities to increase their incomes.

Keywords: Agricultural biodiversity, high-value diferentiation, neglected and underutilised genetic resources, value chain research and development

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Socio-Economic and Environmental Conditions of Smallholder Oil Palm Farmers in the Province of Jambi, Indonesia

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Indonesia is the world largest producer of palm oil (FAOSTAT 2013). With the rise in global demand for palm oil the area planted to oil palms in Indonesia has grown from just about a quarter of million ha in 1980 to almost 8 million ha in 2010. This contributed to economic growth and poverty reduction. This expansion has also been associated with deforestation which has raised concern over its impact on forest dependent communities.

This paper analyses socio-economic and environmental conditions of smallholder oil palm farmers in Indonesia. The empirical basis is a household panel survey of some 291 households which was conducted in four villages of two districts in Jambi province, Sumatra during 2010 and 2012. Households were randomly selected from the list of oil palm smallholders provided by the respective village heads. The survey instrument included modules on household characteristics, income generating activities, especially on oil palm production but also other crops and livestock, natural resource extraction, off farm employment and non-farm self-employment. In addition, an environment module has been added during the 2012 survey. Here the observations and perceptions on changes in environment and natural resources in the oil palm plantation and in the village environment were asked from the smallholder respondents.

In our analysis we compare the well-being of oil palm smallholder farmers in different locations using indicators like consumption, household income, asset endowment, *ex post* and *ex ante* poverty, *i.e.* vulnerability to poverty and inequality. We then proceed to establish a link between perceived environmental changes and the changes in well-being using non parametric testing procedures. Results reveal that significant differences in well-being exist and that environmental changes may play an important role in explaining these changes.

Keywords: Environmental, Indonesia, oil palm, smallholder

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Driving Sustainable Consumption Determining Techniques that have Successfully Influenced Food Procurement Choices towards Sustainable Options

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The current conventional agricultural supply chain is far from sustainable. It has dramatic externalities, of environmental, social and economic nature. Many EU countries support legislation designed to restrain these externalities but the US uses less regulation; allowing the consumer to 'vote' for the type of production they want through purchase choices. Consumers, while not agreeing with the practices and consequences of big agriculture, continue to support this system by purchasing the lowest priced item instead of the most sustainable one.

One solution is found in England: Incredible Edible Todmorden (IET). Operating on a triple platform of 'Community, Education, and Business', this group has accomplished significant results to localise their food chain and raise awareness of the impacts of our purchase choices.

This is a qualitative study using interviews with local consumers who have changed their spending and food consumption patterns because of the IET project. The interviews are designed to illuminate the key outreach and engagement factors that have created a turning point for consumers. Results will be evaluated for replication.

Target population characteristics:

1. IET leaders;
2. Restaurant buyers who are 'middle men'. They have chosen to source locally but are not the final consumer;
3. Consumers who are now buying local food as a result of exposure to Incredible Edible who previously did not;
4. Those with no interest in local or sustainably grown food, or feel that it is a low priority.

If we are to promote sustainability, it must work for the people. Thus if regulation is not effective in the US and UK, perhaps consumers can be influenced to shift their purchase patterns to sustainable alternatives. This change, however, is difficult. Food choice is a complex system, shifted only through a series of turning points in the mind of the consumer. This study is designed to identify key influences used to affect these transitions.

When judged on the 1987 Brundtland Report it was found that Todmorden has indeed developed in a sustainable manner. Methodologies used to engage and influence consumers were widely varied, and context specific. The single overarching semantic theme was activists' avoidance of branding terms such as 'organic' and 'sustainable'. The overall engagement theme was providing learning through doing and community inclusion. When replication value was explored, all respondents unequivocally supported the Incredible edible methodology as appropriate and pertinent in a developed economy setting.

Keywords: Agriculture, consumer, development, sustainability, sustainable, urban agriculture

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Upgrading Opportunities of Niche Markets: The Case of Muscovado Sugar Value Chain in the Philippines

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Tapping niche marketing channels through differentiated products have the potential to improve the livelihood options of smallholder farmers. However, coordination mechanisms such as horizontal and vertical arrangement as well upgrading possibilities are among the critical challenges why niche markets cannot scale in developing economies.

Taking the case of muscovado sugar - an unrefined whole sugar prepared through natural methods, this processing provides an alternative marketing channel for smallholder sugar cane farmers in lieu of the conventional sugar mills. The Philippines being ranked as the 7th biggest among the world's top producer of sugar, the case study is undertaken in Western Visayas, known as the sugar bowl of the country where 54 percent of the national production is cultivated. Using the value chain approach, the objective of the study is to identify the key actors and the mechanisms of coordination among the actors in the muscovado value chain through the conduct of face-to-face expert and key informant interviews using semi-structured questionnaires. Subsequently, it examines the upgrading opportunities in the chain.

The muscovado sugar processing is still in its emergent stages because there are few processors with different forms of contractual arrangement between smallholder farmers (suppliers). For example, one processor provides farmers with technical assistance and start-up capital. These farms are managed collectively, comply with environmental standards (organic and fair-trade standards) and geared towards export. The rest of the channel is dominated by processors who do not enforce contracts between individual suppliers. These arrangements are often prone to mistrust. Additionally, the lack of incentives for farmers - as there is no difference in the buying price of cane processed for white refined sugar - discourage them to process the cane for muscovado sugar.

The findings of the research will be analysed through a SWOT analysis which enables to identify possibilities for horizontal coordination, vertical coordination, product and process upgrading required to achieve the potential of muscovado sugar locally and internationally.

Keywords: Contractual arrangement, differentiated product, environmental standards, fair-trade, horizontal coordination, niche market, organic, SWOT analysis

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Enhancing Food Security in Traditional Food Value Chains of Tanzania

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Food security is among the most pressing challenges to humankind. Fluctuating market situations, droughts as well as related diseases are increasing and enhancing the unpredictability of regional food supply, especially in Africa. There is an urgent need for better integrated food system understanding and targeted linking of region- and site-specific innovations.

A number of recent international research and development projects have been focusing on increasing food security. To achieve positive impacts and sustainable solutions, the projects increasingly focus on integrated in-depth analysis of the food value chain (FVC) and its nexus elements. This encompasses a) natural and human resources, b) the use of production inputs, c) the safety and quality of food produced, d) the consumption patterns, and e) functioning of local and global markets. This analysis must include the specific cultural, political, social, ecological and economic environments, while only a broad participation by relevant stakeholders can ensure success.

We present the collaborative research project Trans-SEC "Innovating Strategies to safeguard Food Security using Technology and Knowledge Transfer: A people-centred Approach". It is targeted to improve the food situation for the most vulnerable rural poor population in Tanzania.

The main features are: 1) a sustainable multidisciplinary German-Tanzanian R&D&I network; 2) in-depth analysis of present Tanzanian food systems; 3) the identification of successful upgrading strategies along local and regional FVC; 4) the testing and adjusting of upgrading strategies among FVC components under site-specific conditions through action research; 5) the tailoring of these strategies to be disseminated for regional and national outreach; 6) determining the transferability of our results to other areas of Tanzania.

Keywords: Food security, food value chain, Tanzania

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Sprouts and Microgreens – An Option to Enhance Food and Nutrition Security in the Rural-Urban Continuum

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Legume crops and indigenous vegetables are suitable as cash crops and as a source of readily available daily sustenance in home or kitchen gardens, and therefore play a major role in AVRDC — The World Vegetable Center's mission to alleviate poverty and malnutrition in the developing world by increasing the production and consumption of nutritious and health-promoting vegetables. Lower income groups for whom indigenous vegetables are more affordable and available than other global vegetables or animal meat products will benefit greatly through increased availability and utilisation of indigenous vegetables. Phytonutrient levels differ according to the growth stages of the plant and often decrease from the seedling (sprout or microgreen) to the fully developed stage. Sprouts and microgreens can easily be grown in urban or peri-urban settings where land is often a limiting factor, either by specialised vegetable farmers or the consumers themselves. Given their short growth cycle, sprouts and microgreens can be grown without soil and without external inputs like fertilisers and pesticides, around or inside residential areas. No breeding is required as seedlings from semi-domesticated or even wild species typically have high levels of phytonutrients, good flavor, and tender texture. Several crops or different varieties of the same crop can be mixed to create attractive combinations of textures, flavors, and colours. As sprouts and microgreens are usually consumed raw, there is no loss or degradation of heat-sensitive micronutrients through food processing. AVRDC is currently studying potential differences in the levels of essential micronutrients and consumer preferences of selected legume crops (mungbean, soybean) and indigenous vegetables (amaranth, mustard, radish) at different growth and consumption stages. The phytonutrient content will be assessed at three plant development and consumption stages for indigenous vegetables: (a) sprouts, (b) microgreens, and (c) fully grown plants at the stage when they are normally consumed as vegetables. The comparison will include landraces from the genebank and modern cultivars available commercially. This may expand the use of genebank materials for specialty produce such as sprouts and microgreens with great potential for improved food and nutrition security of people living in urban and peri-urban settings.

Keywords: Food and nutrition security, indigenous vegetables, legume crops, microgreens, rural urban continuum, sprouts

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Nettle Value Chain Solutions to Bridge the Rural-Urban Divide in Uttarakhand India

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Himalayan nettle (*Girardinia diversifolia*) a natural fiber yielding plant species grows naturally in Uttarakhand, India between 1200–3,000 m asl. The traditional usage by ethinic groups has been restricted to traditional household applications like slippers, bags, ropes etc. This high value plant, having significant potential for value addition, provides alternative livelilhood options for the local communities.

In 2010–2012, the GIZ under its Regional Economic Development (RED) Program, in partnership with Uttarakhand Bamboo and Fiber Development Board (UBFDB) assessed the entire value chain. A series of consultations, findings of value chain analysis, focus group discussions, multi-stakholder meetings showed that a multi-pronged approach is required to widen the bottlenecks in the value chain. Stakholders associated directly or indirectly with himalayan nettle addressed different bottlnecks at various levels. Framework conditions like allowing for sustainable collection of plant from protected forests were address with Uttarakhand Forest Department. Resulting in the allowence to collect plant fiber from reserve forest for livelihood purposes. The state government positively supported the initiative by declaring a minimum support price (MSP) INR 35 per kg for fiber in 2010. MSP was further increased to INR 55 per kg in 2012.

To ensure sustainable harvesting from the wild, the Forest Research Institute, Dehradun started working on its cultivation practices. After streamlining the supply side, GoUk and UkFD along with GIZ-RED concentrated on the bottleneck within the processing technology.

A series of technolgical inventions were initiated to develop consistent, standardised yarn. RED efforts were concentrated on developing carding and slivering machines. The innovation and partial mechanisation for converting bast into weavable yarn helped in improving the overall economics of the nettle value chain. Prominent donars like Sir Ratan Tata Trust (SRTT), IFAD and NGOs were mobalised for upscalling and extension.

Yarn developed is being supplied to women groups for making value added products like stoles, shawls, scarfs, etc. These eco-friendly products are slowly finding their place in the fashion industry. Design firms have started contacting the womens group for products. The innovation has also increased sufficient interest in other Indian states like Sikkim and also from countries like Nepal and Bhutan.

Keywords: Capacity building, *Girardinia diversifolia*, Himalayan nettle value chain, improved technology, Uttarakhand

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Effects, Consequences and Solutions of Population Change in Rural Urban Regions on Agriculture System

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About 60 to 70 % of the population in Africa currently live in the rural areas and depend on agriculture. Projections of the United Nations show that by 2050, 70 % of the global population will be living in urban areas and megacities, especially in the tropical environment. Urban areas are consumers of resources, energy and raw materials for which they rely on the hinterland. This change is expected to induce rapid changes in the distribution of energy, water, nutrient, labour and other resources between rural and urban systems. More so, this change will likely affect agriculture systems, which can be interfaced with resource availability, food production, social peace, health and ecological sustainability. The different effects expected in Africa will be presented in this paper and the consequences, as well as solutions for achieving a more sustainable development discussed. The paper constructs these from information in published sources.

Keywords: Urban agriculture

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Institutional arrangements for value chain development and rural change

Commercialisation of Smallholder Horticulture: Gender and Intra-Household Dynamics and Poverty Implications in Kenya

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Commercialisation of agriculture is often associated with decline in women control even for previously women-managed crops such as vegetables. This in some cases has resulted in negative effects on household food and nutrition security and social gender relationship. The emerging drivers of commercialisation such as rural-urban migration, globalisation among others are expected to change further gender dynamics in agriculture commercialisation as demand for food increases and thus new market opportunities. Here, survey data of over 300 smallholder vegetable producers in selected regions in Kenya is utilised to access the gender roles in commercialisation of vegetables. Drawing from past studies on the disadvantages of women in commercialisation of agriculture, the study further assesses the constraints and determinants of women participation in commercialisation of vegetables. Further, using an empirical method underpinned by the bargaining household model, this study evaluates the impact of women control over production and revenues generated from horticulture on households' wellbeing. The results shows over 83% of the vegetable plots are owned by men. Men dominate in management of export market vegetables (average 55%), while women have a substantial share of management of domestically consumed vegetables (34%). Women have limited access to vegetable production and marketing trainings, to extension services, to agriculture credit and also to membership in farmer producer organisations compared to men. Men receive and manage a larger share of income derived from commercialised vegetable enterprises. Using empirical model that allows for possibility of endogeneity and self-selection, the study show that female participation in commercialisation of horticulture is positively influenced by individual female membership in farmer groups, younger age, education, high dependency ratio, large number of female adults in a household, female ownership of assets and female access to business. On poverty implication, instrumental variable (IV) regression estimates show positive effects of the share of female controlled income derived from domestically marketed vegetables on per adult equivalent asset. Policy implications focus on the need to integrate gender considerations in any agriculture commercialisation-led development strategy, including identification of commodity preferences and roles of men and women at different stages of value chains. Both men and women should be integrated in vegetable value chains and provided with gender training to prevent against negative intra-household effects from market development and commercialisation programs.

Keywords: Commercialisation, gender, horticulture, Kenya, poverty, smallholders

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Transformation of State Forest Enterprises in Vietnam: A Financial Analysis of Different Organisational Scenarios Regarding the Management of Natural Forests

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State Forest Enterprises (SFE) in Vietnam own and manage forests for timber production. Over long time, SFEs operated as dependent enterprises under control of provincial people's committees. The reform of SFE has been undertaken since 2004 with the objectives of efficient use of resources, business orientation, and contribution to poverty alleviation. The SFEs have been transformed into profit-oriented enterprises. However, so far, these objectives have not been achieved. The difficulties SFEs encountered, such as the lack of independence, low profitability, unsustainable forest management, and conflicts with local communities still exist. At the moment, Vietnam is considering whether to restructure the SFEs or to enact a logging ban.

This study investigates the current status of forest management regimes of SFEs and discusses various organisational scenarios based on financial analyses to see how profitability can be generated. A case study approach is used for data collection in SFEs Dak To and Ha Nung in the Central Highlands region of Vietnam which manage natural forests. Input data for scenario development are based on enterprise survey, key informant interviews, group discussions, expert consultation and secondary data. Five scenarios (1) baseline, (2) autonomy from provincial control, (3) FSC certified, (4) FSC certified + self owned logging team and sawmill, and (5) logging ban are discussed and analysed based on these main operations: timber logging, silvicultural treatments, and forest protection and management.

Financial analysis shows that, with autonomy scenario, both SFEs have higher positive profit proportion in comparison with the baseline scenario. Increment of annual cash flow (whole cutting cycle projection) of autonomy scenario is also much higher than the baseline. Except for the logging ban scenario, the other four scenarios show more profit. It shows clearly that the FSC certified scenario is a bit less profitable than the autonomy scenario due to bear the certification costs.

The study indicates that if autonomy is given to the SFEs (free market for timber sales, removal of harvesting quota), the SFEs will have a better financial status and motivation to pursue sustainable forest management and comply with the governmental forestry strategy.

Keywords: Central highlands, forest certification, independence, natural forest management, scenario, state forestry enterprise, transformation, Vietnam

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Welfare Impact of Organic and Fair Trade Pepper in India

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Black pepper is an important crop in India. The fall in pepper production due to low yields, depressed prices and increasing input costs coupled with poor farm management and outbreak of diseases and pests like quick wilt, pollu beetle and fungal pollu have made many smallholder pepper farmers to look at alternative agricultural technologies. Organic agriculture and fair trade marketing practices are the popular agricultural advances considered as solutions by the farmers of this region

Organically produced pepper, which at the same time marketed under fair trade regimes, can help to diversify agricultural export markets. This may lead to an increase and a more stable income from agriculture. However conversion to organic farming and entering fair trade marketing arrangements is not without costs to farmers. Change in farm management practices and entering certification schemes to meet required production and product quality standards can be demanding especially for resource poor less educated farmers.

Hence, this paper studies the drivers behind adoption of organic farming under fair trade marketing practices and evaluates the causal impact of such agricultural technology adoption on household welfare. It uses panel data, collected from 300 smallholder pepper farmers in India. A multinomial cross-section logit applied for each year as well as a panel multinomial random effects logit under generalised linear latent and mixed models (gllamm) is used to understand the determinants of adoption and provide robustness to our findings. To ascertain the welfare impact of adoption, a propensity score matching with multiple treatment effects is employed. Results from the multinomial models identify that farm size and market distance among others as the major factors that influence adoption. The causality from PSM shows that certified farmers do have a significant and higher income per capita.

Keywords: Adoption, impact, India, multinomial logit using gllamm, PSM with multiple treatments

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Microinsurance Decisions: Evidence from Bangladesh

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This paper draws from a field research experiment on gendered aspects of willingness to pay for index-based insurance in Bangladesh. These field experiments were designed to understand gender differences in willingness to pay for index based index insurance. Participants were presented with risky lotteries and a specific insurance contract and were asked to choose how much (if any) of the insurance they want to buy at a given price. The probability structure (whether the risk is catastrophic or moderate and whether there is high or low basis risk) was varied within sessions. The price of insurance was varied across sessions. Each participant was also administered a short questionnaire which collected information on demographic characteristics, risk preferences, agricultural risks, knowledge of insurance products and asset ownership. In this paper we do structural as well as regression analysis. The structural analysis shows that, in line with theoretical predictions, demand for actuarially subsidised index insurance products is decreasing in both risk aversion and wealth, suggesting that index insurance premium subsidies are likely to be captured by the wealthy. When offered actuarially unfair index insurance we find that over 50 % of participants purchased more than the rational (DARA EUT) upper bound in at least one decision problem. When our structural model is extended to allow probability weighting, we find evidence that women underestimate extreme events to a greater extent than men do. Regression analysis reveals that there are no significant differences between men and women on whether they purchase insurance and in the number of units purchased. Women, however, are more risk averse compared to men. On average, the more educated individuals and those who had bought insurance in the past, were more likely to buy more units of insurance. The former effect was driven by men and the latter by women. Having a bank account is positively correlated with insurance purchase. Comparing demand for insurance across high and low probability events the findings suggest that when insurance is actuarially unfairly priced then demand for insurance for the low probability event is higher than the high probability event.

Keywords: Bangladesh, field experiment, gender, index insurance

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Cooperative Behaviour and Resource Scarcity in Commons Dilemma: Experimental Economics Approach

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Economic experiments have established that the behaviour of individuals in commons dilemma deviates from Nash prediction. Individuals act less selfishly than predicted by Nash equilibrium. However, the influence of the commons scarcity on the behaviour of the individuals in commons dilemma was not adequately addressed. Further, the evidence on the role of resource scarcity on the effectiveness of the institutions geared towards solving the commons dilemma is scant. Hence, our experiment was designed in such a way that it enables us to investigate the effect of resource scarcity on cooperative behaviour in commons dilemma. It was also designed to capture the effect of rules (endogenous and exogenous) on the cooperative behaviour of the subjects. In total 130 community members (randomly grouped into 26 sessions) have participated in our experiment. We found that, resource scarcity significantly obstructs cooperation. Subjects that faced less scarce resource condition were found to be more cooperative as compared to those facing high scarcity. It has also been established that the effectiveness of the rules is significantly impeded by resource scarcity. The results also show that (external) regulations could have cooperation promoting or deterring effect depending on whether they are enforced by elected or imposed sanctions. The subjects are more cooperative when they encounter self elected enforcement mechanism (sanction or no sanction) as compared to imposed rules. However, once the subjects are allowed to participate in the election of a rule via vote mechanism, regulations with elected sanctions are more effective than those without sanctions. In sum, our results reveal that using the amalgamation of state and community management (namely joint CPR management) for commons management can be a viable option if it guarantees the participation of the local communities. Particularly when pure decentralised CPR management is impossible or expensive to implement, our results suggest for middle way solution.

Keywords: Commons dilemma, cooperative behaviour, election and imposition, framed field experiment, leadership, resource scarcity

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Governance Strategies and Welfare Effects: Vertical Integration and Contracts in the Pangasius Sector in Vietnam

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We investigate the welfare effects of different vertical coordination options in the Vietnamese pangasius (catfish) sector. In particular, we compare the outcomes from farming pangasius as either non-integrated farmer, contract farmer or an estate farm employee. We use an original dataset comprising 276 farmers from the Vietnamese pangasius sector, which we supplement with data from 52 qualitative interviews with key actors from the sector.

While most of the previous studies focus on separately estimating the effect of contract farming and vertical integration, we simultaneously compare the effect of two vertical coordination forms on farmers' welfare. To account for the effect of the unobservable farmer characteristics, we use the maximum simulated likelihood estimator with instrumental variables. This method yields improvements over the commonly used methods, *e.g.* propensity score matching, in that it allows estimating the sign and the magnitude of the unobservable factors and thereby increases the understanding of the farmer self-selection process. Further on, we combine quantitative and qualitative methods to understand and explain individual and contextual drivers of vertical coordination, and to elicit the functional relationship between farmers' welfare and vertical coordination.

Our results show that gains from participating in intensive export sectors depend on the governance structure. Although being a part of a booming export sector is not conditioned by contracts, we find that producing under contract has a positive effect on per capita consumption expenditure when evaluated against the situation of non-integrated farmers. In our most conservative specification, producing under contract increases the monthly per capita expenditure by 45 %. Conversely, we find no difference in welfare between the employees on estate farms and non-integrated farms, meaning that the estate farm employees who traditionally constitute a group of landless wage labour fare at least as well as independent farm owners. This finding implies that traditionally vulnerable groups – such as estate farm workers – are not losing in the process of rapid transformation of rural economies with the arrival of high-value export sectors. Overall, the results imply that contracts present opportunities for economic growth, but the additional effort is required in improving the accessibility of contracts to smallholders.

Keywords: Agri-food transformation, maximum simulated likelihood, pangasius, vertical coordination, Vietnam

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The Impact of Microfinance on Rural Poor Households' Income & Vulnerability to Poverty: Case Study of North Kordofan State

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Despite the efforts made by government and local NGOs to support the rural poorest, poverty reduction programmes have become the object of unprecedented attention at international summits in the 1990's. Finance is one of the most crucial inputs for economic activity, growth and development. Microfinance has proven to be an effective and powerful tool for poverty reduction. However, microfinance is only a mean and not an end like many other development tools; on the other hand, it has insufficiently penetrated the poorer strata of society. Data were collected during the season 2011/2012 using structured questionnaires distributed to 100 farm households applying multi-stage random technique. In addition, group discussions were conducted with key informants to ensure the accuracy of the data in the questionnaires. Descriptive statistics of measurements and an analysis of the poverty situations of the beneficiaries before and after microfinance were done. The results of the descriptive statistics show that there is a positive effect of microfinance on poverty reduction by 16 %. Before credit approval 60% of the sampled households didn't have sufficient financial means to cover or secure their basics needs, especially during the off-season. Poverty depth was reduced from 95 % to 12 % after microfinance credits and also severity of poverty reduced from 91 % to 2 %. Integrating time dynamics in the analysis the results generally indicate a positive and significant impact of microfinance on household income and strategy of poverty reduction. The results of the study revealed that the microfinance strategy have had impact on both economic and social aspects of the beneficiaries. Thus it can be concluded that the microfinance strategies have succeeded in their role of change agents, which could help in pushing back rural poverty.

Keywords: Kordofan, microfinance, poverty, vulnerability

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Could Microcredit Enhance Agricultural Services among Urban and Rural Dwellers: Evidence from Drylands of Sudan

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Despite the empirical evidence that the linkages between urban and rural areas can contribute vastly to improving the lives of rural and urban dwellers through exchange of goods and services, much evidence indicates that the impact of interaction is still expected. Several factors are contributed for this including; limited access to market, financial services, agricultural inputs, and poor infrastructure. This situation forced households in urban and rural areas to search for different sources of credit in order to secure their life. This study primarily intended to investigate the factors influencing loan utilisation and repayment performance in particular, and whether the factors determining loan use and repayment are the same.

The study focuses on three localities in North Kordofan State namely Shiekan, Um Rwaba and Enuhud, which are purposely selected. The study relies on survey that is conducted in 2011, using structured questionnaire. It surveyed 200 urban and rural households, which were selected through a multi-stage random sampling technique.

Descriptive statistical analysis and bivariate model were applied to analyse the data. The results of descriptive analysis show that 95 % of rural households repayed their loans on time against 87 % of urban households. Typically, about 85 % of rural households have used their loans for investment activities. While only 73 % of urban households have used their loans for investment purposes. In addition, the results of bivariate model showed that application fees, value of assets, frequency of repayment, punishment expected, group lending collateral and geographical locations are significant variables effects household's decision on loan utilisation and repayment performance. To avoid duplication and misleading results, a test of multicollinearity for variables is carried out using correlation commands in Stata software. Based on the multicollinearity test some variables were replaced in both loan utilisation and loan repayment equations. The study suggests that in order for agricultural services in both urban and rural areas to be improved, financial products for different market segments should be improved. This could be possible through providing sustainable loans to income generating activities with high rates of return.

Keywords: Bivariate model, loan repayment, loan utilisation, market segments, microcredit, poverty

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Determinants of Farmers Participation and Credit Constraints in Agricultural Finance Programs: Evidence from Nkoranza Districts of Ghana

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Since 2005 was declared as the international year of microfinance, there has been renewed interest in making rural finance accessible to farmers. Yet, agricultural finance especially for smallholder farmers is still lacking in developing countries. Financial institutions consider smallholder farming as risky, low returns from farm output, untimeliness of loan repayment, high transaction cost and existence of poor infrastructure in rural areas where farmers reside. Microcredit plays a vital role in agricultural development and poverty alleviation. Increasing microcredit to farm households especially the poor can contribute to enhancing agricultural production and improving incomes. However, farmers' access to rural finance partly depends on their participation in credit programs of micro finance institutions. This paper examines farm households' reasons for joining and not joining microcredit programs. It further determines the factors influencing farm households' participation and probability of being credit rationed by microcredit programs. The analysis is based on a survey of 150 farmer households in the Nkoranza districts of Ghana using a structured questionnaire. The study used Garrett Ranking Technique to analyse farm households' reasons for joining or not joining microcredit programs. The probit and Heckman probit model with sample selection were also used to identify the factors influencing farm households' participation and their probability of being credit rationed by microcredit programs respectively. The results show that farmers joined microcredit programs mainly to get loans for agricultural purposes and to mobilise savings. The fear of loan default was the major reason that prevented some households from joining. Female headed farmers, farmers with higher education and those in cooperatives were more likely to participate in microfinance programs. The results also reveal that wealthier households and farmers in cooperatives were less likely to be credit constrained. This study therefore recommends the need to encourage farmers to undertake alternative livelihood activities to boost their income. Also implementing literacy programs to educate farmers with no or less formal education and encouraging them to join cooperatives will enhance their participation in agricultural finance programs.

Keywords: Agricultural finance programs, credit constraints, farmers participation, Ghana

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Contract Farming as Business Model for Sustainable Rural-Urban Supply Chains: Sincere Efforts or Just Profit?

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In recent years significant population growth increased food demand and the financial crisis stimulated commodity price rises, thus putting the pressure on liberalised markets of developing countries whose efforts to escape indigence mainly remained unrealised. Agriculture is hugely important in Malawi and it is witnessing a relative change in farming practices, which underpins millions of livelihoods. Much of the agricultural growth has emanated from the emergence of contract farming, an option that leads to increases in agricultural income for rural and urban farmers, helps to alleviate hunger and poverty, and provides a promising business platform in the value chains. Contracting represents the bridge between marginalised smallholder farmers and access to domestic and international markets. The paper examines contract farming as a business model that is intended to preserve and improve smallholder farmers' production and marketing activities and thus lead to socio-economic growth. It employs an exploration method to review, as well discusses the bias of contract compliance and its consequences for smallholders within a conceptual framework supporting contracting pathways for sustainable agricultural development. This study summarizes and analyses 25 scientific and expert papers on contract farming published since 2007 to date to evaluate the impact of contract farming on smallholder producers in rural Malawi. Primary and secondary data on economic and social performance of contracts have been generated with a preliminary econometric analysis, whereas the research is part of a broader practical PhD project. The conducted study finds evidence that contract farming leads to more expanded markets but limits farmers' direct access to influence market governance due to terms and conditions under which contract farming production, processing and distribution are organised. It also identifies and compares key policy levers that favour and support smallholder farmers' interests to be able to influence market governance and compete with commercial investors through co-operative producer organisations. Therefore, the future will depend on further persistent smallholders' linking and efficient collaboration with neighbouring business and political units.

Keywords: Contract farming, sustainable rural-urban relations, value chain organisation

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An Analysis of Impact of Contract Farming on Farm Productivity and Efficiency: The Case of Hybrid Paddy Seed Cultivation South India

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The adverse impact of globalisation on farmers in developing countries especially in India needs to be seen against the fact that agricultural sector is not internationally competitive on account of low productivity, high cost of production, lack of institutional support and other related factors. For addressing these issues, appropriate institutional innovations/platform is required in agriculture sector in delivering new technology, knowledge, inputs and a better market for farmer's harvest. The private sector could play a role in providing a range of services from input and technology supply to crop assembly and marketing. The studies have shown that contract farming has increased in crop productivity and output growth in agriculture sector by delivering better technology, coordinating producer's and consumer's market as well as strong grass-root linkages. However, the effectiveness of contract farming in terms of farm productivity and efficiency in India has not received much attention among scholars.

In this context, the paper would like to examine whether technological and input linkages in contract farming increases farm productivity and efficiency by taking a case study of hybrid paddy seed cultivation under contract farming in Southern India. Heckman sample selection model is estimated to examine productivity difference between contact and non-contract farmers and production frontier has used to measure the technical efficiency.

The results indicated that non-contract farmers could achieve higher productivity and efficiency in growing general paddy (non-contract crop) compared to contract farmers. On the other hand, contract farmers are more efficient in growing hybrid paddy seed (contract crop) as in growing general paddy (non-contract crop). Small farmers were found to achieve a higher level of efficiency compared to large land holders. The main determinants to attain a higher technical efficiency for growing general paddy are region, pesticide use and education level of the farmers, whereas, region, frequency of fertiliser application and pesticide use were the main determinants for hybrid paddy seed. The fact that education is insignificant in case of the cultivation of the contract crop is understandable as the production strategy is guided by the firm/processor and there is little space for farmer's knowledge.

The result open up many avenues for future research: for instance, the autonomy of farmers in contract farming and the spillover effect of technology. The impact of modern technology in contract farming on traditional knowledge of farmers and local environment should be examined in greater depth.

Keywords: Contract farming, efficiency, productivity, small farmer

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Agricultural Cooperatives to Reduce Rural Poverty in NE-Brazil

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Although Brazil's government scored success in reducing poverty in the last two decades rural poverty is still pervasive. With about 67% of its rural population living in poverty, Brazil's Northeast is considered as one of the poorest and least developed regions in Latin America. In the course of the construction of the Itaparica dam and reservoir at the São Francisco river basin, irrigation projects were established to ensure the livelihood of the local population. Insufficient infrastructure and low market power of smallholders result in high purchase prices of means of production, lack of access to credits, and low producer prices. As a consequence many smallholders and livestock owners live in poverty. Agricultural cooperatives are considered to be a key factor to improve food security and to guarantee a safe income for smallholders. Especially by increasing smallholders' market power, cooperatives can improve their living conditions. Therefore the objectives of this study were to assess and analyse the history, the actual situation, and the potentials of agricultural and livestock cooperatives in the Itaparica reservoir region. Data were collected by 24 qualitative in-depth expert interviews and analysed using coding, categorising, and qualitative content analysis techniques. Interviewees were chosen from local authorities, chairmen and members of agricultural cooperatives and cooperative unions, agricultural consultants, local farmers, and scientists. Based on previous investigations within the INNOVATE project, interviews were held from March to May 2013 in the four main irrigation projects at the reservoir which differ significantly in history, farm size, infrastructure, and production methods. Though the dam operator promoted the implementation of cooperatives and there is a basic willingness of smallholders to cooperate, there are as yet no efficient agricultural or livestock cooperatives. Lack of financial support, organisation, knowledge about and trust in cooperatives caused the failure of most cooperatives. Still there exist efficient ones in fishery and apiculture. The success of these cooperatives provides an example for prospective agricultural and livestock cooperatives. Due to its peasant production structure the study region is particularly suitable for agricultural and livestock cooperatives. Main problems of local farmers could be moderated significantly by cooperative action.

Keywords: Agricultural cooperatives, irrigation agriculture, rural poverty

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Rice Production, Processing and Marketing - Creating Additional Income for the Rural and Urban Population in Benin

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Rice plays an increasingly important role in feeding the rapidly growing population of Benin. With an annual per capita consumption of over 25 kg, only about half of the domestic demand can be met by local production. The existing potential of rice farmers could not be exploited, due to lack of access to fertiliser and seeds and lack of knowledge of sustainable cultivation techniques. Lack of processing capacity meant that the value addition through processing and marketing was not done in the region.
Since 2010, the rice value chain has become a key factor for improving the income of the population in northern Benin. The production of paddy rice has improved through a self-administered fertiliser fund by the rice farmers' association and the application of improved farming methods. The area under rice has increased by almost 20 percent in 2011 compared to the previous year. At the same time yields per hectare have increased by almost 50 percent from less than 2.7 t to almost 4 t. As a result, rice production has increased by nearly 75 percent.
Paddy rice is now processed within the region. Predominantly women process paddy into quality parboiled rice, which is in high demand. About 2,800 women were trained to attain the quality standard of the parboiled rice label "Riz Nati", which was recently introduced in Benin. Consequently, about 15,000 t of parboiled rice were commercialised in 2010 alone. Training led to improvement in the quality of parboiled rice and an additional income of 0,22 € kg^{-1} of parboiled rice.
Additionally, due to the collaboration between the rice farmer associations and private investors, seven new rice mills process paddy rice to white rice. The mini rice mills with a capacity of 10 t day^{-1} have created more jobs in urban areas.
Rice farmers' associations, women's groups and private investors were supported through development-cooperation partnerships with the programme Promotion of Agriculture.

Keywords: Benin, improving income, rice, value chain promotion

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Enterprises Development for Value Addition: The Missing Piece in Rural Development?

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Rural development in least developed countries has been in the focus of development agents and Governments for many decades now. Despite the enormous evidence on both the positive and negative impacts that rural development projects have had many rural dwellers still remain in poverty. This paper argues that rural development has often focused too much on primary production and marketing of often low-value agricultural commodities neglecting the income and poverty reduction potentials of value addition and an adequate distribution of this value added among rural households. Such value addition can lie in producing better quality products and further adding value through improved packaging, transport, and storage as well as in processing and transforming products for local markets and beyond.

Our research engaged in the study of 6 recent cases of rural development projects initiated by development agents such as GIZ, IFAD, USAID, SNV, the World Bank and UNIDO in a range of sub-Saharan African countries. The results indeed show a bias towards technical solutions in primary production and marketing while the percentage of value added that remains within rural communities is often below 5 % of the end-product prices. The reduced participation of rural households in value addition is partly due to underdeveloped entrepreneurial skills and the lack of solid businesses development, be it on the level of farms or within the further transportation, processing and marketing businesses in rural areas. The author therefore suggest that development agents and Governments that aim at rural development study well the existing opportunities in value addition to be able to complement approaches of improved primary production. The results of this paper also point to the lack focus on value chain specific development interventions that help supporting businesses outside the farming community but within the rural areas.

Keywords: Primary production, rural enterprise development, rural households, value addition, value chain

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Productivity and Profitability of a Cotton-based Production System under Organic and Conventional Management in India

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The debate on the relative benefits of conventional and organic farming systems is more topical than ever. The achievements of conventional high-input agriculture were largely brought about at the cost of deteriorating soil fertility; furthermore, they were based to a large extent on fossil fuels. Developing more sustainable farming practices on a large scale is of utmost importance. However, information about the performance of agricultural production systems under organic and conventional management in tropical and subtropical regions is largely lacking. This study aimed to assess agronomic and economic data from a long-term farming systems comparison trial under semi-arid conditions in central India.

Four two-year crop rotations comprising cotton-soybean-wheat under biodynamic, organic and conventional management were investigated, including one conventional system with and one without transgenic *Bt* cotton, between 2007 and 2010.

Results showed 13 % lower yields in organic compared to conventional systems. Yields in cotton, soybean and wheat were on average 14 %, 7 % and 15 % lower, respectively. However, production costs of organic systems were on average 32 % lower than those of conventional systems, which led to similar gross margins in all systems.

To our knowledge, this is the first long-term field trial comparing the agronomic and economic performance of organic, conventional and conventional+*Bt* cotton-based farming systems. The results of our study suggest that organic farming is a promising alternative to conventional farming in cotton-based production systems in central India. The less capital intensive nature of organic systems may be particularly interesting for smallholder farmers as it decreases dependence on loans for farm inputs. Therefore, our findings have the potential to be useful for decision-making and in turn may lead to a redirection of agricultural policies.

Keywords: *Bt* cotton, economic analysis, long-term experiment, organic agriculture, smallholder farmer, soybean, systems comparison, wheat

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Farmer's Perception of Transaction Costs in Vertical Integration Schemes: The Case of Poultry Producers in Rio Verde (Goias, Brazil)

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Since 1997 poultry production has been considered an option to add value to grains, produced in the municipality of Rio Verde (Goias, Brazil). Crop based protein (soybeans) and energy (corn) are converted into animal protein (poultry and pigs). The setup of big processing plants in the region created new economic development chances through enabling new income opportunities for small and middle sized farms by access to new markets. The region became nationally prominent in food processing. Processing plants moved closer to the sources of raw materials (grains) in order to (a) reduce transportation costs; (b) take advantage of (i) favourable environmental conditions; (ii) proximity of grain producing areas; and (iii) remarkable tax incentives. This study aimed at analysing the contractual relationship between processing industry and farmers, using a transaction cost economics (TCE) approach to describe relevant aspects of the producer's perceptions on the dependence on the contracting processors. In this case, contractual relations are coordinated by the processors and not the producers. Since they are in a dominant position, due to their large market-share, they often try to impose their rules and possibilities of negotiations onto potential raw material providers (farmers). We considered the two classical analytic categories: (a) behavioural assumptions (bounded rationality and opportunism) and (b) attributes of transactions (asset specificity, frequency and uncertainty). Our findings are based on a survey with 40 farmers providing poultry to a contracting processor. Key findings are that changes in the structure of management of the transaction between poultry producers and processors are efficient responses to the growth of specificity due to dedicated assets. From the farmer's perspective, there is a certain lack of information about the content of the contracts. This may enable some kind of opportunistic behaviour of contracting processor. However, vertical integration significantly reduces producer's risk. We conclude that farmers' dependence on processors is high on specialised small-scale farms and low for more diversified and larger farms.

Keywords: Chicken production, transaction cost economics, vertical integration

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Networks and Coffee Innovation System in Ethiopia and Rwanda

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We use social network analysis (SNA) to investigate the networking and knowledge management in the coffee value chain in Ethiopian and Rwanda and its applicability to the agricultural innovation system (AIS). The AIS aims at putting farmers at the centre of the knowledge management and innovation system. Results of the SNA show that farmers from both Ethiopia and Rwanda are not at the centre of the innovation system. In the Ethiopian coffee value chain, cooperatives are at the centre of the knowledge management and innovation system. In Rwanda, NGOs play a central role in the knowledge management. We found the Rwandan coffee value chain to be more connected and cohesive than that of Ethiopia. This suggests that the AIS framework has not been fully adopted by development practitioners in both countries. Based on the IS and IAR4D perspective, this has serious implications for knowledge management and innovations in the coffee value chain. Information and innovation may not spread quickly in situations where there are low rates of connection, and actors that are less connected may be constrained to mobilise their resources and may be unable to bring multiple and diverse perspectives to solve their problems. From the Ethiopian coffee ego networks, farmers are constrained to information access and innovation in the sense that many of them are not members of cooperatives and they are disconnected from exporters who are the knowledge hubs. However, Rwandese farmers are not restricted by law to have links with NGOs.

In conclusion, we suggest that the dependence on both international and local NGOs must be limited as is the case in Rwanda. This is because NGOs are short term project operations in nature and can therefore affect farmers' expectations once they leave the country, or runs out of funding. For the effective support to farmers, we call for strengthening organisational and knowledge management capacity of cooperatives and other players along the value chain. It is therefore important that international NGOs change the role they have been playing in leading value chain activities, to a more supportive catalytic role.

Keywords: Coffee, density, efficiency, Ethiopia, innovation, networks, reciprocity, Rwanda

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How do GAP Standards from Different Public and Private Sectors Influence Horticultural Value Chains?

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A wide range of private standard and certification schemes evolved in the global horticultural value chain during the last decades. Thailand as one of the leading exporters of tropical horticultural products has started to actively promote a set of "Good Agricultural Practices" (GAP) standards for on-farm and post-farm activities aiming to enhance food quality and safety levels, and to increase the competitiveness of its horticultural sector. The Q-GAP standard issued by the Thai government is currently the most important standard for export-oriented producers. On the other hand, Thai authorities and horticultural stakeholders have increasingly paid attention to comply with international private standards such as GLOBALG.A.P. As a consequence, the presented study aims to analyse how GAP standards from different public and private sectors influence Thai horticultural value chains. Taking the example of 408 certified and non-certified orchid and mango producers as well as expert interviews with key informants, the study revealed that large differences exist with respect to the type of horticultural products. In contrast to the orchid sector, the value chain of mangoes has been successfully upgraded by different kinds of certification schemes. Certified and non-certified orchid producers can either sell their products to export or domestic markets. Most certified Q-GAP mango producers sell their products to producer groups and/or cooperatives that have contracts with exporters or high-value domestic retail chains. Certified private GLOBALG.A.P. producers are directly linked to exporters solely on the basis of contract farming. They receive a purchase price and a sales volume with a floor price (based on market price) guaranteed by the export company. Furthermore, the compagny supports certified and new GLOBALG.A.P. producer candidates by providing training related to certification procedures, record keeping and covers the costs of certification. Based on these results, GAP standards offer added value for horticultural products and can serve as an upgrading strategy for the value chain of horticultural products as a whole.

Keywords: GLOBALG.A.P., Good Agricultural Practices (GAP), horticultural value chain, Thailand

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Mpharane Plantation – Access Mechanisms: The Effect on People´s Livelihoods and Future Benefits

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Forest resources serve as an important component of the livelihoods of rural households in developing countries. Access mechanisms can enable or constrain the generation of value from forest resources through the effectuation of access rights and management practices of the resource. Using an inter-disciplinary approach, the objectives of this study are to assess the household use and natural resource condition of a plantation and investigate the institutional arrangements, access mechanisms and possibilities for future development of the resource in Mpharane, Eastern Cape province of South Africa. Mpharane village is within the former homelands region of South Africa and underwent significant governance changes with the abolishment of Apartheid in 1994. This impacted the plantation through the withdrawal of central Government management and control. Responsibilities and power over plantation resources have been left in the hands of the traditional chiefdom, although elected local government structures are also present. The resources are predominantly Eucalyptus, used mostly as subsistence goods, supplying basic needs of firewood for energy use and building materials, such as poles for roofing or fencing, as well as non-timber forest products. Using the framework of access by Ribot and Peluso (2003) we have identified that although it can be considered a *de facto* open-access common-pool resource, there are underlying restrictions to plantation access mechanisms. The lack of control and management of the plantation have certain constraints on household use of the plantation, such as perceived levels of crime and lack of technology for processed products. These constraints have shaped ideas of future changes in the plantation and desired outcomes include increased security, management and fencing. Potential actors for the implementation of these developments are considered, following local expectations of possible management by an outside private company. This is discussed in comparison with the existing context of current local capacity. Institutional constraints have to be addressed and an expectation setting in the village should be implemented before changes are made to the resource.

Keywords: Institutional arrangements, livelihood diversification, plantation management, power relations, rural development, South Africa

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Evolution of Input Supply and Service Hubs in Dairy Development at Ada'a Milk Shed in Ethiopia

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Efficient input supply and service delivery may call for a hub approach where all the necessary inputs and services are supplied in a coordinated manner, either by a single supplier or by several and separate entities in a given geographical location accessible to beneficiaries. Based on experience from Ada'a milk shed in central Ethiopia, this paper assesses the evolution of input supply and service provision in the dairy sub-sector, focusing on coordination and the degree of competition among different actors at different levels in the value chain over time. Data were collected from key value chain actors engaged in provision of input supply and output marketing services in Ada'a milk shed. The major lesson is that the development of coordinated input supply and service delivery by different business entities or under a single business entity may not emerge at once, but through a gradual evolution. This depends on the level of demand for the inputs and services as determined by the degree of demand for milk and milk products, and the economies of scale input suppliers and service providers could attain from the expansion of demands for these inputs and services. Moreover, at the early stage of a hub development, collective actions and integration of services and marketing within a business organisation could be the main strategy to attain efficiency. But, once the demand for inputs and services has grown, competition among different entities will lead to more efficient input supply and service delivery. In general, where there is an increasing demand for inputs and services, there is a faster development of input supply and service provision by private actors and collective actions in a more competitive way. The role of the public sector could change gradually from provision of inputs and services to coordination, capacity building, quality control, and regulation.

Keywords: Collective action, dairy development, input supply, service delivery, service hub model, value chain

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Performance of Micro and Small Scale Enterprises in Tanzania: Growth Hazards and Architecture of Fruits and Vegetables Processing Vendors

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Processing of agricultural products is becoming important for food insecurity and economic development in Tanzania. Unfortunately, smallholder food processing enterprises do not access opportunities created by market, thus their growth is less likely. Therefore, this study analysed growth performance of micro and small scale enterprises (MSEs) involved in fruits and vegetables processing activities in Tanzania. In a field study, cross-sectional and three panels data were collected from 140 MSEs in Dar es Salaam, Morogoro, Coast and Tanga regions of Tanzania. The sampled enterprises operated independently, meaning without alliance under individual competitive mode "unilaterally".

Returns on investment (ROI) analyses were done to study the enterprise investment returns. Results showed that their average ROI under unilateral mode is lower as compared to collective investments in each of the study regions. The 14 years forecasted ROI results showed that if the enterprises in each study location invest their last profit as a group their ROI increases significantly over time.

Furthermore, Cox Proportional Hazard model was used to recognize sampled MSE's, manager-owner's, and geographical proximity characteristics associated with their growth. It included estimation of time transpires until such enterprises achieve European Commission (EC) and Tanzanian growth levels. The following characteristics were identified as main growth drivers of sampled MSEs: their operational capital; number of owners; staff-size; profit; annual production of products; access to basic market information; linkage to supportive bodies; government business improvement services; distance to main inputs sources and marketplace of processed products; manager-owner's age and business experience.

This study identified a low growth rate of the sampled MSEs, *i.e.* 0.24 % and 0.15 % per year for revenue and capital investment, respectively. These results suggest that if they continue to operate individually under the same conditions and growth rate, it will take centuries to realise large scale standard growth levels. Therefore, it is proposed to merge MSEs and form cooperatives as appropriate operational mode for a better performance. Finally, logit regression results demonstrated that the willingness to cooperate of the manager-owners is around 62 %.

Keywords: Fruits and vegetable processing, MSEs, organisation

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Fairtrade Certification and Poverty: A Panel Analysis of the Coffee Sector in India

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The fairtrade minimum price and the price-premium make fairtrade certification unique. This particular certification scheme has gained popularity in the developing countries with the fact that it gives small-scale farmers access to global markets and directly or indirectly reduces poverty. Having said about fairtrade´s role as a poverty reduction measures, there has been too little research known about the impact of certified Indian coffee on Indian small-scale farmers. Although coffee had been introduced a long time ago, certification schemes remain limited in India. Fairtrade initiative is a new concept in the coffee sector of India, only started in 2007, which explains the limited impact studies. The cooperative called Small and Marginal Tribal Farmers Mutually Aided Cooperative Society (SAMTFMACS) of Araku Valley is the largest cooperative of coffee in India and is the first one to have received fairtrade certification.

The paper addresses the impact of fairtrade certification on coffee smallholders' livelihoods through a case study in Araku Valley, India. Assessing the impact of fairtrade on income and poverty of small-scale coffee producers and further investigating the role of fairtrade's social premium on community welfare development, this study tries to answer the question: does fairtrade certification improve the well-being of small-scale coffee producers of Araku Valley, India? The empirical analysis of this study is based on the balanced panel data collected two times over a period of 2010 and 2011 and uses the simple matching method in the absence of baseline data to find out the impacts for smallholders in certified producers groups by comparing them with similar non-certified groups.

Keywords: Coffee, fairtrade certification, India, panel analysis, poverty, smallholders

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Extensive livestock systems

NomadSed: A Board Game on Sustainable Land Use of Mobile Pastoralists under Global Change

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Mobile pastoralism has been proven to be an appropriate type of land use in drylands to cope with harsh climatic conditions. However, in society and policy making, misconceptions exist on functioning and relevance of mobile pastoralism in particular under recent processes of global change.
In the frame of the interdisciplinary Collaborative Research Centre 586, the board game NomadSed was developed where up to six players step into the role of nomadic herdsmen. The goal for each of the players is to build up capital in terms of sheep while coping with multiple social-ecological challenges. The rules of the game map important ecological and socioeconomic aspects and their interrelations with respect to resource utilisation of pastoralists in drylands.
NomadSed is, firstly, designed and already in use for environmental education in *e.g.* schools, university courses or, in the frame of outreach activities. The game provides insight into the everyday life of nomadic households, their strategies of resource utilisation, and the complex challenges they have to master in order to secure their livelihood. One of these challenges is how to maintain their live support systems through enabling sufficient regeneration of their pastures. Coping actions can be influenced by events on the individual, regional or even global level such as job migration of a member of the individual household, a regional drought or a rise of price for supplementary feeding on the world market. These influences are simulated by means of event cards which incorporate knowledge of empirical socio-geographic research in various dryland regions (*e.g.* Syria, Morocco and Tibetan Highlands).
Secondly, the game offers the potential to support the dialogue and knowledge exchange of science and development organisations with local stakeholders. It is planned that the board game is played by local stakeholders (*e.g.* the nomadic herdsmen) themselves. Therewith new insights can be gained on pastoral decision making and important aspects of local knowledge: *e.g.* under which condition cooperation between the players is pursued or how stakeholders react on external influences. This endeavour is supported by cooperation with non-governmental organisations working with pastoralists in drylands (*e.g.* Veterinaires Sans Frontiers Germany).

Keywords: Decision making, global change, pastoralism, social-ecological dynamics, strategic board game, transdisciplinarity

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Escaping Insecurity through Increased Livestock Mobility – A Sustainable Strategy?

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The highly extensive animal husbandry system in southwestern Madagascar – characterised mainly by the keeping of mobile herds of zebu cattle and mostly sedentary flocks of small ruminants – is liable to several constraints such as seasonal water and forage shortage. In recent times, security issues, especially armed cattle rustling, are also gaining importance, reflecting the country's political crisis since 2009. Local pastoralists are therefore forced to adapt their herd management by more frequently changing grazing grounds and modifying transhumance patterns. We aimed to determine the consequences of these changes both for the animals and the regional vegetation known for its high botanical endemism.

The study was carried out with herds from four selected villages on the Mahafaly Plateau and along the coastal zone around the Tsimanampetsotsa National Park. During November 2011 – April 2013, individuals from three flocks of cattle and three flocks of small ruminants in each village were fitted with GPS tracking units, recording their diurnal grazing movements and spatial distribution during three consecutive days in two-monthly intervals. Additionally, the animals' activities were monitored by direct observation.

Results show a strong dynamic, especially in the seasonal movements, of cattle flocks that had not been expected to be that distinct at the beginning of the study. Herds were dislocated more frequently and, during their transhumance from the coast to the richer feeding grounds farther inland, moved back after shorter periods than originally reported by the herdsmen. At the same time, herds from the plateau which usually stayed extensively in their area, were increasingly moved to the coastal zone during the dry season to avoid security problems. The coastal pastures are thus exposed to an increased number of animals grazing nearly year-round on the relatively scarce vegetation, temporarily leading to extremely high grazing pressure and negative consequences for the abundance of preferred pasture plants. If insecurity prevails on the Mahafaly plateau, strategies such as plantation and systematic use of indigenous fodder plants in the coastal zone, and hay making on the vast but deserted plateau pastures, should be envisaged by local communities and supporting governmental and nongovernmental organisations.

Keywords: GPS tracking, grazing itineraries, Madagascar, transhumance

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Who Benefits Whom? A Gendered, Socio-Economic Comparison of Maasai Men and Women

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Gendered division of responsibilities is traditionally anchored in Maasai culture. While men focus on livestock as the main income activity, women are in charge of milking and also autonomous with regard to milk use decision. In addition, many Maasai men are married to several wives. All family units usually cooperate in various ways like food sharing or income pooling.

With the changing environment (socio-economic and natural) a diversification of livelihood strategies is observed by researchers. Concurrently, there appears to be some empirical evidence of shifts in gender roles.

In this paper, we use data of Maasai families living in rural areas of Morogoro region, Tanzania. First, we describe the characteristics and the socio-economic spheres of Maasai men (who are family or household heads) and women (who are sub-household heads) as separate economic actors. Second, we assess income levels of women and men and compare their contributions to the whole family income. Third, we focus on milk sales as women's main income source, and investigate who benefits from milk commercialisation.

Our findings suggest that with the limited income alternatives in the research area the traditional gender roles remain valid. While the total income of men is higher than the total income of women, the income-ratio at the sub-household level suggests a higher contribution by women. Our results indicate that most women control the direct use of income from milk sales. Considering indirect effects like reduced shopping money received from the husband, the milk income only benefits one fifth of women respondents. The supplementary housekeeping budget is mostly spent on diversifying and increasing food purchases.

Keywords: Gender roles, livelihoods, Maasai, milk sale, pastoralists, Tanzania, women's income

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Sustainable Rangeland Management: How Grazing Management and Woody Cover can Alter Herbaceous Diversity, Forage Quantity, and Carbon Stocks in Semi-Arid Rangelands of Ethiopia

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Semi-arid savannah rangelands are currently under threat by overgrazing, which can lead to dense woody cover in the absence of fire and often results in the suppression of herbaceous plants. On the other hand, woodland expansion might result in a large increase in Carbon (C) storage in the grassland ecosystem, an important aspect for climate change mitigation potentials. Particularly the influence of grazing intensities on the belowground herbaceous root biomass, where large amounts of C can be stored, has poorly understood. We compared the effect of livestock exclosure under varying woody cover in pastoral grazing systems of southern Ethiopia. Caged plots and transects were established to assess species composition, dry matter and above-and below-ground C stocks of herbaceous plants, as well as total ecosystem C under the different treatments. Herbaceous above-and belowground dry matter yield and overall ecosystem C storage was declined with increasing woody cover. Grass dry matter yield was significantly higher in exclosure compared to open grazing lands but was dependent on woody plant density and cover. Herbaceous species composition did not significantly vary across grazing management while root biomass and total soil organic C positively responded to grazing exclusion. Older age of exclosure did not pronounce differences in herbaceous species composition, above- and belowground dry matter yield, which highlights the importance of rotational grazing practices. We conclude that high woody cover suppresses herbaceous cover and could aggravate soil erosion, less stabilise soil organic carbon (SOC) or increases its loss, and hence climate change mitigation strategy through soil C sequestration need to focus on improving the condition of herbaceous cover through implementation of better woody management, improved grazing and livestock management systems in this semi-arid rangelands. While enclosures represent important management tools, rotational grazing should be fostered to restore herbaceous vegetation and its C stocks.

Keywords: Borana rangelands, bush encroachment, carbon sequestration, carbon stock, enclosure, grazing management, herbage yield, land cover changes, savannah, species richness

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Determinants of Grazing Management in the Borana Pastoral System of Southern Ethiopia

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Borana pastoralists of southern Ethiopia had a very sophisticated grazing system where herding decisions across heterogeneous landscape was regulated by customary institutions. In this system, water and pasture use was carefully regulated to allow flexibility and strategic mobility dictated by the high spatial and temporal variability. Recent policy changes including the creation of the Pastoral Associations (PAs) have significantly weakened the traditional institutions thereby undermining their role in regulating pastoral land use. The objectives of this paper is to establish the implications of these changes on herders' decision space in three ecologically different zones of Dirre, Golbo, and Malbe in the Borana rangelands of southern Ethiopia. We used participatory rangeland mapping with Borana pastoralists using print outs of satellite imageries to delineate and characterise grazing units. Seasonal grazing calendar were used to reconstruct herd grazing itinerary for 90 cattle herds for over a year. Eighteen key informant interviews were conducted to learn about the regulations that are still controlled by the customary institutions and to understand the implication of weakening of the customary institutions for pasture use/grazing decisions. In each of the three zones, pastoralists successfully delineated the different grazing units (with sizes between 3 and 40 km^2) and the described the characteristics and use of each unit. We established that herd owners have limited and at times no opportunity for individual decision to choose grazing units due to constrained grazing space that led to communal grazing arrangement of lumping grazing units into dry and wet season use. Across all the three grazing zones, herd mobility has been reduced to a predictable routine movement between wet and dry season in a communally administered fodder deferment plan instead of the traditional arrangement of herd division into mobile Foora (Dry stock) and Hawicha (Milk stock). Herd mobility is further constrained by the ubiquitous settlements resulting to all year round use in most of the grazing units. More centralised water and pasture resource management has reduced the role of customary institutions in decision making. Due to the reduced flexibility, pastoralists in Borana rangeland are more vulnerable to external shocks including frequent devastating droughts.

Keywords: Borana rangeland, customary institutions, pastoral land use, southern Ethiopia

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Resources of the Agro-Pastoral Transition Zone of Inner Mongolia Grasslands: Challenges and Opportunities for 'Marginal Lands'

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Grasslands are considered as terrestrial key ecosystems affecting sink and source dynamics of global matter fluxes. Main services provided by (semi-)natural grassland systems are, among others, biomass production, carbon and nitrogen sequestration, biodiversity conservation, and providing the livelihood base for millions of pastoralists. Traditionally, grasslands of Inner Mongolia (North China) were used as sustained grazing land by nomadic herdsman. However, since the 1950s farm based, stationary land use systems were introduced and grasslands were increasingly over-grazed and converted to cropland. Today, urbanisation, global food prices and trends to grow bio-energy crops enforce economic pressures, threatening multiple grassland ecosystem services and consequentially valuable steppe and wetland biotopes.

Most impacted by management change are natural semi-arid grasslands located in the agro-pastoral transition zone (APTZ) such as the forest-steppe ecotone in the Hailar County, Northern China. As grasslands of the APTZ are accessible from cropland-dominated and urbanized regions with developed infrastructure, they were identified as hot-spots for future land conversion. Therefore, steppe ecotones in transition zones are not only threatened by intensification of grazing management, but also by intensive cropping activities including fertilisation, pesticide application, and intensive irrigation. First negative impacts of uncontrolled intensification are already visible such as fast decreasing ground water tables, contaminated water discharge to rivers, top soil wind erosion and loss of biodiversity.

New adapted land use concepts within the APTZ are required to prevent or mitigate resource-, social- and economic conflicts in the near future. The presentation will out-line strategies for "sustainable land-use intensification" addressing both, food/life security and multiple ecosystem services from a multidisciplinary view. Concepts must be based on an improved understanding of the underlying mechanisms affecting regional matter fluxes, which will include effects on water cycles, vegetation dynamics, soil microbial activity, carbon and nitrogen cycles, soil erosion, greenhouse gas emissions and social and economic system. The paper highlights the results of an international, multidisciplinary symposium held in Hailar, Inner Mongolia in July 2013 dealing with challenges and opportunities for marginal lands within the urban-rural-continuum in currently one of the most dynamic societies of the world.

Keywords: Agro-pastoral transition zone, grassland ecotones, sustainable land-use intensification, urbanisation

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Livestock Biodiversity and its Sustainability in Relation to the Millennium Development Goals in Nepal

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Agriculture is the mainstay of more than 65 % of the population and is one of the best options to mitigate the deep rooted poverty in Nepal. Agriculture sector provides about one-third to the gross domestic production (GDP) in Nepal. Livestock is the integral part of Nepalese agricultural system which contributes about 28 % share to agricultural gross domestic production (AGDP). It is the flourishing industry that directly addresses poverty (MDG 1), gender issues (MDG 3) and environmental sustainability (MDG 7) and indirectly to almost all Millennium Development Goals (MDGs).
Nepal is very rich in livestock biodiversity, but average production and productivity of the indigenous livestock breeds is very low. There is the potentiality of improving the productivity of indigenous breeds by intensive selection. Livestock products will only be cost effective if they are based on forage feeding. About one-third of Nepalese livestock are underfed which not only negatively affected the production potential of the existing livestock but also the breed improvement programme initiatives of the Department of Livestock Services (DLS). Lack of quality forage is more prone in trans-Himalayan regions, *e.g.* Mustang and Manang regions where very important livestock species like Yak, Nak, Chauries, Lulu cattle and Himalayan goats can be found. Livestock enterprise is getting paralysed in these regions because of the scarcity of quality fodder and pasture. Pasture species like White clover (*Trifolium repens*), Rye grass (*Lolium perenne*), Dhimchi (*Pennisetum flaccidum*), Kote (*Medicago sativa* var. *falcata*) and fodder species like Bains (*Salix babilonica*), Pipal Pate (*Populus* spp.), Khasru (*Quercus semicordata*), Bhote Kantus (*Castanopsis* spp.), Thotne (Ficus hispida) are very important in these areas. They can be grown and multiplied by using the traditional knowledge of the local population. Am intervention to ameliorate the quality of the pasture will ensure low cost of livestock products, enrich the biodiversity, help in sustainable and environment friendly livestock production and will be the mile stone in achieving the MDGs in the trans-Himalayan regions of Nepal.

Keywords: Biodiversity, livestock, MDG, pasture, traditional knowledge, trans-Himalayan regions

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Pastoralists' Perceptions on Local Innovations

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In the past decades, many top-down approaches aimed at introducing innovations into pastoral systems have failed due to the lack of sensitivity towards context-specific pastoral production where changes in production must fit a combination of particular and specific environmental, socio-cultural and economic conditions. Local innovations, on the other hand, respond to specific problematic situations experienced by the respective innovators. Spreading such local innovations through pastoralist-to-pastoralist exchange sessions offers an opportunity to study how other pastoralists view these innovations with regard to their problem solving capacity, applicability within the respective production system and particular characteristics which may or may not render them beneficial.
The objective of this study was to gain a better understanding of pastoralists' perceptions of applicability and usefulness towards local innovations. Pastoralist-to-pastoralist knowledge exchange sessions were conducted as the main source of data, namely the innovators' presentations and participants' questions. Eleven exchange sessions for five different local innovations (three technical innovations and two organisational innovations) were conducted and recorded. From the pool of participants, 33 individual follow-up interviews were conducted using semi-structured questionnaires. All recordings were transcribed resulting in 198 pages of primary data. These transcriptions were then used to identify trait carriers and traits with subsequent "levels" of observation made by the pastoralists when evaluating the innovations. In addition, positive and negative aspects for the respective innovations were also identified. When judging the applicability and usefulness of the technical innovations, pastoralists considered characteristics of innovations within the local context, such as availability of materials and ease and efficiency of their use. Comparisons were made between the innovators and their environments in relation to the participants' along with cost/benefit assessments in relation to durability, accessibility, and labour required. For organisational innovations, characteristics considered were the roles that members must play within the group, the benefits they receive and how members' duties are regulated. $^{\text{Cost}}/_{\text{benefit}}$ assessments were made between contexts and the perception of possible member distrust against the innovations' benefits.

Keywords: Agricultural knowledge and innovation systems, local innovations, local knowledge, pastoralism

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Which Institutional Arrangements Can Halt Pastoral Degradation in Uzbekistan's Rangeland Systems? A Political Economy Perspective

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As historical analysis shows, the former Soviet regime was able to establish a productive and sustainable system of pastoral management for the vast rangeland resources of Central Asia. Since the political transition, more than 40 % of the pastoral areas have been lost in Uzbekistan, mainly due to land degradation and obsolete infrastructure. Natural rangelands occupy over half of the country territory and the pastoral degradation has far-reaching implications for incomes of rural households, for regional food security and for the soil carbon balance.

This paper deals with the question as to why it has not been possible in the two decades since the fall of the Soviet regime to establish a sustainable pasture management system, even though the political transition would have offered the opportunity to replace the centralised system with a sustainable and equitable community-based approach for pasture management. The paper combines a historical analysis with a political economy perspective and a Grounded Theory approach to answer the following research questions: Which lessons can be derived from pasture management under the Soviet regime? What factors led to pasture degradation, and why does the current political regime do not have sufficient incentives to establish a sustainable alternative system? What institutional arrangements for future pasture management would be feasible?

The analysis showed that the Soviet system was able to achieve a productive use of the rangelands in Central Asia due the following factors: extensive rangeland research that started in early 1920's and covered geo-botanical, groundwater and pasture rotation maps; zoo-climatic assessments; the set-up of a comprehensive institutional structure providing zoo-veterinary, melioration, pedigree, shelter, monitoring/enforcement and labour rewarding schemes. This system was centrally subsidised, and the development race with industrialised states was the major political incentive. The current agricultural reform policies prioritise irrigated areas over drylands, since its cash crops have higher returns on investment. Therefore, the pastoral system receives low research funding, has insufficient monitoring/enforcement institutions, in addition to dominance of clan networks. Despite the deconcentration of administrative power, there is a lack of legal recognition of community-based pastoral groups to grant them fair access to rangelands, public services and micro-credit.

Keywords: Dryland research, institutional change, pastoral degradation, political economy, Uzbekistan

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Value Chain Development of Cashmere: An Option to Improve Livestock Production of Herders in Mongolia?

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Livestock husbandry is the most important sector of agriculture in Mongolia and the main employment opportunity in rural areas. Herders keep their livestock in nomadic systems and live of the sales of livestock and its products. Herders' livelihood depends on the pastures as the fodder basis of livestock. In recent years pasture degradation and erosion have been identified as major threats for the livelihood of herders. Overgrazing caused by increasing livestock numbers is the main reason for pasture degradation. An option to improve the situation and decrease herders' vulnerability is to destock herds. Destocking will only be feasible, if herders can have a similar income with destocked herds as they have with the present number of livestock. The present study analyses the potential of value chain development as a means to support destocking of herds in the region of Tariat; the option analysed is labelling of cashmere.

Data analysis showed that most herders are aware of the problem of decreasing pasture quality but at the same time most herders don't want to decrease their livestock numbers. Herders with large herds have been found to have lower intentions on increasing their herd size further. These herders seem to be more open towards engaging in cooperation outside of kinship. Since they also own more than half of the region's livestock, they could be targeted for the development of a project on labelling. Herders seem to be positive towards value chain development: most herders would be willing to work on the quality of their products if it would be rewarded by higher prices. The experts and retailers interviewed were rather positive on the potential of labelling cashmere. If a CBA-model is calculated on a project scenario, cashmere labelling would not be profitable in the short term. In the long term labelling could be profitable if the assumed effect of decreasing pasture productivity would be taken into the model. Although the prospect of eco-labelling is positive and promising as a means to support destocking, it is only feasible, if improved pastures can be enforced and livestock numbers can effectively be controlled.

Keywords: Cashmere, labels, Mongolia, overgrazing

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The Impact of Conditional Cash Transfer on Pastoral and Agro-Pastoral Livelihoods

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In Ethiopia social protection programs such as cash transfer schemes are being used by the government and development partners to reduce the incidence of poverty among rural households. Revitalizing Agricultural Incomes and New Markets (RAIN) is one of such programs that targeted pastoral and agro-pastoral communities in the eastern part of Ethiopia. The programme which was implemented over a three-year period (2009–2012) targeted half a million beneficiaries with various interventions including cash for work. Motivated to investigate whether the cash for work intervention have brought the long term impact that the programme intended, a survey was conducted on 897 housesholds (214 treatment and 683 control). The estimation was performed using four matching algorithms: nearest neighbourhood (with one and five) matching, kernel (normal density) matching, and local linear (tri-cube kernel) matching. Having these different estimates simultaneously helped to check the robustness of the estimation and ensured that the results were not driven by the selection of a particular matching algorithm. The estimation was performed on three selected outcomes: (i) expenditure and food aid status, (ii) food security situation, and (iii) asset building and asset protection endeavours. The findings of the study are that the conditional cash transfer has at best helped the beneficiary households to better meet their short term food needs. The result on food security situation was mixed with lower food access situation but marginally better dietary diversity. Nevertheless, the project has not encouraged households to engage in asset accumulation or asset protection activities. In general, the programme was not only limited to providing short term support, but it did not lead to sustainable asset building and social protection. The policy implication of the study is that in order for conditional cash for work programs to bring long term and sustainable impact, the cash transfer has to be adequate both in terms of amount and period of intervention.

Keywords: Conditional cash transfer, food security, impact evaluation, propensity score matching

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Borana Women in Livestock Management: Roles, Perceptions, Recent Changes

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Pastoral production is a family farming system in which the different household members take over specific tasks and responsibilities. In the last decades, the Borana pastoral production system has changed due to a number of factors, such as environmental degradation, enactment of policies that affect pastoral land use, and infrastructure development. These changes might be accompanied by changes of the roles of pastoral women in the production system.

This study examines livestock related roles and responsibilities of women in the Borana community of southern Ethiopia. It explores women's perceptions on their role in livestock management, and investigates changes in the last 40 years. We conducted 82 semi-structured and 30 narrative interviews with Borana women across all age-sets and with elderly and middle aged men.

Borana women's current roles and responsibilities include milking of cattle and shoats, milk processing, and care of young stock. The spectrum of shared tasks is considerable, including for instance camel management, cattle dung removal, and livestock medication. Women can take over all traditional men's roles in case of labour shortage except slaughtering. Husbands likewise assist their wives in the course of their regular activities and in puerperium particularly; thus, the gendered labour division is flexible. Girls are actively involved in herding and in their mothers' livestock work. Widows take over the role of their late husbands in case their sons are not able to carry out the activities; hence, the workload of young widows is particularly high. Throughout all age-sets and family situations, the respondents showed great contentment with their role in livestock management. Main factors of gender change include both environmental changes and governmental interference, the first increasing the labour requirement and the latter retaining labour force through compulsory labour of doubtful effect. Novel livestock management strategies such as fencing of grazing reserves and fodder storage are mostly conducted jointly by both genders, whereby most of the specific working steps are again allocated to either men or women. The general trend points to enhanced mutual support of women and men, with particularly men becoming increasingly involved in former women's activities.

Keywords: Borana livestock production, gender, pastoral women, southern Ethiopia

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Contribution of Wild Plants to Pastoralists' Diet and their Conservation Threats in Kajiado County, Kenya

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The wild edible plants (WEPs) are not only important for their nutritional value but also as alternatives to staple foods during food shortage. Their roles especially in the drylands where they serve as sources of both regular and famine food for millions of pastoral communities is crucial for food and nutrition security. However, rapid land-use changes in the drylands accompanied by destructive exploitation of natural habitats such as extractive use through charcoal production, clearing for cultivation and settlement threaten the WEPs. Despite these concerns, there is scanty information on the use as well as the extent to which their conservation is affected by the prevailing demand for natural products and pressure on land.

This study was conducted in the pastoral areas of Kajiado County of Kenya in two locations neighbouring the city of Nairobi and the other two further away from the city. Semi-structured questionnaire was used to collect qualitative and quantitative data on priority WEPs. A combination of focus group discussions and resource mapping was used to determine the current and past availability of the WEPs, as well as their threats. In addition, on-the-spot observations through guided transect walks and photography were used to complement the collected data.

The results of this study present information on the priority WEPs based on informants' consensus, and the frequency of their use in comparison to conventional foodstuff as a way of determining their contribution to households' food basket. Also presented are the plant parts used, harvesting methods and their preparation. Additionally, availability and specific threats to the priority WEPs are provided. Finally, the authors give recommendations on the entry points for sustainable exploitation of wild edible plant resources and research gaps.

Keywords: Contribution to household food basket, pastoral areas, seasonality, threats, uses, wild food plants

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Use of Wild Medicinal Plant Resources and Threats to their Conservation in Kajiado County, Kenya

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Maasai pastoralists in southern Kenya are known for their knowledge on and use of wild medical plants (WMP) to treat human and animal diseases. However, wild plant resources are increasingly under pressure because of land conversion, as witnessed in rangelands close to urban centres. This poses a major threat to the sustainable use of WMPs and to overall biodiversity conservation. There is however little information on the extent that specific WMP are used by the Maasai pastoralists and whether those priority species are affected by the current pressures. We therefore conducted a study to assess the contribution of WMPs to human health care in pastoral households and to learn about the change in availability of the priority species.

The study was conducted in pastoral areas in Kajiado County of Kenya in four locations, two being close the urban centre and two further away. Quantitative and qualitative data were collected. Using semi-structured questionnaires the treatment history of over 120 disease cases in pastoral households was determined. Focus group discussions and resource maps together with key informant interviews were used to determine the current and past availability of the plant species. Direct observations through guided transect walks and photography complemented the data collected.

The results give the incidence of human diseases in the pastoral households under study, the percentage of use of the different WMP for their treatment and the rate of successful treatment disaggregated for the different diseases. This permits quantification of the contribution of the priority WMP to household health care compared to conventional medicine. For the priority WMP, details on the use are given, including plant parts used, harvesting methods and drug preparation. In addition, For these plants, the availability and the specific threats have been identified. Based on the results we provide suggestions on the way forward for sustainable exploitation of the priority wild medicinal plant resources and further research needs.

Keywords: Availability and threats, contribution to household healthcare, Kenya, Maasai, medicinal plant species, pastoral areas

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Expansion of Crop Cultivation and its Impacts on Land Cover Changes in the Borana Rangeland Southern Ethiopia

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Rangelands form one of the most important parts of the terrestrial ecosystem. The benefits of rangelands include regulation of ecosystem services, storage and sequestering of carbon, mitigation and support of extensive livestock production. However, such benefits are sometimes underestimated especially when crop cultivation is introduced into the rangelands. Unlike livestock production, which is the traditional form of land use, cultivation activities have been proven to deteriorate the ecology of the rangeland. Furthermore, it is one source of greenhouse gas fluxes. Activities such as clearing vegetation in favour of crop farms result in a loss of plant biomass, soil erosion, loss of soil organic carbon and land degradation. The pastoralists are engaging more in crop cultivation as an adaptation strategy against economic stress. However, the impacts of the new land use on land cover changes are not fully appreciated. The study examines the reasons for expansion of cultivated land and its impacts on land cover changes from 1985 to 2011. Data was collected from 265 agro-pastoral communities via interviews and integrated with rainfall data and satellite images. Landsat images of February 1985 and 2011 were also used to ascertain land cover changes. Results showed that inadequate household income and larger family sizes are the main causes of expansion of cultivation among the Borana pastoralists. Cultivated land increased by 12 % and barren land by 2 % while grassland, woodland and bush land decreased by 2 %, 1 % and 10 % respectively. Unreliable rainfall and bush encroachment constrain pastoralism which necessitates livelihood diversification. Grass and woodland are in threat of degradation because they are decreasing in favour of farmland. To ensure sustainable rangeland management there is need to strengthening cooperation and communication among the pastoralists, policy makers and all other stake holders.

Keywords: Cultivation activities, land cover changes, rangeland ecosystems

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Evaluation of Methods to Identify Grazing Activity in Free-Ranging Ruminants Fitted with GPS Collars

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Activities performed by grazing herbivores influence the energy available for their growth and production. Although the activity pattern can be identified by fitting GPS collars to free-grazing ruminants, conclusions derived from these data may differ depending on the method used to classify the animals' behaviour. Hence, we compared two methods to estimate the time animals spent grazing, walking, and resting from GPS data.

From July to September 2008, six ewes grazing six different 2 ha-plots in the Inner Mongolian steppe, China, were fitted with GPS collars for 24 h recording their locations every 30 seconds. Behaviours (*i.e.* grazing, walking, resting) of animals at different locations were derived from GPS data using the speed threshold (SP) and residence time (RT) method. Simultaneously, the actual behaviours performed by the animals were determined every 3 min by direct observation. SP was implemented by analysing the speed time-series at increasing lag intervals, discriminating periods of low but sustained movements (observable at increasing lags) from static periods (low speed is kept at increasing lags). RT uses the time an animal stays within a circle of a certain radius. Radiuses ranging from 5 to 20 m were tested to identify the circle size that delivers the clearest separation between segments. When animals spent < 3 min, 3–30 min, or > 30 min within the defined circle they were considered to walk, graze or rest, respectively. Statistical differences between values obtained by the two methods were analysed by ANOVA using R software.

Both methods resulted in higher grazing (8.7 vs. 7.6 h d^{-1}; $p = 0.02$) and lower resting times (7.5 vs. 8.7 h d^{-1}; $p = 0.002$) than the observed activity pattern. In terms of walking time, SP resulted in higher values than both RT and observed (0.5 vs. 0.1 h d^{-1}; $p = 0.008$). For both methods, the main source of error was the misclassification of resting locations as grazing ones (15 % of the resting locations).

No method was advantageous over the other. However, their utilisation could lead to significant overestimation of grazing time and hence energy requirements, particularly when grazing speed is low.

Keywords: Free-ranging ruminants, GPS collars, grazing activity, residence time method, speed thresholds

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Improving Market Access for Pastoralists, Especially for Women Headed Households, in Peri-Urban Areas

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Increasing urbanisation and the growing need for land used for crop-production and infrastructure like roads and buildings more and more threatens the livelihoods of pastoralists and peri-urban dwellers. With a growing population, demand for animal-based protein, such as milk products and meat, increases significantly. However, this increased demand cannot easily be met by pastoralists due to weak infrastructure, long distance to markets or poor hygienic standards. This paper proposes that strengthening market access and thus increasing and stabilising incomes, strengthens the resilience of pastoralist communities and especially women-led households, respecting the gendered structures of livestock production.

We review development interventions by VSF Germany in Sudan and Somalia. In Omdurman, Sudan's largest city whose population has doubled in a few years, the dynamics of a growing city, expanding and absorbing its periphery are explicit. The VSF Germany project in cooperation with the German Foreign Office targeted especially women by enhancing the milk production – traditionally a task of women – through donation of small ruminants to female-headed households. Trainings on milk hygiene, community saving schemes and animal health were carried out to guarantee the sustainability of the project. In Somalia, VSF Germany has initiated the establishment of a meat supply chain for slaughtered animals, thus minimising the risk of livestock trade. Too little has been done to build on existing structures, maximising market access and minimising transaction costs. Only meat that is compliant with regional sanitary and food safety standards will be able to serve domestic and regional markets. The same applies for the milk market, which has been targeted by VSF Germany in a similar way. VSF Germany fostered the establishment of milk cooperatives and distribution points, enhancing women's market access and income diversification. This paper proposes that development interventions based on already existing structures, starting from gender based differences in traditional tasks in animal production, have great chances for success. Thus women's economic empowerment can serve as the entry point for their involvement in decision making processes – starting from the family level.

Keywords: Animal health, gender, milk production, pastoralism

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Effects of Grazing Intensity on Nutritive Value of C3 and C4 Species in Typical Steppe of Inner Mongolia, China

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Forage nutritive value is a plant functional trait to reflect forage intake and digestibility, as well as herbivore performance. Understanding the plant nutrient dynamic is important for grassland management and conservation. Here, the nutritive value of five dominant species (three C3 species and two C4 species) in the Inner Mongolia grassland of China were studied, within a large-scale grazing experiment including seven grazing intensities (from ungrazed to very heavily grazed) in a wet year (2008) and a dry year (2010). Our results showed that for the five species, the effects of grazing, year, growing period and their interaction on plant nutritive value were highly significant in nutritive parameters. Grazing increased crude protein (CP) and cellulase digestible organic matter (CDOM) concentration and decreased neutral detergent fibre (NDF) concentration in all species in the wet year, whereas the nutritive value of C3 species were relatively unchanged in the dry year. The trade-off between C3 and C4 species in nutritive value was more obvious in the wet year than in the dry year. Grazing had consistent positive effects on nutritive value of all five species for their stem and leaves. C4 species *Cleistogenes squarrosa* showed increased trend in CP and CDOM concentration over growing season (from June to August), which was inverse to C3 species. Our results suggest that grazing, precipitation and growing period were three main factors in driving species nutritive value dynamics. The nutritive value trade-offs between C4 and C3 species may help to keep the balance of forage nutrient in grassland ecosystems and ecological resilience. Although a strong shift from C3 to C4 species in steppe grassland ecosystems is indicating overgrazing and sward degradation processes, our results show that a moderate increase of C4 species can contribute to ecosystem functioning in terms of offering high forage quality for herbivores in late season.

Keywords: C3 and C4 species, grazing, growing period, nutritive value, precipitation, temperate steppe

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Grazed Vegetation Types near Tsimanampetsotsa National Park in Southwestern Madagascar

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Grazing of natural rangelands is the dominant land use on the calcareous semi-arid Mahafaly plateau in southwestern Madagascar, especially during the rainy season. Then, transhumant herds of cattle and, to a lesser extent, small ruminants, populate the vast grazing areas, locally exerting high grazing pressure. However, during the dry season, drinking water scarcity and professionally organised livestock theft lead to a considerable destocking of the plateau and utilisation of the sandy plains of the adjacent coastal region close to the Tsimanampetsotsa National Park.

In both regions we determined the dominant vegetation types and inventoried their floristic composition, the biomass availability, and compared the production of herbaceous forage biomass in the rainy season 2011/12 and dry season 2012. To this end we installed 60 permanent plots (30 m $\times$ 30 m) along a 4 km long east-west transect centreing on each one of four coastal and four plateau villages. Altogether, six types of grazed vegetation were identified in the coastal littoral, on the plateau and in the National Park area of the study region.

The following main vegetation types are prevailing in the region: dry forest (plateau, National Park), dry spiny forest thicket (National Park), coastal bushland with *Euphorbia stenoclada* (coastal plain), shrubland (plateau and coastal plain at degraded areas), wooded grassland (plateau) and grassland (plateau at degraded areas, plain near Tsimanampesotsa lake). The highest floristic diversity was found in the forest and the lowest in the grassland, which mostly develops after slashing and burning of forests. In both seasons, the highest herbaceous forage biomass was recorded in the *Heteropogon contortus* wooded grassland of the plateau, whereas the forest understorey offered the lowest herbaceous mass. During the dry season, the coastal bushland was an important source of forage due to the direct grazing as well as harvest and feeding of the succulent branches of the *Euphorbia stenoclada*.

Keywords: Deciduous spiny forest, *Euphorbia stenoclada*, forage, Mahafaly plateau, wooded grassland

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Leaf Area and Biomass Dynamics of a Thorn-Shrub Savannah Ecosystem in the Borana Zone, Ethiopia

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Many uncertainties exist concerning the quantification of the carbon sequestration potential in savannah ecosystems. Biomass and carbon pools are highly variable within the different vegetation types of this zonal ecosystem, and very often most basic and sufficient accurate information related to biomass dynamics are not available.

Here we present a methodological non-destructive approach to determine high-resolution data of leaf area index (LAI) and above-ground biomass (AGB) from a thorn-shrub savannah ecosystem in southern Ethiopia, representative for the African Sahel-Zone with bimodal rainfall distribution.

Optical and destructive LAI measurements were taken from 5 dominant shrub and tree species in weekly intervals during one rainy season. We correlated the results of multiple biomass harvestings with the non-destructive optical method. Multiple optical LAI measurements performed in different horizontal vegetation layers at a 5 m grid allowed us to upscale LAI and biomass information collected at the species to the plot level of the shrub-tree formations. Established allometric equations for above-ground biomass estimations of dominant shrub and tree species were additionally used to validate our method.

We discuss our results towards the option to use this optical method for estimating above-ground net primary production (ANPP) and, thus, the carbon sequestration potential for shrub-tree dominated savannah ecosystems. The results indicated that spatial and temporal biomass heterogeneity at species and plot level resulting from the system's high natural variability will be the main methodological challenge to cope with.

Consequently, optical biomass monitoring will be a key-method to determine the spatial and temporal variability of ANPP from tree and shrub dominated savannah ecosystems and should therefore be subjected to a scientific discussion as promising approach to estimate the carbon sequestration potential of this major tropical ecosystem.

Keywords: ANPP, biomass, carbon sequestration, destructive, LAI, non-destructive, Sahel

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Estimation of Carbon Sequestration Potential under Different Vegetation Types in the Borana Rangelands, Ethiopia

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The Borana rangelands in southern Ethiopia used to be among the most productive pastoral areas in East Africa. However, over-utilisation and over-grazing have resulted in declining rangeland conditions and woody-species encroachment. Payment for environmental services (PES) based on carbon sequestration has been proposed as additional livelihood option to offer an incentive for an improved and sustainable management which in turn is expected to increase the carbon sink in such semi-arid ecosystems. Nevertheless, information on basic above- and below-ground biomass and carbon pool inventories providing reference data for common vegetation types of the Borana rangelands is missing.

Within four representative vegetation types (grassland (GL), tree savannah (TS), bush-tree savannah (BT) and bushland (BL)), we repeatedly determined above- and below-ground biomass (AGB, BGB) using destructive sampling methods and allometric equations (for woody biomass). Total mean AGB (herbaceous + woody biomass) was highest in TS (24.2 ± 7.6 t ha^{-1}) and lowest in GL (1.0 ± 0.4 t ha^{-1}). Regarding the sum of all herbaceous biomass fractions (green, standing dead, litter), AGB decreased from 1.94 t ha^{-1} (BL) to 1.02 t ha^{-1} (GL) in June 2012 (after the rain season) and from 2.83 t ha^{-1} (BL) to 0.30 t ha^{-1} (GL) in Oct. 2012 (after the dry season). In contrast, below-ground biomass (BGB) of the herbaceous layer ranged from 3.20 t ha^{-1} (BT) to 2.45 t ha^{-1} (GL) and did not show this pattern among vegetation types. Dynamic sampling indicates AGB minima before and maxima after the rainy season, but only for the vegetation types GL and BT, while BL and TS did not show a pronounced seasonal dynamic.

Our data provide a first multi-seasonal quantification of above- and below-ground biomass and carbon stock estimates for common vegetation types in the Borana rangelands. We hypothesise that differences in biomass and carbon pools of the herbaceous layer between vegetation types are mainly based on above-ground vegetation dynamics, while below-ground biomass allocation does not reflect the above-ground pools. Thus, a first step to building a database as reference for PES systems and sustainable rangeland management has been taken.

Keywords: Above- and below-ground biomass, Borana rangelands, carbon sequestration, Ethiopia, semi-arid savannah, vegetation types

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Nutritive Evaluation of Eight Browse Trees in Butana Area, Sudan

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This study was conducted during the late rainy season (September – October) to evaluate the proximate composition, mineral content, condensed tannins and and *in vitro* organic matter digestibility (IVOMD) of eight pasture plant species collected from Butana area, Abu Deleig, Sudan. The browse tree species were, *Acacia tortilis*, *A. mellifera*, *A. seyal*, *A. ehrenbergiana*, *A. nilotica*, , *A. nubica*, *Ziziphus spina-christi*, and *Balaneties aegyptica*. Twigs from the browse trees species were collected, air dried, and analysed for dry matter (DM), crude protein (CP), ether extract (EE), ash, crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, calcium, phosphorus, magnesium, sodium, potassium, manganese, ferrous, zinc, cobalt, selenium, and copper, and compared with general requirement of camels.

The results revealed that the range of CP and CF of browse trees in Butana area were 12.37–26.61 % and 19.54–31.11 %, respectively. For condensed tannins, *Z. spina-christi* contained the highest level of tannins (5.2 %), however, *B. aegyptiaca* contained the lowest level of condensed tannins (0.2 %) among the eight tree species studied. The highest IVOMD value was recorded for *Z. spina-christi* (79.1 %) followed by *A. mellifera* (71.3 %).

The calcium and phosphorus contents were relatively low and ranged between 0.68–1.07 % and 0.11–0.57 %, respectively. Plant species were high in magnesium content except in *A. nilotica* and *Z. spina-christi*. The mean values of magnesium lay within the average of 0.27–0.51 %. High level content of potassium (1.08–2.56 %) and sodium (1.58–2.26 %) were recorded. The content of micro-minerals in browse trees was relatively high with 0.13–0.29, 0.27–0.76, 6.67–19.95, 0.31–0.60 and 0.15–0.84 ppm, for Cu, Mn, Fe, Zn and Se, respectively.

As a conclusion most of plant species in Butana area which examined in the present study may provide a considerable part of camels demand for energy, crude protein, and macro and micro minerals.

Keywords: Browse trees, Butana area, chemical composition, *in vitro* digestibility, late rainy season, mineral content, Sudan, tannins

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Feed Intake and Grazing Behaviour of Sheep in Response to Decreasing Herbage Allowances

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Herbivores are known to modify their grazing behaviour in response to decreasing forage availabilities. This might enable them to maintain their feed intake, but will increase their energy expenditures and thus, reduce feed use efficiency in pastoral livestock production. The objective of this study was therefore to determine the effects of decreasing herbage allowances (HA) on organic matter (OM) intake and behaviour of grazing sheep.

The experiment was conducted in the Inner Mongolian steppe in August 2010. Six different HA classes were established on two plots each ranging from >12 kg (HA 1) to ≤1.5 kg (HA 6) dry matter per kg of animal liveweight (LW). In four ewes per plot OM intake was determined using titanium dioxide to quantify fecal excretion and the crude protein content in feces to estimate diet digestibility. For this, fecal samples were collected during five consecutive days. Global positioning system loggers were fitted to two sheep per plot during four days. The devices recorded the animals' position every second when sheep were moving and every 15 s when no change in their position was detected. Horizontal and vertical walking distances were calculated and the time sheep spent for resting, grazing, and walking was derived from walking speed using velocity thresholds of ≤0.05, >0.05–0.7, and >0.7 m s^{-1}, respectively. Mean values of the sampled sheep per plot were used for the statistical comparisons between HA classes by SAS 9.2.

Horizontal distances (±standard deviation) averaged 3.6±0.99, 3.3±0.70, 4.7±0.92, 4.2±0.51, 4.0±0.92, and 3.7±0.51 km d^{-1} at HA classes 1–6, respectively ($p > 0.05$). Similarly, vertical distances of 174–435 m d^{-1} did not differ between HA classes ($p > 0.05$). The mean time animals spent for resting, grazing, and walking (±standard deviation) of 17.8±1.04, 4.9±0.95, and 0.9±0.33 h d^{-1}, respectively, was also not affected by HA class ($p > 0.05$), indicating that sheep did not compensate for the decrease in forage availability by prolonging their grazing time or daily walking distances. Nevertheless, daily OM intake of 68.1–73.5 g $^{-1}$ $kg^{-0.75}$ LW was almost identical despite the decrease in HA, showing that sheep must have adopted other strategies *i.e.* increasing their bite rates.

Keywords: Feed intake, GPS, grazing behaviour, small ruminants

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Assessing Longitudinal Relationship between Rainfall and Aboveground Net Primary Productivity Variability in an Arid Environment in Northern Kenya

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Arid and semi-arid ecosystems are subject to both intra- and inter-seasonal and annual variability in rainfall. These temporal fluctuations produce corresponding variability in vegetation cover and biomass on both seasonal and annual time scales. Estimation of forage availability in relation to temporal rainfall variation is therefore crucial for informing decisions on pasture and livestock management under the low-external input livestock production systems that rely on the natural vegetation. However, accurate, detailed, and systematic measurements of aboveground net primary productivity (ANPP) on small geographic scale to allow site-specific decision making are rare in the arid and semi-arid areas. This study was conducted to determine the relationship between seasonal and annual rainfall variability and ANPP in the arid rangelands of northern Kenya. The study made use of long-term satellite normalised vegetation difference index (NDVI) data set from 1979 to 2010 derived from the 1 km Advanced Very High Resolution Radiometer of the National Oceanic and Atmospheric Administration (AVHRR/NOAA) and MODIS and rainfall data from Kenya Metrological Department. Analysis of data show that long-term inter-annual variability in NDVI is not sufficiently sensitive to detect differences in ANPP equally well within the grazed areas and sites dominated by invasive plant species. However, this study emphasises the need for use of remote sensing to provide real time data for forecasting. We conclude that the relationship between rainfall and NDVI is not a simple linear one and must be based on detailed analysis of the vegetation type and season. This knowledge and information generated can also be included into budgeting and modelling for climate change studies in the region.

Keywords: Climate variability, Kenya, NDVI, rangelands, vegetation

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Drought Adaptation of four Native Shrub Species in Northeastern Mexico

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Water deficit is one of the most limiting factors in the northeastern region of Mexico. The aim of this study was to determine the water potential (WP) of native shrub species such as *Amyris texana* (Rutaceae), *Bumelia celastrina* (Sapotaceae), *Cordia boissieri* (Boraginaceae) and *Leucophyllum frutescens* (Scrophulariaceae) and its relationship with soil water content, evaporative demand components and rainfall. The study was conducted at the Experimental Research Station of the Faculty of Forest Sciences, UANL, located in Linares county, state of Nuevo León. Water potentials were determined at intervals of 15 days from January 17 to October 31, 2011, at 06:00 h (WPpd; predawn) and 14:00 h (WPmd; midday). Cumulative rainfall recorded at the site was 502 mm. During the wettest period, WP ranged from -0.40 MPa (*B. celastrina*) to -0.92 MPa (*L. frutescens*). With respect to WPpd during the driest period, it varied from -1.86 MPa (*L. frutescens*) to -4.0 MPa (*A. texana*). In contrast, WPmd during the wettest period ranged from -1.08 MPa (*C. boissieri*) to -1.56 MPa (*A. texana*), while during the driest period ranged from -2.0 MPa (*L. frutescens*) to -4.0 MPa (*A. texana*). Diurnal WP showed maximum values at dawn, then decreased gradually to minimum values at midday and in the afternoon it recovered. On a seasonal basis, WPpd and WPmd was positively correlated with soil water content and negatively correlated with air temperature, however, no correlation was detected with relative humidity and precipitation. Diurnal WP was negatively correlated with air temperature and vapour pressure deficit, whereas, relative humidity showed a positive correlation. WPpd explained 74 % of the total variability WPmd. Since *B. celastrina*, *C. boissieri* and *L. frutescens* showed high WPpd and WPmd during water stress conditions with respect to *A. texana*, these species are considered tolerant to water shortage induced by drought.

Keywords: Drought, Tamaulipan thornscrub, water potential, water stress

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Influences of Different Grazers on Belowground Production and Root Turnover in Songnen Grassland, China

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In temperate grasslands, the belowground system is the central part of carbon allocation and cycle. Belowground primary productivity (BNPP) and root turnover are important indicators of ecological properties of this ecosystem, such as carbon cycle and balance. Songnen grassland is located in north-eastern part of China, and the livestock grazing has been considered as one of the important land-use regimes. This area is under an increasing pressure of degradation as a result of the rising demand for natural resources and animal products. Much of previous studies have only focused on the effects of grazing intensity on aboveground production. However, little is known about the influences of different grazers on BNPP and root turnover.

Based on the different grazers, four treatments were established, including cattle grazing, sheep grazing, mixed cattle and sheep grazing and control without grazing. BNPP and root turnover were measured by Ingrowth Donuts method and the improved root window method, respectively.

The highest value of BNPP was found under sheep grazing followed by cattle grazing and mixed grazing. Un-grazed treatment showed the lowest value of BNPP. Similarly, root turnover was faster under grazing condition than the un-grazed treatment, especially in the cattle grazing treatment. The differences in BNPP observed among grazing treatments can be explained by selective herbivory of different grazers. Furthermore, BNPP and the proportion of root cohort surviving are positively correlated to soil moisture, suggesting soil water availability is an overriding factor controlling the formation of belowground net primary production and root turnover. Positive relationship between BNPP and root turnover indicates that high BNPP under grazing condition may facilitate root replacement, thus increase soil C sequestration.

Keywords: Grazing ecosystem, ingrowth donuts, root cohort surviving, root window

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Changes at the Aerial Biomass Accumulation of Rangeland Grassland and Tropical Pastures in Response to Edaphic Humidity

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Climate is crucially influencing grasslands' productivity. The aim of this work was to understand the relationship between the aerial biomass accumulation (ABA) with seasonal rainfall and edaphic humidity of an acuic argiudol soil. We studied this relationship on, i) a tall grass rangeland dominated by *Sorghastrum setosum* (SA), (ii) *Andropogon lateralis* (AL); and on the two most used pastures by farmers, iii) *Setaria sphacellata* var. *Sericea* cv Narok (SN); and iv) *Digitaria eriantha* (DE). Every 28 days under closure conditions the following measurement were made, ABA (DM kg ha $^{-1}$) at ground level in cages of 1 m^2 (four in each rangeland and pasture); monthly precipitation (LM-mm); and gravimetric humidity (HG g g^{-1}) up to 20 cm depth. In both cases; no relationship was observed between HG and ABA when analysed annually ($R^2 = 0.0173$) or seasonally (summer $R^2 = 0.0541$, spring $R^2 = 0.0011$, fall $R^2 = 0.0137$ and winter $R^2 = 0.0028$). At SN a positive relationship was found at fall ($R^2 = 0.4605$) and spring ($R^2 = 0.5209$); and at DE in summer ($R^2 = 0.3977$) and fall ($R^2 = 0.5672$). The HG explains 52 % and the 56 % in SA and DE respectively at these seasons. At all the tropical pastures and rangeland studied and from 2008 until 2013 the soils were at permanent wilting point only at the summer of 2011/2012 and at the summer 2008/2009 for SN. The rest of the time the soil was always between ready available water or it was saturated. The latter may explain the low relationship among both variables. Therefore HG cannot explain rangeland ABA, and explains only partially the ABA for the tropical pastures during the growing seasons.

Keywords: Available soil moisture, climate change, dry weight

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Responses of Vegetation and Soils to Three Grazing Management Regimes in a Semi-Arid Highland Mixed Crop-Livestock System in Northern Ethiopia

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Communal rangelands in sub-Saharan Africa have been undergoing dynamic changes due to the highly variable effects of grazing on the vegetation and soils. This study evaluated the effects of three grazing regimes (cut-and-carry (CC), seasonal grazing (SG), and continuous grazing (CG)) on herbaceous vegetation (species composition, diversity, richness, cover and biomass) and soil (bulk density, total nitrogen, available phosphorus and organic matter) attributes in the semi-arid highland mixed crop-livestock farming system of Tigrai in northern Ethiopia. Vegetation and soil measurements were carried out using a set of line transects and quadrats located in three sites in the highlands of Atsbi-Womberta of Tigrai region. The abundance of desirable species varied among the three grazing regimes, with more than 50 % of the species located in the CC and SG treatments. Herbaceous biomass and basal cover were 2.3 and 6.8, respectively, times more in the CC than in the CG treatment during the dry season. Herbaceous species diversity and richness were also higher in the CC and SG than in the CG regime. The relationship between biomass and species richness showed an initial positive increment and richness declined after the 4500 kg ha^{-1} production. The CG treatment affected soil bulk density and total N negatively. It is concluded that the vegetation and soil parameters measured in the three grazing treatments suggest that grazing systems in the semi-arid highland mixed crop-livestock farming in Tigrai region of northern Ethiopia have not lost their resilience and if given proper management can show dramatic improvements.

Keywords: Biodiversity, biomass, cover, richness, Tigrai

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High Impact Grazing as Management Option for Excess Standing Biomass in Argentinean Grasslands

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Despite northern Argentinean grasslands are very productive, farmers of large scale cattle ranches stock their rangeland with comparably low rates due to low winter forage availability. As a result low quality standing dead biomass accumulates with negative impact on the next year's grass growth. Although being prohibited, fire is often used to eliminate dead biomass and therefore, alternative sustainable management options are highly requested. By implementing elements from the holistic grassland management approach, short-term high-intensity grazing could improve grassland productivity and standing dead/green biomass ratios due to high feed intake, trampling, excrements, and the impact-timing.

At the INTA Corrientes experimental station we designed a three times replicated 18 ha grazing experiment, where in each month of the year a different area is subjected to three days high impact grazing (150 cattle ha^{-1} day^{-1}). A control site with traditional management is monitored additionally. Grass re-growth was monthly sampled inside moving cages. Monthly outside cage biomass harvests were separated for green and dead biomass. Cattle behaviour was continuously monitored with GPS collars.

Impact-timing had minor effects on the monthly inside cages mean biomass growth rates (60–80 g m^2) from July-March. Green biomass outside cages accumulated linearly until reaching peak values of 400–500 g m^2. However, the standing dead biomass also increases rapidly up to 350–500 g m^2, indicating fast turnover rates and underestimated re-growth based on inside cage measurements. The control site had comparable green biomass amounts but more than 700 g m^2 standing dead biomass, suggesting that about 30–50 % of the dead material was build up in the previous growing season. Cattle were preferentially grazing at sites with impact treatment 2–3 month ago.

High impact grazing offers options with regard to biomass- and animal management. Impact timing will affect residual dead biomass during the winter time, which however could promote C3 cold season species growth. This in turn could support cattle during winter grazing with additional biomass and, thus, finally increase ecosystem carrying capacity. High impact grazing will be on the other hand discussed for potential negative effects and applicability.

Keywords: Carrying capacity, cattle, grazing experiment, rangeland, vegetation dynamics

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Intensive livestock systems and services

Do Para-Professionals Provide Quality Veterinary Services? Results from a Role Play Experiment in Rural Uganda

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The study examines the interaction of farmers, veterinarians and paraprofessionals in the provision of clinical veterinary services. A role play experiment is used to analyse how the interaction of farmers and service providers influences the quality and the demand for clinical services. The game was played in four rounds, and the quality of clinical services was measured by scoring the accuracy of a service provider prescribing the appropriate drug for selected animal diseases in each round. Statistical tests were performed to establish whether the quality of services provided by different types of paraprofessionals and veterinarians differ. Learning curves for service providers were constructed to examine whether the quality of services provided by paraprofessionals improves as they continue to interact with veterinarians. Belief updating curves were constructed for farmers to examine whether they change their beliefs about paraprofessionals after receiving information about the quality of their services. A probit regression model for binary panel data was estimated to determine the factors that influence farmers' decisions to change service providers. The results show that the ability to identify the signs of different diseases and the accuracy of prescriptions by veterinarians is not significantly different from that of paraprofessionals trained in veterinary science. However, the ability of service providers who are not trained in veterinary medicine ability to perform these tasks is significantly lower than that of service providers trained in veterinary science. The continued interaction between paraprofessionals and veterinarians gradually leads to an improvement in the ability of paraprofessionals trained in general agriculture and social sciences to perform these tasks. This is not the case for paraprofessionals with no formal training or education. Farmers do not easily change their beliefs about paraprofessionals, even if they receive information on their lack of ability to diagnose diseases correctly and prescribe the correct drugs. Belief updating depends not only on the outcome of the previous round, but also on the gender of the farmer and the livestock production system. The paper argues that the slow pace in which farmers update their beliefs about paraprofessionals limits paraprofessional's willingness to learn or consult with veterinarians.

Keywords: Belief updating, lemon market, role play game, Uganda, veterinary services

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Determinants of Referrals by Paraprofessionals to Veterinarians

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Building referral networks in veterinary service delivery by supporting and strengthening linkages between paraprofessionals and veterinarians is seen as an important approach towards improving the quality of veterinary services and ensuring prudent use of antimicrobial agents in animals. In this paper, a probit regression model is used to identify factors influencing referrals to veterinarians by paraprofessionals in animal health care. The results show that the paraprofessional's mobile phone ownership, gender, availability of veterinarians, training, prevalence of epidemic animal diseases, the number of paraprofessionals not trained in animal health, attendance of short term trainings, annual assessments, and membership in paraprofessional associations influence their referrals to veterinarian. The paper argues that the legislation/supervision of paraprofessionals as well as provision of mobile phones to paraprofessionals, expansion of their membership in associations, and investing in short term training are key to building and strengthening referrals between paraprofessionals and veterinarians.

Keywords: Referrals, paraprofessional, probit model

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Assessing Different Levels of Intensity on Economic and Water Footprint in Dairy Farming Systems in Bangladesh: Implication for Sustainable Milk Supply to the Urban Consumers

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Milk production in Bangladesh falls under pressure due to rising demand from increasing urbanisation leading to intensification and higher water scarcity problem which ultimately affects environment, society and dairy production. To meet the growing needs of urban consumers without creating environmental burden, dairy farming needs to be efficient in both costs and water footprint. Therefore, the objective of this study was to assess the costs and water footprint (WF) in low, medium and high intensified farms located in rural, peri-urban and urban areas, respectively. This study further analysed four different scenarios based on rural low intensified farms in order to identify potential ways to reduce costs and WF in rural areas while keeping increasing production. A combination of both Life Cycle Assessment (LCA)-based WF calculation methods and TIPI-CAL (Technology Impact Policy Impact Calculation) model was used. The results showed that the higher the production intensity, the lower the costs per kg energy corrected milk (ECM) in urban farms while the opposite results were observed when analysing the WF. The single stand-alone WF (L H_2O kg^{-1} ECM), integrating consumptive and degradative water use (WU) impacts, ranged from 11 to 45 (low to high intensity). On the other hand, the WF considering degradative emission in terms of a theoretical water volume ranged from 21 to 112. The feed cost had the highest contribution (an average 0.18 which accounts for 67 % of average costs 0.27 USD kg^{-1} ECM) to the total costs while the WF impact was mainly driven by the regional water stress index (WSI). The scenario analysis showed that there was a potential tradeoff between economy of production and reduction of WF that revealed that the altering farming system toward high yielding cows and on-farm feed production in rural areas with low WSI and increasing market link with urban consumers might be an option to reduce costs, decreasing environmental burden whereby it provides the option to supply milk to the urban consumers at a competitive price. This study, therefore, suggests that improving dairy farming in rural areas while linking rural farmers with urban consumers might be the sustainable milk production scenarios in future.

Keywords: Bangladesh, costs analysis, dairy farming, intensification, water footprint

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Modelling Factors Affecting the Decision to Exit Dairy Farming in Bangladesh: A Two-Stage Regression Analysis

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Dairying is seen as means to improve rural livelihoods by increasing income and creating opportunities for employment for both rural and urban farmers. The increasing demand for milk and milk product due to increasing urbanisation, rise in income and increase population signifies to motivate dairy farmers to keep their business. But in reality, the fluctuating milk price and ever increasing feed price are considered as the obstacle for dairying and hence are postulated as the primary reason for exits from dairying. Therefore, it is high of interest to see whether milk price alone or there are some other factors that drive away the dairy farmers. A field survey was conducted to collect data from 218 dairy farmers from north and north-eastern part of Bangladesh. The sample dairy farmers represent three major production systems such as traditional, extensive and intensive production systems. Out of 218 farms, 67 farmers (31 %) indicated an imminent exit from dairying, whereas 151 dairy farmers (69 %) expected to remain in dairying for ≥ 5 years. A binary choice logit regression model, based upon the dependent variable decision to exit or to remain in the dairying, was used as part of a two-stage regression process to ascertain why dairy farmers prefer to exit from dairying. The hypothesis states that decision is a function of four independent variable category: socio-demographic, farm management, farm economics and opportunity costs. Eight variables were found that significantly influence the exit decision. Return over variable cost, farm profit, total costs for purchased concentrates, farm efficiency, milk yield, herd size, use of pasture, access to veterinary services and opportunities for off-farm income were like to be associated with a decision to leave the dairy farming. This study suggests adopting strategies beyond milk price which focus to improve farm economics in order to establish a sustainable dairy farming and thus a reduction in the rate of dairy farms exit. The policy framework for keeping dairying as profitable business and attractive for dairy farmers might play significant role in increasing milk production to meet the growing demand especially for the urban consumers.

Keywords: Bangladesh, dairy farms, exit, farm economics and logit model

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Situational Analysis of the Creole Pig Farming in Rural Areas of Otuzco District, Peru

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The present study aimed at characterising the creole pig farming in Otuzco district, highest pork producer in the highlands region of La Libertad, Peru. 70 families from 5 towns in Otuzco district were interviewed. Socioeconomic situation of producers, the production systems, feeding and health care of pigs, production parameters, marketing and perception of farming were charactised. Data analysis included relative frequencies, means and standard deviations. 93.5 % of the respondents were in poverty (monthly income less than $ 271). The production system was 100 % traditional, with 3.5 ± 3.6 pigs per year and family. 66.7 % of the production was marketed through middlemen (40.9 %). The management practices were disorganised, no programmed breedings (100 %), no managed records (100 %), and only 21.2 % of the farmers had in mind the age and 10.6 % the weight of the gilts in planning the breeding. Disease prevention consisted in free vaccination from state programs (71.5 %), only 5.7 % performed deworming pigs and 7.5 % kept facilities sufficiently ventilated and disinfected. The genetic improvement consisted in hire boars (86.5 %), however the improvement can not be assured because they didnt use any criteria to choose the boar. The number of births per year, the average age at weaning and litter size was 1.8, 56 days and 6.04 piglets, respectively. The age of slaughter was 285 ± 156 days with a slaughter weight of 53.7 ± 34.59 kg. The variability of the data was caused by animals being sold to satisfy the financial need of the family at any given time. The pig management system is agro pastoral, with the animals being grazed 9.8 ± 4.9 hours per day and addionally suplemented with herbs, grain harvest residues, or crop byproducts as boiled tubers. The minority of the farmers used concentrated feed like barley or corn. Pig mortality was less than 10 %.

Keywords: Creole pig , farming , Otuzco

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Contribution of Dual Purpose Cattle and of Dairy Products to Smallholder Family Nutrition in Crop-Livestock Production Systems of Ethiopia

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In crop-livestock systems of Ethiopia, livestock are an integral part of the system and contribute in multiple ways to the livelihood of smallholder farmers. In the southern and south-western highlands of Ethiopia, integration of dual-purpose cattle with perennial crops is common, but little attention has been given to quantify the contribution of cattle to family nutrition in the system. This study was therefore designed to quantitatively analyse the direct contribution of dual-purpose cattle in meeting the nutritional needs of smallholder families, as well as to determine the underlying factors accounting for differences on village- and household level. In total, 270 cattle owning households in the Enset (*Ensete ventricosum*) growing mixed production system were selected using a multistage random sampling. By means of a household dietary diversity survey and a longitudinal survey over 12 months, the relative importance of milk and dairy products compared to other animal source foods consumed by smallholder farmers was described. Influencing inter and intra-household as well as village level variables on the consumption of milk and dairy products were identified. Anthropometric measurements of 196 children between six months and five years of age were used as indictors for the nutritional status of the farming households. The preliminary results show that milk-in-coffee, fermented butter milk and butter ghee along with the common staple food of the region ('Kocho', made from the Enset plant) and/or other cereal foods were the most common forms of dairy products consumed by smallholder farmers. Cultural differences in the consumption of dairy products were observed particularly for cottage cheese and butter ghee. Compared to other animal source foods (meat, chicken, and egg) that are only intermittently utilised during peak religious or cultural holidays/festivities, milk and dairy products are the most prevalent animal source foods consumed on a daily basis. Dual-purpose cattle kept by smallholders in the mixed system thus play an important part in meeting the daily nutritional requirements of the family members.

Keywords: Animal source foods, contribution of cattle, family nutrition, milk products, mixed farming

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The Contribution of Community Livestock Workers to Animal Production in Rural Ghana

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A two month survey was undertaken to determine the contributions of community livestock workers (CLWs) to animal health and production in the Savelugu/Nanton District of the Northern Region of Ghana. In all, 100 respondents consisting of 80 livestock farmers and 20 CLWs were interviewed. From the CLWs, information on their particular activities was gathered, species of animals covered, activities carried out and charges per activity per animal and earnings per CLW per year were obtained. The farmers on the other hand provided information on the period for which they have worked with CLWs, how they thought the work of CLWs could be enhanced, what activities were undertaken by the various personnel, what prophylactic measures they took, what species of animals they kept and why they kept them. They also provided their opinions on which species of animals were more susceptible to diseases and what in their views were the causes of these diseases.

Sheep (1282) was the dominant species of animal handled by CLWs, while pigs (93) were the least. Deticking was the activity mostly (1484 animals) carried out by CLWs, while veterinary personnel mostly (59) carried out deworming. Most (50 %) of the farmers became aware of the CLWs concept over 3 years ago. Most of the deworming (82.5 %) and ectoparasites control (57.5 %) were carried out by CLWs while vaccinations were mostly (75 %) carried out by veterinary personnel. Most of the Farmers were of the view that provision of veterinary drugs to CLWs would help enhance their services. The highest proportion (37.5 %) of farmers kept both sheep and goats. Animals were mainly kept for income. Half of the farmers' interviewed were the view that the species of animals most susceptible to infections was sheep, and about the same proportion believed that these diseases were caused by harsh environmental conditions and contact between the sick animals with their livestock. Most farmers occasionally dewormed (87 %) their flocks and applied acaricide (97.5 %) on their animals as a prophylactic measure.

Keywords: Acaricide, livestock workers, prophylactic, rural community, vaccination

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A Feed-Based Typology of Crop-Livestock Systems in Eastern Africa

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Over two thirds of the human population lives in mixed crop-livestock systems, and they provide the majority of cereals and livestock products in developing countries. However, productivity of mixed farms in sub-Saharan Africa (SSA) remains low, despite a projected doubling of demand for meat, milk and eggs until 2050. Livestock production is also known for its large ecological 'hoofprint' by consuming significant amounts of land, nutrients and water and generating 18 % of anthropogenic greenhouse gas emissions (GHG). Sustainable intensification is needed to increase outputs with more efficient use of all inputs on a durable basis, thereby minimising trade-offs between productivity, livelihoods and environment.

Livestock feeding lies at the heart of sustainable intensification. Sufficient quality and quantity of feed on a consistent basis is the main constraint of smallholder livestock production in SSA, considering that feeding can constitute up to 70 % of total production costs. At the same time, feeding requirements can lead to considerable global land use change, degradation and GHG – *e.g.* 50 % of GHG associated to land use change is attributed to livestock production. Integration of improved tropical forages could play a role in sustainable intensification by increasing productivity while preventing and/or reversing land degradation, improving nutrient cycling and mitigating climate change through carbon sequestration and reduced nitrous oxide and methane emissions.

Crop-livestock systems in SSA are highly diverse and dynamic, based on site-specific conditions such as agroecology and markets, resource endowments, land use, farm management and livelihood strategies. Instead of giving blanket recommendations or aiming at 'silver bullets', we need to better understand the heterogeneity of farming systems, past trajectories and possible future pathways if we want to target sustainable intensification interventions. The proposed feed-based typology of crop-livestock system clusters crop-livestock systems along an intensification gradient from extensive communal grazing, residue feeding, tethering to zero-grazing cut-and-carry feeding. Each type represents an alternative state within a given system. The feed-based typology will be further used to (a) understand the multi-dimensional (potential) impact of different intensification pathways and associated trade-offs at farm, landscape and regional level; (b) identify entry points for sustainable intensification and target tropical forage system interventions.

Keywords: Crop-livestock systems, farm typology, sustainable intensification, tropical forages

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Impact of Darfur Conflict on Animal Health Delivery Systems in North Darfur State, Sudan

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The impact of the Darfur conflict on the livestock and animal health services were studied during the year 2008?-2009, in North Darfur. The study area comprised 100 villages of which 20 % were randomly selected. In 14 localities focal group discussions were held and informal personal interviews with groups of 5?-8 persons as well as with traditional leaders. Also a household survey with 10 % of all households in the 20 villages was carried out. Informal interviews with 50% of the former INGOs and veterinary staff were held. Secondary data, official documents, reports of veterinary services, INGOs and UN agencies were studied. The study revealed that the people of Darfur were caught up in a conflict resulting from years of underdevelopment, resource-based disputes over land, water, as well as political and military engagements. Many people have been killed; houses destroyed, animals looted, and basic animal health delivery system disrupted. The situation of the veterinary clinics in the area was highly affected: 45 % stopped functioning, 22 % were looted, 15 % destroyed and only 18 % were still functioning. The study also disclosed that animal health services were confined to the main towns (Elfashir, Kutum, Kebkayia, Malliet and Umkadada). Insecurity prevented veterinary authorities from moving to rural areas to provide veterinary services such as vaccination, treatments and diagnosis. Therefore, the vaccination rates were low: 8.5 % in 2005, 12.3 % in 2006, 7.3 % in 2007 and 22 % in 2008. Many pastoralist groups (22 %) were effectively marooned in one area with very limited mobility due to closed grazing routes, putting pressure on grazing and water resources. As a result the management system was affected: 53 % of the animals were looted, 19 % were forced to sale or slaughter, 14 % were migrated to neighboring countries, and the rest (14%) was maintained in the area. The major constrains to animal productivity were: water and feed shortages (40 %), bad marketing structures (30 %), lack of qualified veterinary staff (10 %). Most INGOs programs during the conflict included rehabilitation of water supply, improvement of animal health status through provision of fodder, restocking, training of Paravets and free vaccination. This study recommended that interventions should be made in order to improve the animal health delivery systems, restocking of animals, emergency fodder supply, as well as veterinary drug supply. A focus should be put on the training of community animal health workers.

Keywords: Conflicts, Sudan

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An Analysis of Veterinary Service Delivery in Western Kenya: A Case Study of Kakamega County

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Liberalisation of both animal health and related services in the early 1990s allowed many players into the livestock service sector. Much has been written on the effects of privatisation of animal health in the high potential areas and the pastoral areas in Kenya. However, the fate of the small scale dairy farmers in the medium potential areas remains largely unclear. This study aims to contribute to this knowledge gap by identifying the key actors in the livestock service sector in medium potential areas of Kakamega County and the factors that influence the demand for veterinary services in the area. Socio-economic data was collected through a household survey of 128 randomly selected households and 30 purposively selected service providers. The descriptive statistics revealed that 59 % of all cases attended to by animal health assistants, with private animal health assistants attending to 38 % of all the cases. The results of multinomial logit econometric model estimated with self treatment as the base category a negative relationship between distance and the choice of government service providers but a positive relationship with tropical livestock unit, treatment cost and education level of the farmer. The treatment cost and nature of the disease had a positive influence on the choice of private service providers, which is a clear indication that the farmers are willing to pay. Improving education to enhance the farmer's knowledge base and the need for a better herd health service for their livestock would be instrumental in increasing demand for animal health and related services.

Keywords: Animal health, liberalisation, smallholder dairy, western Kenya

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Circumstances, Constraints and Prospects of Honey-Bee (*Apis mellifera*) Conservation: The Case of Dale District, Sidama Zone, Southern Ethiopia

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This scientific study was conducted in South Nation nationalities and Peoples Regional Sate, Sidama zone, Dale district. It examines the major constraints and prospects of honey-bee (*Apis mellifera*) conservation at the grass root level. The study mainly focused on identification of the constraints that hamper beekeeping practices and also serve as disincentives for non-beekeepers to participate in the activity. Data were collected from 36 keepers, 24 non-beekeepers and 11 peasant association chairmen and development agents.

Combination of RRA tools (key informant interview, in-depth semi-structured interview, group discussion and observation) were employed to collect primary data from beekeepers, non-beekeepers, and peasant association chairman. Intensive field observation was carried out to visit apiary site of the beekeeper households to collect tangible data and observe practically their current status in beekeeping practices. All necessary secondary data were also collected from relevant sources.

Honey-bee pests (ants, wax moth (*Galleria mellonena*), birds, lizard), high cost of modern beehives, shortage of improved bee forage, lack of beekeeping equipment, dependence on traditional production system, lack of market and credit access, and poor extension methods are the main constraints of beekeeping development in the area. Among the beekeeping constraints and/or threats honey-bee pests, cost of beehives and shortage of bee forage during dry season were the most pertinent factors accounting for 32 %, 19.5 % and 13 % of the sample respondents, respectively. The study also revealed that lack of appropriate beekeeping training, financial problem, and appropriate extension methods were the core features hindering the non-beekeepers to participate in beekeeping activities.

Even though several constraints stalled beekeeping development in the area, participatory water shed management, high motivation of the beekeepers and non-beekeepers, traditional knowledge of farmers, availability of indigenous tree species as bee forage and participation of all family numbers in beekeeping activities were among the aspects that encourage honey-bee conservation in the area

The study concluded that beekeeping practice in the district is more traditional and affected by main constraints. Hence, technical and institutional support from the government, and provision of long-term credits could result in a sustainable way of honey production and bee forage management.

Keywords: Bee forage, beekeeping development, constraints, Ethiopia Dale district, honey-bee conservation, prospective, rapid rural appraisal, traditional knowledge

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Evaluation of Impact of Beekeeping Extension on Farmer's Livelihood in Angacha Woreda, Kembata Tembaro Zone, Ethiopia

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Beekeeping is a very important off-farm income source for small-scale farmers in South-Ethiopian highlands. The origin of traditional beekeeping techniques reaches deep into the history and Ethiopia is considered as the biggest exporter of natural honey in Africa. Although farm land availablility is low beekeeping allows farmers to increase their income without losing farmable land because of the small footprint of the new beehives. This study focuses on the technology impact and socioeconomic situation of beekeepers in the rural areas. Three representative sub-areas were selected considering the information received in the local agriculture office. In Chino Funamura, Angacha and Mesena 92 small-scale beekeepers were questioned using a semi-structured questionnaire. Collected data were supplemented by information obtained from beekeeping experts on 6 administrative levels and by own observations. 52.2 % of the respondents use traditional beekeeping techniques, while 16.3 % use modern beehives and 30.4 % have both of them. From the total 339 beehives 81.4 % were traditional and 18.6 % modern. The seasonal natural honey production was 4.9 kg per modern beehive compared to 1.9 kg kg per traditional hive. The mean price of 1 kg of honey from a modern beehive represents $USD 3.31, while 1 kg of honey from a traditional hive costs $USD 3.05. According to beekeepers among the main constrains of beekeeping are animal pests, pesticides and adverse natural conditions. Soil contaminated by DDT was considered as the biggest constrain by 58.3 % of the beekeepers in Chino Funamura. Insufficient training for the proper use of modern hives was observed. Although both beekeping techniques have their limitations, it is recommended to intensify the extension of modern beehives due to its greater production potential. There is a great potential for specialised beekeeping if appropriate training on modern beehives management is provided.

Keywords: Beekeeping, honey production, modern beehive, small-scale farmers, traditional beehive

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Milk Production and Utilisation Patterns in Disadvantaged Areas: A Study of Eastern India

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The dairy sub-sector occupies an important place in the agricultural economy of India. Milk production has grown so strongly that it now contributes more to the national economy than any other farm commodity. In Bihar, a populous but poor state in the eastern part of the country, milk production is reported to have increased from 2.5 million tonnes in 2000-01 to 6.5 million tonnes in 2010-11. However, milk productivity in the state is still very low. Organized marketing of milk in Bihar remains relatively insignificant, despite efforts in the past to develop and promote collective market mechanisms. The dairy cooperatives are only procuring about eight per cent of the marketable surplus milk (Government of Bihar, 2008). For smallholder producers in remote areas, there are hardly any alternative market options besides the traditional informal traders and shopkeepers.

In this context, the present study was carried out in Bihar to better understand production and utilisation of milk among different types of farmers in three categories of market access. Primary data were collected from three districts categorised by dairy market quality into high (Samastipur), medium (Katihar) and low (Nawada). Results highlight the differences in milk production and utilisation between districts. Unsurprisingly, producers sell more milk where market access and infrastructure are better, underlining the important role markets have in the development of the dairy sector. Average daily milk production per farm in Samastipur, Katihar and Nawada is 5.6, 2.3 and 2.4 litre, respectively, while daily milk yields are 4.5, 1.6 and 2.3 litre. Producers sell about 65 % of their milk in Samastipur, where the market is dominated by formal dairies and cooperatives, while in Katihar about 43 % of milk is sold. Here the market is dominated by informal milk traders. Finally, only 16 % of milk is sold in Nawada as there are no formal traders nor do farmers have good access to informal milk traders. Therefore, these farmers are only selling their milk to household consumers or nearby shops.

The contribution of revenue earned from milk sales to total income is highest in Samastipur (22 %) followed by Katihar (8 %) and Nawada (5 %).

Keywords: Income, market access, milk production, utilisation, yield

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Assessing Improved Management Strategies and Technologies on Cost of Milk Production in Different Dairy Production Systems in Bangladesh: Implication for Dairy Development

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The demand for milk production in Bangladesh is increasing faster than its production that widens the gap between milk supply and demand. This gap will continue to increase due to increasing urbanisation that will induce radical changes in demand. To respond to this market demand, it is necessary to increase milk production especially to supply the urban consumers but this increase milk production should be at competitive cost. This might be achieved once the farm applies improved management strategies while the policy might enhance the adoption of technology at farm level. Therefore, the objective of this study was to assess a set of management strategies and policies in traditional, extensive and intensive production systems in order to identify the suitable management framework for producing milk with competitive cost. This study utilised the method developed by International Farm Comparison Network (IFCN) which is based on the Typical Farm Approach (TFA) and Technology Impact Policy Impact Calculations (TIPI-CAL) model. First a "status quo or baseline" analysis was done and secondly 10 scenarios were developed and applied to the baseline farms. The cost of milk production in baseline farms were 43.46, 39.44, 34.67 USD/100 kg ECM (energy corrected milk) in traditional, extensive and intensive production systems, respectively. These costs were significantly reduced while those farms adopt improved management strategies and different technologies. The highest decrease in cost of milk production (37 %) was observed for using improved veterinary services (IM-VET) in intensive production systems while 24 % and 22 % can be decreased by using community based fodder production scheme (CB-FPS) in extensive production systems and establishing cooperatives (ES-COP) in traditional production systems, respectively. The baseline analysis clearly showed that intensive farms have competitive advantages in producing milk. The adoption of improved management and policy would further decrease the cost although the level of decrease is highest in intensive and lowest in traditional production systems. This study, therefore, might be useful to decide on dairy development strategies by using improved management strategies to increase milk production to feed the growing urban consumers at competitive price in the era of increasing urbanisation in Bangladesh.

Keywords: Cost of milk production, management strategies, policy, urbanisation

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Site Selection Criteria for Locating Innovation Platforms in a Dairy Development Project

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Within the rural research and development communities innovation platforms are promoted as an efficient approach to stimulating change and achieving development goals. This paper discusses the selection of sites for locating innovation platforms within a dairy development research project on the basis of results from the initial innovation platform meetings. A village census was conducted in 93 villages of 2 sub-districts (Sult, Almora district and Bageshwar, Bageshwar district), covering variables such as marketing channels, dairy animal populations, active institutions, road accessibility and feed resources. Subsequently, 10–30 settlements (in 4–6 villages) were grouped into a total of 12 potential innovation platform clusters, based on their vicinity and interaction. Within each sub-district 2 of these clusters were selected, one with a high potential for dairy development and one with a medium potential. Potential is defined by dairy animals, cultivated land, quality of milk marketing channels and road accessibility. Innovation platform meetings are being held at regular intervals for developing the dairy value chain and for improving feeding systems. The discussions have been recorded in structured templates. Unsurprisingly, the high-potential cluster in Sult, Baseri, has quickly developed formal links with the state dairy co-operative and is interested in introducing new technologies such as concentrates or cross-bred cattle. However, platform members in Saknara, the medium potential cluster in this sub-district, are also discussing the establishment of a milk collection centre and are developing feeding interventions in their IP meetings. On the other hand, the high potential cluster in Bageshwar, Sainj, seems so crowded with development initiatives and institutions that it appears difficult to concentrate on specific constraints and actions. Finally, the mid-potential cluster in this sub-district, Chhona, is hardly showing any interest in improving dairy marketing or production. Here a large part of the community works at the local mine and depends on neighbours for milk. Thus, when estimating the potential interest of communities in marketing and production innovations the physical factors considered in the village survey appear to be valid where the social context is similar. However, including more social indicators seems to be especially important where the context shows considerable variation.

Keywords: Dairy development, innovation platform, site selection

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Determining Feed Resources and Feeding Circumstances: Usefulness and Lessons Learned by Applying FEAST in Tanzania

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Feeds and feeding for livestock are among the major constraints towards improved productivity in smallholder systems. This drove the need to devise a rapid, systematic and technical tool that addresses feed issues. The Feed Assessment Tool (FEAST) was developed to aim for optimising feed utilisation through designation of intervention strategies based on available feed resources. The tool collects both qualitative and quantitative information through focus group discussions (FGDs) and brief interviews. FEAST is among the components of the IFAD-funded 'MilkIT' project that runs in India and Tanzania. In Tanzania, over 22 FEAST half-day meetings involving 300 farmers (52 % male, 38 % female, 10 % youth) in FGDs and 101 individual interviews have been conducted in the regions of Pemba, Morogoro and Tanga since first training of trainers took place in July 2012. Thirty seven staff members from various institutions were trained on applying the tool. Application of FEAST in the field enabled identification of local feeds and feeding practices in the context of the dairy value chain. The tool enabled participating livestock keepers to identify key constraints and opportunities through pairwise ranking, providing crucial entry points for strategizing future interventions. Among the key issues raised by participants were land and water shortage, gender aspects, marketing, breeding bulls and child labour. Despite the obvious lack of feed, particularly in the dry season, livestock keepers rarely ranked this among the five most important challenges. An additional instrument may have to be developed to identify the links of these other challenges to and the indirect effects of them on feeds and feeding. Further experiences obtained during the FEAST sessions were that a short training on the tool benefits facilitators and interviewers. FDGs should not be held with more than 20 people because otherwise different views may not be expressed. It is equally important that local leaders or extensionists need to choose FEAST participants meaningfully to represent the full array of wealth classes, gender and production systems in a village. These and other experiences will help to improve the tool that is readily available on the internet under http://www.ilri.org/feast.

Keywords: Dairy value chain, feed, feeding, focus group discussion, seasonality, Tanzania

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Assessing Feeds and Feed Availability for Dairy Cattle on Pemba Island of Zanzibar, Tanzania

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Pemba Island is part of the Zanzibar archipelago, forming one of the administrative regions of the United Republic of Tanzania. A high proportion of Pemba's population is rural, where agriculture marks an essential contribution to livelihoods with an essential part formed by livestock production. Population density is high and considerable rural poverty exists. Since the islands have become tsetse-free in 1997, the cattle population has steadily increased, consisting predominantly of local cattle, so-called 'Zanzibar Zebu' type. Despite relatively low productivity/cow, milk production has increased in Pemba also due to the introduction of improved cattle, although their population is still small (<3 %) and more prevalent in the rural-urban domain. To identify potential for feed interventions by the IFAD-funded 'MilkIT' project, the dairy value chain was investigated on Pemba Island in July 2012 by the International Center for Tropical Agriculture (CIAT) and the International Livestock Research Institute (ILRI) in collaboration with local partners. The rapid Feed Assessment Tool 'FEAST' was applied in two group sessions with overall 37 producers (7 women) to appraise feed availability. Results combine findings from two focus group discussions and 13 individual interviews. Local cattle are mainly tethered under shade and graze on open land, *e.g.*, along roadsides. Improved cattle are stall-fed with cut-and-carry grasses and often supplemented with feedstuffs, like pollard, maize bran, rice polish, minerals, and coconut or sunflower cakes. Collecting naturally occurring forages is the primary component of the feed base throughout most of the year, second is grazing. Because of land scarcity, only about half of the farmers established plots with improved forages, such as Signal (*Brachiaria decumbens*) and Napier grass (*Pennisetum purpureum*), or harvest leaves from planted trees/shrubs like *Gliricidia sepium* and *Leucaena leucocephala*. Planted forages contribute substantially to feed quality throughout the year. Strong seasonality affects grazing opportunities that drastically reduce during the dry season, December to January, when crop residues are plentiful; however, little use seems to be made of these residues. Although feeding has scope for enhancement, key conclusions were that, instead of further increasing production, promoting and marketing of milk and milk products are more important currently.

Keywords: Dairy value chain, feed, focus group discussion, improved forages, seasonality, Tanzania, Zanzibar,

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Adaptation of Peri-Urban Cattle Production Feeding Strategies to Environmental Changes in Southern-Benin

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This study aimed at a characterisation of the diversity of peri-urban cattle production systems in southern Benin and at a better understanding of herders' strategies and perspectives in meeting their herd's feeding requirements. One hundred and twelve (112) farms were surveyed using a semi-structured questionnaire. The information collected included the socio-economic characteristics of the farms, feeding and herding practices, herders' perceptions of changes in feed resources' availability and of their driving forces. Categorical principal component analysis and two-step cluster analysis were performed to classify the surveyed farms into more homogeneous groups of farms reflecting different farming systems. Subsequently, the logistic regression technique was used to predict the adaptive strategy of a given farm in function of its socioeconomic characteristics. Four distinct types of cattle farms were identified: large integrated agro-silvopastoral farms (LAS, 17 %); small agro-silvopastoral farms (SAP, 28 %); non-integrated farms (NIN, 30 %) and silvopastoral farms (SIP, 25 %). These groups of cattle farms differed significantly ($p < 0.001$) according to several characteristics of the farm, including land sizes, source of labour, feeding practices and constraints. Herdsmen perceptions of feeding constraints differ from one farm type to another. However, the low availability of pasture (94 %) and the difficult access to pasture (100 %) were commonly shared by all herders and were perceived as resulting from increased crop and vegetable farming (77 %), urbanisation (25 %) and climate variability (40 %). Herdsmen current coping strategies included the use of lowlands pastoral resources (78 %) and exploring new grazing routes (60 %). Their future coping strategies in case of worsened environmental conditions include inter alia moving animals from the peri-urban area to rural locations (43 %) and this choice significantly depends ($p < 0.001$) on the farm type and the distance to urban centres.

Keywords: Cattle farming, environmental changes, feeding strategies, typology, urban fringes

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Approaches for Sustainable Community-Based Native Chicken Raising, Sam Sung District, Khon Kaen Province, Thailand

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The feasibility study on the sustainable development approach for the community-based native chicken raising aims to assess the current system, development needs, and approaches for the improvement of native chicken raising. The target communities were the Swang and Sam-Ong village, Houi Toei sub-district, Sam Sung District, Khon Kaen Province, Thailand. Forty-one native chicken raising households were studied by using a semi-structured interview and an adopted rapid rural appraisal method.

The results revealed that native chickens were commonly held in an extensive system and raised by any household member. Native chickens were well adapted to the local ecosystem and the localy available feed resources. Technological aspects were commonly based on the existing indigenous technical knowledge that is transfert from generation to generation. The purpose for raising chickens was mainly for home-consumption (average consumption of 16.3 $\pm$4.8 birds per household per year), and partially selling. The feeding resources were based on by-products of rice and crop residues, as well as on pesticide-free vegetables grown in the community.

The major areas of improvement were: 1) raising infrastructure and 2) parasites and diseases prevention. Respondents reflected the high feasibilities and further development of the community-based native chicken raising in their village. The supply chain system from chick-seeds production, fattening, processing and local marketing should be strenghtened. In this way a sustainable chicken production can be established which will forward food security and poverty reduction.

Keywords: Community-base, Native chicken chick-seeds, supply chain, Thailand

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Adaptation Strategies to Climate Change for Productive and Reproductive Performance of Desert Sheep in Semi-Arid Zone, Sudan

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Climate change has great impact on livestock production systems in semi-arid zones, such as traditional nomadic systems.

Two experimental studies were carried out to decrease the impact of climate change on sheep productivity in north Kordofan state. In the first experiment 340 ewes and 18 rams of desert sheep were selected from the nomadic herds, animals were divided randomly into four groups, group one was as farmer's practice (no supplement) and the other three groups were supplemented. The breeding is controlled by tiding the reproductive organ of the rams, this application is known by nomadic herders as "Kunan" and applied during the breeding season (February to March). The birth of the lambs occurres in the rainy season. The study indicated the importance of the nutritional status of ewes at mating and supplementation improved the productive and reproductive performance. The improved nutritional status of the animals made them better adaptable to environmental changes on rangeland. The study showed that supplementation and application of Kunan are very important strategies to adapt environmental changes in semi-arid zones.

In the second experiment 32 ewes were selected, the ewes were in late pregnancy. The animals were divided into 4 groups, three groups were allocated to supplementation diets and the last group was the control as in farmer practice. Animals were maintained on pasture and supplemented with treatments until day 60 post-partum. Live weight of delivered ewes and lambs were recorded at birth and weekly till weaning weight. The results indicated that supplemented ewes had improved body weight and the birth weight of the lambs were higher.

Keywords: Adaptation strategies, climate change, ewes, lambs, Sudan

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Agricultural production

Plant production systems within the rural-urban continuum

A Biological Control Pipeline for Cowpea in West Africa

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We are presenting past and current activities leading to the development and deployment of a 'biological control pipeline' for addressing insect pest problems in cowpea (*Vigna unguiculata*) from a West African perspective. Biodiversity and population genetic studies are catalyzing the identification of novel biological control candidates, which are subsequently assessed for their potential in sustainably reducing pest populations. Eco-climatic suitability, but also more technical aspects such as colony establishment, rearing methods, ex-ante socio-economic assessment are also taken into consideration as crucial factors for identifying successful candidates. Pre-release assessment studies are targeting critical questions such as potential impact on biodiversity and biosecurity in general. Also, experience from the field has indicated the importance of the right deployment system for establishing a population of the released natural enemy through inoculative releases. Using the case study of the legume pod borer Maruca vitrata, the presentation leads through the various steps of the pipeline, including challenges and opportunities for partnerships with *e.g.* social enterprises. The same pipeline approach is also illustrated for the development of bio-pesticides against the same target pest, as one of the valuable components of integrated pest management (IPM) for cowpea.

Keywords: Bio-pesticides, biodiversity, cowpea

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Different Maize Cultivars Overcome Climate Change Deleterious Effects at Regional Level – Hybrid and Community-Developed Cultivar

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Maize is one of the world's most important cereals, cultivated in a wide range of environments, and for various purposes. Understanding climate change and its impacts on crops is crucial to determine anthropogenic responses. Simulations of climate change impact in agricultural systems using crop models are often run for individual sites with a single cultivar. This approach, besides generating important information, limits its benefits of the results, especially regarding regionalisation and use of distinct crop cultivars (particularly locally developed cultivars). The objectives of this work are to assess i) the impacts of climate scenarios on maize production in Santa Catarina State, Brazil and the ii) effect of contrasting maize cultivars (commercial hybrid AS1548 and open-pollinated MPA01, selected through participatory processes with peasants) and five planting dates as adaptation strategy. The location of agricultural land use (>800 thousand ha) was mapped using satellite images and GIS, allowing the coupling of soil (1:250000 scale) and weather information for the crop modelling procedure CERES-Maize. Seven climate scenarios from regional circulation models (RCM) were tested. Simulations of impact on yield were done with an ensemble of four RCMs (LMDZ+IPSL+RCA2+RCA3) that was able to mimic the past 30 years of observed yield. Results showed that the identification and allocation of agricultural areas permitted the crop model to accurately simulate present yields and match census data of production. Once crop model, RCMs and regionalisation processes were validated, simulations for 2012–2040 using different cultivars and planting dates were run. Simulations for 2012–2040 without adaptation strategies (actual management) showed reductions of 13.5 % in regional maize production. When using the best cultivar for each area (AS1548 or MPA01), total production was 6 % higher than present level; when using both adaptation strategies – cultivar and best planting date – total production increased by 15 %. This analysis showed that cultivar and planting date are feasible adaptation strategies to mitigate effects of climate changes, and crop models can be successfully used for regional assessments. Furthermore, results indicate at refined level the best cultivar and planting date. Finally, it confirms that local cultivars are too a feasible alternative to cope with climate change effects.

Keywords: Adaptation strategies, corn, impacts of climate change, landraces

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Virtual Crop Modelling for Technology Impact Assessment - Lessons from a Potato Crop Growth Model

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Efforts are under way in the agricultural research for development community to employ crop growth simulation models for the *ex-ante* assessment of the impacts of agricultural technologies, in particular improved crop varieties. The approach, dubbed "virtual crop modelling", consists in the manipulation of genetic coefficients of the cultivars contained in crop growth models to simulate productivity effects of genetic improvements brought about by future breeding efforts and assesses the impacts of these improvements under field conditions. However, the suitability of the models for this purpose is not yet proven.

In an effort to explore the suitability of crop growth models for virtual crop modelling, the DSSAT-SUBSTOR potato growth model, a model which simulates potato growth as a function of abiotic, but not of biotic factors, is used to carry out a sensitivity analysis of changes in genetic coefficients of a modern tropical potato cultivar. Yields are simulated across a wide range of genetic coefficients of the crop model at sites located in four contrasting tropical, subtropical and temperate environments.

Simulation results show that the model responds to parameter changes as expected and that it gives meaningful results in all tested environments. Site characteristics appear to play an important role for potential simulated yield levels and for the responses of the model to changes in genetic coefficients. However, there is substantial unexploited potential for productivity growth from improved management practices. This potential appears to be greater than the benefits from genetic improvements that appear likely today.

The analysis shows that, by helping to identify yield constraints for different environments, crop modelling can make substantial contributions to *ex-ante* impact assessment of agricultural technologies. Virtual crop modelling, however, is only a viable option if crop growth is actually constrained by those genetic factors which are represented by adjustable genetic coefficients of a given crop model. Furthermore, the scope of many crop models is limited to abiotic yield-limiting factors and an extension towards biotic factors, *e.g.* a linkage with disease models, might be necessary for some environments.

Keywords: Crop improvement, crop modelling, DSSAT, *ex-ante* impact assessment, potatoes, SUBSTOR

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Agricultural Use and Vulnerability of Small Wetlands in East-Africa

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Research on small wetlands in East-Africa has been largely neglected in the past. The majority had been unused until the mid 1980s. Rapid population growth and associated demands for food have lead to increasing conversions of wetlands into sites of food production since then. Some wetlands remain resilient when taken under cultivation while others collapse after a few years. A collaborative research project has been established in 2007 to understand the underlying reasons from agronomic, ecological, economic, geographical and hydrological viewpoints. This presentation summarises its main findings.

51 wetlands and their subunits were initially inventoried in a 484 km^2 survey area in Kenya and Tanzania. Five major cluster groups were identified comprising (1) largely unused narrow permanently flooded inland valleys, (2) extensively used wide permanently flooded inland valleys and highland floodplains, (3) medium used large inland valleys and lowland floodplains with seasonal flooding, (4) completely drained wide inland valleys and highland floodplains under intensive cultivation, and (5) narrow drained inland valleys under permanent horticultural production. Main drivers of wetland use change are land scarcity in upland areas, physical access, water availability, and market proximity.

Detailed multidisciplinary studies were carried in two floodplain (Pangani river, Laikipia) and two highland wetlands (Mt. Kenia, Usambaras). The two highland wetlands were generally more productive and less vulnerable than the two floodplain wetlands. Degradation and ecological regime shifts were primarily caused by drainage beyond the water supply level. Spatial-temporal soil water availabilities differed between the highland and floodplain wetlands. Prolonged cultivation lead to stronger declines in soil C and N in the floodplain wetlands than in the highland wetlands. Changes in vegetation composition reflected alterations in hydrologic and edaphic conditions. A fieldbook of indicator species was produced to enable decision makers to assess the consequences of their management actions. A household survey was carried out in 275 randomly selected farms. 12 farms types were identified based on different combinations of land attributes and production objectives. Highland and lowland wetland characteristics were reflected in remote sensing surveys. Analyses of historical land-use maps revealed temporal patterns in use changes.

Keywords: Agricultural use, East-Africa, vulnerability, wetlands

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Improving Smallholder Groundnut Production Systems through use of Composted Rock Phosphate – A Case Study at Mutare, Zimbabwe

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Phosphorus (P) deficiencies are limiting crop production in many agricultural soils worldwide where conventional fertilisers are inaccessible. Continuous cropping in the absence of external nutrient inputs to soils has led to unproductive farmland due to loss of nutrients including P. This has been made worse by the abandonment of traditional methods of land fallow that were important in soil fertility conservation. Groundnuts are among the most widely grown legumes for food and nutrition therefore their production needs to be improved. Alternative sources of phosphorus replenishment to soil should be able to increase yields and ensure food security in the smallholder agriculture where access to fertilisers is poor due to unaffordability. There is significant response of the composted rock phosphate (RP) on available P and yield. Increase in rate of RP results in increased P solubility thus availability to the groundnut crop. Legumes are effective in dissolving RP and in absorbing its dissolution products because of their demand for Ca and the acidifying effect of nitrogen (N) fixation in the soil near the root system (rhizosphere). Composting RP results in higher levels of P compared to uncomposted RP as a variety of microorganisms such as fungi, bacteria and actinomycets solubilise different insoluble inorganic phosphates and make P available to the groundnuts through the formulation of humic acids and chelating agents that form complexes, dissolving P from the phosphate rock. Great benefit can therefore be derived from composting RP with different crop residues. Apart from enhancing P availability and solubility, the N fixed in the legumes may also contribute to the yields thus giving a double impact, N and P, which are the most limiting nutrients in smallholder production, therefore improving yields and contributing to food security in Africa.

Keywords: Composting, dorowa phosphate rock, groundnut, P dissolution

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Evaluation of Total Protein, Starch and Hordein Gene Expression Profiles of Three Field Grown Kenyan Barley Genotypes Grown under Different Nitrogen Regimes and Seeding Rates

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Barley (*Hordeum vulgare* L.) suitable for brewing purposes is characterised by low grain protein and high starch content. Storage protein of barley is an important trait influenced by the growing environments. Nitrogen rich volcanic soils in major barley growing zone in Kenya have resulted in production barley with undesirable malting properties. We performed biochemical and molecular analysis to gain insights on grain quality under critical nitrogen requirements. An evaluation of different level nitrogenous (N) fertiliser application and seeding rate on seed protein and hordein expression profiles of two row barley were investigated using three commercial varieties used by the East African Malting Company in Kenya. The relationships between the traits were examined. Analysis of variance showed that there was significant difference in total protein content within the genotypes. A significant difference in D hordein was observed only in one genotype at 40 and 50 kg ha^{-1} N fertiliser dose. Formation of D fractions was genotype dependent. Only two genotypes contained D, C and B fraction across the nitrogen levels. The data on gene expression is under progress.

Keywords: Barley, hordein polypetide fraction, hordein gene profiles, *Hordeum vulgare*, nitrogenous fertiliser, SDS-PAGE

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Genome Wide Association Studies Targeting Adaptive Traits for Low Phosphorus Soils in West African Sorghum

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An important impediment to agricultural crop production in sub-Saharan Africa is low phosphorus (P) availability in soils which affects about 75 % of the available agricultural land. Sorghum (*Sorghum bicolor* L. Moench) is one of the most widely grown crops in the region with the grain being important for food security and the stover increasingly used for livestock feed. Plants possess many mechanisms for adaptation to low P availability, including physiological traits, root morphology and mycorrhizal symbiotic relationships. Understanding the genetic basis and role of these traits is important for their consideration in breeding programmes targeting improved P acquisition in P deficient soils. Objective of the present study was therefore to dissect the genetic basis of sorghum adaptation to low P soils using genome wide association mapping. Association mapping is a powerful technique for high resolution mapping of loci underlying quantitative traits.

A total of 188 West-Central African sorghum lines were phenotyped at 38 days after planting for traits such as mycorrhizal root colonisation, crown root architecture, shoot biomass and shoot P content in a pot trial using low P soil (5.6 ppm Bray-1 P) at ICRISAT-Mali. We observed significant genotypic differences for these traits. Their relationship to sorghum growth and yield performance under low P field conditions is presently being investigated. Furthermore, the 188 sorghum lines were genotyped with 308 000 SNPs through genotyping-by-sequencing (GBS). Currently we are associating the phenotypic data with the genotypic data to identify possible quantitative trait loci (QTL) and specific candidate genes for these adaptive traits for low P soils. We will present our findings and discuss the possible future use of these traits and markers in different breeding programs. Identified gene loci and markers derived from this study are expected to facilitate effective sorghum breeding strategies and possibly enhance sorghum productivity under low-input conditions in West Africa.

Keywords: Adaptation traits, association studies, breeding, low phosphorus soils, mycorrhiza, sorghum

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Genome Wide Association Study for Exploring Salt Tolerance in Barley

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System inherent salinity is a major constraint to barley production in many barley growing areas. In combination with a shift in seasonal vapour pressure deficit (VPD) patterns, salinity effects on the crop may increase at several development stages of the crop. Salt tolerance is a complex trait due to constant interactions between genes and their environment. Therefore, robust screening techniques and tools are necessary for identifying novel heritable traits and genes that confer salt tolerance. Thus, this research aims at elucidating the relationship between the barley genome, its plasticity for genotypic adaptation to combinations of salinity and VPD stress as well as the morpho-physiological traits involved at different development stages of barley. A diverse set of 216 spring barley accessions of worldwide origin (constituting of both the six row and two row spike morphology types) were initially screened at emergence and early seedling stage at three salt concentrations (250, 340 and 420 mM NaCl) and under control conditions. Subsequently, these genotypes were grown on hydroponics within a phenotyping platform and were exposed to varying VPD levels (0.73 and 1.85 kPa) in addition to salt level of 200 mM NaCl. Using genome wide association studies (GWAS) employing 9K SNP markers (iSelect assay), we aim to explore the genetic variation for salt tolerance in barley for traits such as seed germination rate, mobilisation efficiency of endosperm reserves, biomass accumulation, tiller number, leaf area and plant height for the aforementioned stress combination. The robust phenotypic data and genome wide markers will be used to detect and validate QTLs for salt tolerance in barley.

Keywords: Genome wide association study, *Hordeum vulgare*, quantitative trait loci, salt tolerance, single nucleotide polymorphism (SNP), Vapour pressure deficit (VPD)

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Genetic Analysis of Vegetative-Stage Drought Tolerance in Cowpea

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The continued improvement in the yield of cowpea for the semi-arid regions where it is a dominant crop will record rapid progress if the genetic basis for yield under different moisture regimes is better understood. This study investigated the genetic combining abilities and heterosis for grain yield, yield components, earliness to flower and biomass production among diallel hybrids derived from nine cowpea genotypes. Hybrids and their parents were evaluated under adequate soil moisture conditions and conditions of soil moisture stress during the first 30 days of growth. Results showed that soil moisture stress significantly reduced grain yield, biomass production, and the number of pods per plant. Grain size however, increased under moisture stress. Only for grain yield was a significant interaction of moisture regimes and genotypes observed. Genetic control for grain size, number of seeds per pod and days to flowering was dominated by additive genetic effects. For these traits, mass selection is judged adequate to make selection gains. For grain yield, both additive and non-additive genetic effects were dominant, but the greater influence of non-additive effects was observed under both adequate soil moisture and moisture stress conditions. The genetic control of yield under the two soil moisture conditions indicated that grain yield improvement will be more challenging for drought prone regions compared with regions with adequate soil moisture. Nonetheless, careful selection of genotypes that have complementary but different alleles for yield under different soil moisture conditions might permit yield improvement through recurrent selection systems. This study has identified parental lines, developed populations, and provided a breeding strategy for developing cowpea cultivars with higher grain yield potential for the Guinea and Sudan savannah regions of West Africa.

Keywords: Combining abilities, cowpea, developing cowpea cultivars, diallel hybrids, drought tolerance, heritability, heterosis, trait correlation

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Towards a Protocol for Double Haploid Production in Pearl Millet using Wide Hybridisation

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an important allogamous staple cereal in the semi-arid tropics (sub-Saharan Africa and South Asia). A protocol for doubled haploid (DH) production in pearl millet could facilitate genetic studies as well as crop improvement (via recurrent DH selection) including hybrid breeding. The objectives of the study were to develop a production system for doubled haploid pearl millet through wide crossing and to investigate the haploid induction rate (HIR) of a maize inducer line (RWS). A cytoplasmic male-sterile (CMS) pearl millet (A) line was crossed with regular maize (cv. Gama), inducer maize line (RWS), inducer hybrid (G1F1), sorghum, triticale and a fertile pearl millet (control). Embryo development was triggered by 2,4-D treatment 24 h after pollination and florets/ovaries/embryos were cultured *in vitro*. Simultaneously, grains were obtained from the mother plants of all wide crosses while selfed female plants proved to be fully sterile. Few green and albino plants were regenerated from rescued embryos, however all died after transplanting to soil. Grain setting efficiency varied from 38.1 (regular maize) to 4.3 (RWS) grains per pollinated panicle with a germination percentage of 22 to 50 %. Flow cytometric analysis of the candidate haploid plants revealed haploid induction of 29 out of 146 plants investigated from all crosses with the HIR amounting to 1.6 to 10.5 % in crosses with G1F1 followed by sorghum (6.6 %), triticale (8.0 %), RWS (8.3 %) and Gama. Although no phenotypic markers were observed to identify the haploids, there was retarded endosperm growth in most of the crosses. Haploid panicles exhibited inferior morphological performance such as stunted growth and missing development of floral organs and were completely sterile. The protocol needs to be further investigated with regard to reproducibility before it can be considered useful for breeders. The mechanisms of haploid induction need cytological examination for the insertion of paternal chromosomes and the occurrence of spontaneous chromosome doubling. Morphological markers also need to be developed to facilitate straightforward identification of haploids after wide crossing. Haploids will be subjected to colchicine treatment for DH production.

Keywords: Double haploid, flow cytometry, pearl millet, wide hybridisation

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The Potential of Wild Yams to Improve Food Security on the Mahafaly Plateau in Southwestern Madagascar

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While yams constitute a staple food in many other African countries, they are traditionally used as substitutes during periods of drought and food insecurity in rural areas of Madagascar. The diversity of yams in Madagascar is particularly rich with altogether 41 species of which 27 are endemic. In our study region on the Mahafaly plateau in the semi-arid region of southwestern Madagascar, wild yams collection is practised by 87 % of the households. Based on semi-structured questionnaires, data on wild yams collection, usage and consumption was collected for 218 households in four villages. Altogether, six species of wild yam (*Dioscorea ovinala* Baker, *Dioscorea alatipes* Burk. & H.Perr., *Dioscorea nako* H.Perr., *Dioscorea fandra* H.Perr., *Dioscorea bemandy* Jum. & H.Perr, *Dioscorea soso* Jum. & H.Perr.) were identified as important source of food during lean periods, to substitute cassava and maize.

Hot spot areas for wild yams collection comprised a total area of 350 km^2. To determine the distribution and abundance of the different yam species, a systematic sampling approach in a hot spot region was used (N = 58 plots), covering different soil and vegetation types. For each plot (size = 400 m^2), abundance of harvestable yams and number of yams seedlings, the number and age of harvesting holes, which are left open after tuber extraction and soil samples were taken. The use of interpolation methods and collection of additional geospatial data (soil and vegetation maps) within a GIS allowed mapping of the distribution of the yams species.

Age and number of harvesting holes are correlated with the species regeneration rate. Tubers of *D. alatipes* and *D. bemandry* are collected most frequently. Since trade and sale of tubers is increasing on local markets, traditional methods of tuber harvest contribute to the extinction of this resource leading to low densities of harvestable tubers and soil degradation (harvesting holes). The distribution mapping of wild yams will allow to define pressure zones and serve as a basis for the establishment of conservation and management strategies of forest resources such as yam.

Keywords: Food security, Mahafaly plateau, wild yams, yams distribution

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Effect of Seed Priming on Rice Seedling Vigour under P-deficient Soil Conditions

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Rice is a staple crop of Asia. However, P-deficient soils, coupled with lack of resources and access to fertilisers cause low yields. Hence, there is a need for simple strategies with low cost measures to suit low-input farmers. A greenhouse experiment was conducted at the International Rice Research Institute (IRRI), Philippines from August to October 2012 to test the effect of water and P priming under P deficient conditions on early plant vigour. A set of contrasting genotypes: Apo, DJ 123 and Sadri Tor Misri (both with high and low seed P) and Near Isogenic Lines (NILs) IR74+Pup1 and IR74-Pup1 were selected for the study. The specific treatments were control (unprimed seeds), water priming (soaking seeds in water for 24 h), and P priming (soaking seeds in 200 mM KH_2PO_4 for 24 h). All seeds were dried to approximately 14 % moisture content before seeding. The substrate was a P deficient soil (2.35 mg P kg^{-1}) collected from a farmer's field in Kapatalan, Siniloan, Laguna, Philippines. The plants were grown at "field capacity" conditions and harvested 35 days after seeding. At harvest, plant height was taken. Additionally, shoot and root weight as well as P content and uptake were also determined. These parameters were used to assess plant vigour. All parameters from water and P-primed genotypes were significantly higher than the control (unprimed genotypes). Water priming significantly increased all parameters of Apo, DJ 123 and Sadri Tor Misri (both with high seed P) while P priming significantly increased all parameters of Sadri Tor Misri (low seed P). On the other hand, both water and P priming significantly increased all parameters of DJ 123 (low seed P) and the 2 NILs (IR74+Pup1 and IR74-Pup1). Although genotypes had different reactions to priming, all these findings showed that water and P priming increased seedling vigour of rice.

Keywords: *Oryza sativa*, P uptake, phosphorus, seed priming, seedling vigour

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Linking Stable Isotope Methods and Electrical Resistivity Tomography Imaging: Improving Our Understanding of Competition in Poly-Culture Systems

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Poly-cultures are cropping systems using multiple crops in the same space and time, avoiding large stands of sole crops, hence contributing to reconciliation ecology. These land uses have several advantages over monocultures, *e.g.* increased biodiversity and diversification of agricultural production. Coupled with soil conservation measures, they also contribute to erosion control and resource protection in fragile areas. The viability of such systems often depends on their efficiency under limited resource conditions, which in turn makes them acceptable among the farming community. Most farmers, however, are reluctant to adopt such systems because they may compete for water and nutrients. This study was conducted during 2011 on the Queen Sirikit research farm, Ban Bo Wi village, Ratchaburi province, in North-West Thailand to investigate the competition in maize based soil conservation systems. The soil at the field site ranged from an endoleptic Alisol to ahyper skelletic Leptosol. The treatments were maize under farmer's practice (control) and maize-chili intercropping combined with alley cropping of Leucaena under minimum tillage and Jack bean relay cropping with and without fertiliser application. Plot size was 4 m by 13 m and slope of 18–20 %. We used both carbon isotopic discrimination and electrical resistivity tomography (ERT) imaging, a novel non-invasive method, to understand and distinguish the competition for water and nutrients in tropical field conditions. A negative relationship was observed between ^{13}C isotopic discrimination and total nitrogen in grain with R^2 ranging from 0.63 ($p \leq 0.01$) to 0.70 ($p \leq 0.001$) while a positive correlation was found between total nitrogen in grains and total dry matter production with R^2 ranging from 0.51 ($p \leq 0.04$) to 0.84 ($p \leq 0.001$). Nutrient competition induced an increase in $\delta^{13}C$ values in maize rows close to Leucaena hedgerows and decreased their total dry matter production. ERT imaging showed different water depletion patterns during the growing season, directly linked with the growth and development of maize such as leaf area index, plant height and canopy cover. This helped explaining the impact of hedgerows on crop growth and yields in maize rows adjacent to the hedges, leading to various spatial patterns along the slope.

Keywords: Competition, destructive methods, maize, non-invasive methods

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Indoor Plant Production Systems - Effects of Light Quality on Light Transmission Ratio of Rice Canopies

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Climate change related constraints to plant production such as extreme weather events, pests, and soil erosion are stimulating discussions on the feasibility of indoor plant production systems. Concepts are being considered that range from small scale units for specific biochemicals (biofarming) to industrial scale for production of vegetables or ornamental plants. Even though many environmental factors are modifiable in such systems allowing a high degree of control of the growing conditions of plants, artificial environments are far from meeting plant requirements for optimal growth and development. For instance, light intensity and light quality are being kept constant inside a growth chamber for the entire growth cycle despite the fact that light absorption patterns will change as a function of interactions between canopy development and structural components of the growth chamber. Changes in the physical properties of the canopy such as leaf area, leaf angle distribution and the appearance of generative organs may require adjustments over time in both light quality and light intensity to fully meet the requirements for optimal growth and development of the plant
To investigate these kinetics we measured the light distribution above, inside and below a growing rice canopy in a customized growth chamber with specifically developed LED panels. We show that the light transmission ratio of the entire canopy depends on light quality and and on chlorophyll concentration. In addition, we show to what extend the light reflectance and light diffusion properties of the inside of the the growth chamber affect overall light intensity and influence the illumination of lower canopy layers. These results contribute important aspects to the discussion on the optimal light quality for plant growth and specification of future lighting solutions such as LED or sulfur plasma lamps as here the light properties of the entire canopy are taken into account which affect canopy gross photosynthesis (productivity) and phenological development.

Keywords: Canopy extinction coefficient, growth chamber, LED, light penetration, light quality

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Spatial Variations among the Field Positions on Grain Yield and Environmental Impact of Paddy Rice Production in Southeast Asia

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Understanding the spatial variations in grain yield and methane (CH_4) emission is essential for site specific management recommendation for grain yield and mitigating CH_4 emission from paddy rice in Southeast Asia. To access the spatial variation in crop yield and CH_4 emission, field experiments were conducted in Yen Chau district, Northwest Vietnam and Kanyutkwin district, Myanmar. In Vietnam, two rice cascades were divided into fertilised and unfertilised parts and all measurements were conducted at top, middle and bottom field during spring and summer season in year 2011. In Myanmar, two successive lowland rice fields were divided into fertilised and unfertilised and measurements were done at inlet, middle and outlet positions of both rice fields in year 2012. For the fertilised field, farmers practices were conducted using sulfate and ammonia based nitrogen fertiliser.

In Vietnam silt, clay, total nitrogen and carbon content was found to increase from the upper field to the down filed. Grain yields in the middle fields of both rice cascades were higher than other field positions in both fertilised and unfertilised fields. The highest cumulative CH_4 fluxes were observed in bottom fields of both cascades in both crop seasons. Fertilisation significantly lowered cumulative CH_4 flux in both cascades. Economic analysis showed that top and bottom fields need more management practice to increase yield and net income. In Myanmar, sand, total nitrogen and total carbon content decreased from top to bottom, while silt content increased. Grain yields were significantly higher in positions closer to the channel. The highest cumulative CH_4 fluxes were observed in 1st outlet of 1st field and 2nd inlet of 2nd field. Fertilisation reduced CH_4 emission but the degrees of reduction were spatially dependent. Economic analysis showed that fields near the channel, no or few fertilisers is required to increase net income. But more fertilisers were needed in fields far away from channel to increase yield as well as net income.

To increase grain yield and net income as well as to mitigate CH_4 emission, site specific management using sulfate and ammonium based fertilisers should be practiced at both study areas.

Keywords: Ecobalance, grain yield, methane emission, paddy rice, spatial variation

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Traditional Uses of Weed Flora by Local Communities in Agriculturally used Wetlands of East Africa

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The status of biodiversity indicates that most ecosystems in East Africa are losing biodiversity at an alarming rate. This has compromised ecosystems functions and services with a resulting loss of livelihoods among local communities. One of the most impacted ecosystems by such trends are the small wetlands of East Africa. Land shortages and the degradation in most upland areas combined with a high production potential of wetlands is the single most important driver of the growing demand for wetlands resources. Clearing, drainage and cultivation of wetlands have created an ecological shift in species composition that promotes an opportunistic weed flora at the detriment of natural vegetation. We investigated the impact of the weed flora on the livelihoods of local communities within two floodplains, the Ewaso Narok swamp on the Laikipia plateau in Kenya, and the Pangani plain close to Malinda in the Tanga region of Tanzania. Land use gradients were classified as unused, abandoned (fallows) and cultivated areas (croplands). Weed species presence and cover were recorded in 117 plots measuring 100 m^2 each. Interviews were conducted with plot owners and key informants regarding the uses of the weeds. We used indicator species analysis to group the weeds relative to land use gradients. Some 330 species in 67 families were classified as weeds. Plots under crops had higher weed species richness compared to unused plots ($p < 0.007$). Five key indicator weed species were identified including *Cynodon dactylon* in completely drained and seasonally grazed plots; *Leersia hexandra* in moist hydromorphic plots, *Malva parviflora* in partially drained cultivated plots, *Oxalis corniculata* in drained cultivated plots, and *Typha domingensis* in alkaline flooded wetlands. A list of indicator species and their importance to the local communities has been established. Despite negative impacts of weeds on crop production, local communities use most weeds as traditional leafy vegetable or as medication against various ailments for both humans and livestock. While the conversion of wetlands into crop fields leads to an ecological shift from (semi)natural to weed-dominated plant communities as is viewed by ecologists, rural folks use the weeds as sources of food and medicine. Sustainable use of wetlands is however advocated, for ecological integrity and sustainability of rural livelihoods.

Keywords: Biodiversity, indicator species analysis, livelihoods, opportunistic species, regime shift, traditional medicine

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Nitrogen-Use-Efficiency in Maize-Based Farming Systems in Malawi: A Simulation and Meta-Analysis of Literature

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Degraded soils and poor soil fertility are the major constraints limiting agricultural production in small-scale farming systems of sub-Saharan Africa. Nitrogen-use-efficiency (NUE) in maize-based farming systems remains low as a consequence of unrealistic nitrogen fertiliser application recommendations, inherently low and highly variable soil fertility and resource limited agronomic management. By examining literature, the efficiency of on-farm N fertiliser response was evaluated by a meta-analysis of commonly reported agronomic use efficiencies of N fertiliser applications (N-AE) for Malawi. The N-AE is defined as the increase in grain yield per unit of fertiliser N applied. Therefore it is an important value to analyse and compare present management systems. Other than poor access to fertiliser and lack of resources to purchase fertiliser, inappropriate management practices and application rates have resulted in lower N-AE than expected. Commonly reported N-AE from on-farm evaluations was highest in moderate amounts of N fertiliser (20–30 kg N ha^{-1}) and ranged between 15 and 28 kg grain per kg N applied. In experimental trials N-AE values varied between 17 and 24, and simulated values between 19 and 25 kg grain per kg N applied. As soil fertility is generally low, additional phosphorus (P) fertilisation of 18 kg ha^{-1} significantly increased the N-AE in the experimental trials to a maximum of 65 kg grain per kg N applied. Overall, N applications exceeding 30 kg ha^{-1} seemed to result in decreasing N-AE. This paper also describes how the crop simulation models, such as the Agricultural Production System Simulator (APSIM), could simulate N and P fertilisation strategies under scenarios with varying planting time and density, fertiliser application rate and timing as well as weed management. This allowed the major drivers influencing on-farm NUE to be identified leading to more robust nutrient strategies for sustainable intensification.

Keywords: Agronomic N use efficiency, APSIM, farming systems, maize, Malawi

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Constraints in the Dissemination of Improved Groundnut Varieties in Malawi, Mozambique and Zambia

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Sub-Saharan African economies primarily rely on agriculture as income source, which makes the sector crucial for poverty reduction and food security. Investments should focus on inclusive and commonly cultivated crops. Groundnut represents a major alternative to improve the living standard of the community with its valuable nutrient contents and nitrogen fixating attributes as well as cash crop potential. NARS and ICRISAT collaborate to make groundnut more inclusive by upgrading yields and land expansion in Malawi, Mozambique and Zambia. However, the NARS have not yet achieved expected outcomes in the release of improved varieties and improvements of stagnant adoption rate.

Based on personal interviews with local and international scientists and high-profile authorities; this study aims to reveal the constraints that limit the NARS performance using the framework of institutional economics.

Mostly centralised and slow, the NARS are bound by their own procedures and bureaucracy. Compared with the extent of their activities, their resource endowment is low. Focused on the design of feasible policy measures to overcome institutional constraints, the discussion led to the conclusions.

Multiple principals and objectives tend to overestimate the resource need, which combined with un-efficient incentive schemes, impose a broken feedback loop between donors and agricultural beneficiaries. Substantial increments in the transactional costs of foreign aid diminish the efficiency of institutional arrangements.

Qualitative analysis demonstrates differences among the three countries and provides sufficient evidence to formulate policy measures that could improve governance showing credible commitment to invest in Agricultural R&D. Improved coordination of research projects and explicit Agricultural R&D agendas should guide their development strategies. In order to improve productivity and reduce the transaction costs, benevolent institutions should design a clearer incentive scheme, as well as an operational planning that will make organisations and human resources accountable for their actions.

Keywords: Agricultural Research and Development (AgR&D), agriculture policy, institutional economics, National Agriculture Research Systems (NARS), transactional costs

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Towards a Water and Nutrient Efficient Forages Production in Pakistan

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Agriculture is a major sector of Pakistan's economy providing food and employment to fast growing population. Livestock farming, the most important sub sector of agriculture, contributes more than 50 % in agricultural value added. Sustainable availability of green forage is critical to livestock farmers, as it is the most valued and economic source of feedstock. Pakistan's forage production is highly affected by non-availability of sufficient irrigation water and high costs of fertilisers.
To evaluate different forage crops with respect to water and nutrient efficiency, an experiment was conducted at the research farm of the University of Agriculture Faisalabad, Pakistan, during 2010-12. The experiment was conducted as a split plot design whereby main plots comprised three levels of fertiliser *i.e.* control (C), farm yard manure (FYM) and mineral fertiliser (MF), factorially combined with two irrigation intervals *i.e.* recommended irrigation (RI) and half recommended irrigation (HRI). Subplots randomised within each mainplot were assigned to the two cropping systems *i.e.* Egyptian clover + Maize (CS-1) and Oat + Sudan grass (CS-2). Data was recorded for dry matter yield (DMY), water use efficiency (WUE) and chlorophyll content (SPAD value). Data obtained (two years average) was analysed by statistical software MSTAT-C. DMY and WUE showed significant differences ($p < 0.05$) for all treatments and interactions except three way interaction of DMY that was not significant. Highest DMY (27.59 t ha^{-1}) was obtained for CS-2 in RI with MF, whereas maximum WUE (29.16 kg ha^{-1} mm^{-1}) was expressed by the same cropping system with FYM in HRI. Regression coefficient for SPAD at time "t" vs. DMY at time "t+1" was significant ($p < 0.05$) for all crops which revealed that SPAD value can be used to predict the yield during growth of the crops. It is concluded from the results that CS-2 is more water and nutrient efficient, while WUE of the crops in HRI is much better than for RI indicating the ability of crops to use limited water more efficiently. CS-2 can be suggested in the areas with limited water and fertiliser availability to improve the feedstock production.

Keywords: Chlorophyll content, dry matter yield, forages production, water and nutrient efficiency

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Efforts to Introduce Sugar Beet Crop in Sudan for a Sustainable Improvement of Agricultural Production in Rural Communities

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The industrial processing of agricultural products play an important role to improve farmers income. The sugar industry in particular has such a positive economic impact on farmers in Sudan. Sugar cane is the main crop for producing sugar in Sudan at the moment, and delivers about 50 % of Sudan needs for sugar. There is a need to increase sugar production for self satisfaction and possible export of this strategic commodity. However, insufficient water resources limit the increase of sugar cane acreage in Central and North Sudan. Sugar beet (*Beta vulgaris* L.) is an important alternative for sugar production, it needs less water and has a shorter cultivation period. The present study tried to investigate the possibility of introducing sugar beet in Sudan. The study focused on the suitability of various varieties of sugar beet to be cultivated in different parts of Sudan. Experiments were carried out at six locations and included 2-36 varieties per season and site. A number of varieties were found to be suitable under Sudan conditions and two varieties were released for commercial use. A number of field experiments were executed to study appropriate cultural practices. The results indicated that early sowing gave the best yield. Nitrogen fertilisation gave significant increase in yield. The study also showed that sugar beet needed 19 – 20 irrigations with an average of 200 – 300 m^3 of water per irrigation, while sugar cane needs almost twice as much. The optimum planting population was found to be 83 333 plants ha^{-1}. The study showed that sugar beet is highly sensitive to weed infestation and yield can be reduced by 85 % if weeding was delayed to 10 weeks after sowing. The study also showed that sugar beet was attacked by insects feeding on leaves such as *Spodoptera exiguae*, whereas three population peaks were recorded in the season. The study indicated that sugar beet can successfully be grown in Sudan for sugar production and can play an advantage role in improving the economy of rural communities.

Keywords: Cultural practice, Sudan, sugar beet, sugar industry, varieties

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Use of Remote Sensing Data to Assess Crop Yields and Food Security on the Mahafaly Plateau in SW Madagascar

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The rainfed, subsistence-oriented slash-and-burn agriculture on the Mahafaly Plateau is limited by the availability of water and nutrients throughout the year and is regularly faced with natural hazards such as drought events, cyclones and locust infestation. Consequently, food insecurity affects more than 68 % of the households and information on local food production and agricultural vulnerability are urgently needed. Our study, therefore, aims to develop GIS-based methods in combination with socio-economic data to assess food security at the household and field level.

High resolution aerial photographs and field inventory data of different years were used to establish detailed land use and cadastral maps and to analyse the land use dynamics for three selected villages. To assess crop yields, the following reference data for cassava and maize were collected on 10 fields per village over a period of two years: GPS location, crown cover, total plant height, aboveground (leaves and sticks) and belowground biomass (tubers) of cassava (n=80); Height, corn- and leaf biomass of individual maize plants (n=50). Additionally, the yield and plant cover of supplementary crops (beans, sweet potatoes and millet) was measured (n=10).

The most important staples on the Mahafaly plateau are cassava (*Manihot esculenta* L. Crantz) and maize (*Zea mays* L.), followed by beans (*Vigna unguiculata* L.) as a vegetable. Cassava occupies 77 % of the fields on the plateau and 55 % of the fields in coastal areas.

Based on aerial photographs the cover of individual cassava plants and total maize cover was calculated for all fields using object based image classification. Aboveground (R^2=0.70) and belowground (R^2=0.51) biomass of cassava strongly correlated with plant cover and the resulting regression formulas are used to extrapolate crop yields. The crop yields of the labour intensive, low-input agriculture are relatively low (2–5 t DM ha^{-1} for cassava), but the high diversity of cultivated crop species (n=36) with more than 70 varieties reduces vulnerability to natural hazards. Our results will be combined with socio-economic base data from household surveys to identify and assess household-level food security and food insecurity coping strategies.

Keywords: Biomass, cassava, food security, object based classification

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Application of Remote Sensing in Evaluation of Vegetation Change for Sustainable Development

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Sustainable forest management has become the primary goal of forestry institutions worldwide, as it involves managing forests to achieve production of continuous flow of services without excessive reduction of their future productivity. One of the significant initiatives for sustainable forest management is assessing forest change. In this paper a case study in semi arid forest (El Rawashda forest reserve, Gedaref State, Sudan) serves as a research site where a comprehensive coverage affords an evaluation of the vegetation change. Gedaref State lies in the zone of low rainfall woodland savannah on clay. El Rawashda forest is located near the transition between two main vegetation types of low-rainfall woodland savannah on clay: *Acacia mellifera* thorn land and *Acacia seyal-Balanites aegyptiaca* woodland.

Multi-temporal Landsat ETM+ and Aster data acquired during early dry season in 2000 and 2006 have been used for classification and mapping land cover. Training data were selected in easily identifiable areas of the following four classes: grassland, close forest, open forest and bare land. Following classification of imagery from the individual years, a post-classification, approach of subtracting the classification maps 2000 and 2006, was applied. An advantage of this approach is that it provides "from-to" change information. As part of our analysis we have compared area estimates from the Landsat classifications with aster classification. In our research, the potential to derive indicators of sustainable resource use from satellite remote sensing is discussed. Particular attention focuses on indicators related to land cover condition and type in semi-arid forest environments. This includes quantitative and qualitative assessment of forest cover change as well as the impacts of human and other biophysical factors on the forest. Each of these issues is discussed with emphasis on the potential to increase the level of information extraction beyond that derived with conventional approaches in order to obtain more usefull information for sustainable development practices.

Keywords: Forest change, remote sensing, sustainable development

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Remote Sensing Based Study on Land Cover/ Land Use Dynamics in Agriculture of Semi-Arid Lands, Eastern Sudan

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This study applied two different techniques of change detections: Matrix change detection of routine supervised classification and multivariate alteration detection (MAD). These techniques were used for mapping and assessing the land cover / land use dynamics of the semi arid lands in the Gash agricultural scheme, eastern Sudan, during the period 1972 to 2010. For that, four free cloud remote sensing data sets (multi temporal satellite images), were acquired for the years 1979 (MSS), 1987 (TM), 1999 (ETM+) and 2010 (Aster). These images were covering the study area, were geometrically, radiometrically, and atmospherically corrected to remove the distortions, and were classified for analysis using maximum likelihood classifier via Erdas imagine software. The analysis produced five land cover / land use classes namely: mobile sand land, high dense mesquite trees land, low dense mesquite trees land, stabilised sand land and cultivated land. The routine matrix change was applied to determine values and to map land cover change during the study period. A MAD was also applied as linear transformation to identify the change quality. Final results showed a noticeable rapid decrease of the cultivated land to 50 %, from 25.2 % to 13.8 %, as a result of accelerated and drastic increase of both the mesquite trees land (42.3 %) and sandy land (42.0 %) during the last period (1999-2010) of the study. Furthermore, the increase of both the mesquite trees land and sandy land affected the residential areas as well as threatened the Gash River course during dry season, consequently led to decreased arable cultivated land, and hence decreased crop production in the study area. The study concluded that remote sensing can be used to support mapping and assessing land cover dynamics and to provide more information on changes in vegetation, particularly for studies in semi arid regions.

Keywords: Gash agricultural scheme, land cover / land use dynamic, mapping and monitoring, remote sensing

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Crop Yield Responses to Climate Change in Nepal

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Crop yield in rainfed agriculture depends highly on seasonal climate patterns. The empirical relationships between crop yield and seasonal climate variables are important for predicting agricultural production. The study assesses the effects of seasonal climate variables on crop yield and the uniformity of effects across crops, growing seasons and regions in Nepal. Three tropical districts (Banke, Chitwan and Morang) in three regions (western, central and eastern) of Nepal and seven major crops as rice, maize, wheat, potato, lentil, chickpea and rapeseeds were considered. The observed district level average data of crop yields and seasonal climate variables (rainfall and temperatures) during 1976 to 2011 were considered for the regression analysis. A multivariate regression (time series) analysis was employed to evaluate the empirical relationships between crop yield and seasonal climate variables. The dependent variable in the regression equation was the first difference (change) in crop yield (ΔYield). The independent variables in the regression equation were the first differences (changes) of total seasonal rainfall, average seasonal maximum temperature, average seasonal minimum temperature, standard deviation of monthly rainfall, standard deviation of monthly maximum temperature and standard deviation of monthly minimum temperature. The regression analysis was done for each crop across corresponding growing season and district. The regression results yielded with the coefficient of determination (R^2) value ranges from 0.07 to 0.61. The regression results show that the climate variables significantly influence the crop yield, but not uniformly on all crops and in all growing seasons and districts. Increase or decrease of maximum and minimum temperature shows heterogeneous effects on yield of some crops. Deviations of climate variables within growing seasons also show heterogeneous effects on crops yields. The study concludes that the climate variables and their deviations across growing seasons are the important determinants of the crop yield. The effects of seasonal climate variables on crop yield depend on crop types, growing seasons and regions. The effects can be significantly positive or negative or insignificant. It is, therefore, difficult to generalise the effects of climate variables on crops yields.

Keywords: Climate change, climate variables, crop yield, regression analysis

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Investigation of Rainfall Characteristics in Sub-Saharan Africa and their Implications for Rain-Fed Agriculture

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Ninety percent of the rural population in sub-Saharan Africa is dependent on rain-fed agriculture. Considering the highly variable yields (in both space and time), the study of rainfall and its characteristics is crucial to understand local dynamics and develop region-specific adaptation strategies. Rainfall characteristics, *e.g.* beginning and end of the rainy season, number and length of dry/wet spells, number of extreme events or rain per wet day are impacting yields of crops. The aim of this work is to analyse rainfall characteristics and evaluate their impact on the yield of the main staple crop maize, using an agricultural model.

The analysis of rainfall characteristics for each season is carried out for the Upper Zambezi River Basin for the time period 1998 to 2010. A soil plant atmosphere system model (DAISY) is set-up on a cell by cell basis to simulate maize yields from rain-fed agriculture. The model is forced and calibrated using the satellite-based rainfall estimates TRMM-3B42v6 which were bias-corrected prior to this analysis; other meteorological data is obtained from the global dataset ERA-Interim. Finally, a Self-Organising Map (SOM) is utilised in order to identify rainfall characteristics showing a strong impact on agricultural outputs as well as to investigate region-specific patterns.

Results imply a significant spatio-temporal variability of both rainfall characteristics and resulting maize yields. The characteristics having the highest impact on yields are identified as the duration and number of dry spells as well as the duration of wet spells. In general, the north/northeast of the Upper Zambezi (sub-catchments Upper Zambezi, Kabompo and northern part of Barotse) experience longer rainy seasons and less dry spells. These parts also receive more extreme events affecting yields negatively. On the contrary, in the south/southwestern areas (Namibian and Angolian parts as well as the south of Barotse sub-catchment) less favourable conditions are observed in most of the years resulting in very low yields. The results of this study enable decision-makers and agricultural planners to develop appropriate adaptation strategies on a high spatial resolution.

Keywords: Agriculture, rainfall characteristics, satellite-based rainfall estimates, SOM, sub-Saharan Africa

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Options to Increase Yield Stability of Rainfed Maize in Drought-Prone Areas in the Central Highlands of Kenya

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Rainfed farming systems in the Central Highlands of Kenya have been experiencing low and declining agricultural productivity. High spatial and temporal variability of rainfall, reflected by dry spells and recurrent droughts is among the most important factors affecting agricultural productivity in the region. With this background, a study was set up with the objective of evaluating effects of planting dates, maize variety and rainfall variability on maize performance and to assess the performance of the water productivity model AquaCrop to predict the effects of these options on maize yields. The study was carried out in Mbeere and Maara Districts in Kenya, representing a low potential area in terms of agricultural productivity due to low and erratic rainfall. The trial followed a 3×2 split-plot design replicated thrice in randomised complete blocks. The main factors were three staggered planting dates (dry planting, wet planting and late planting) while the sub factors were two maize varieties. The trial results showed that, relative to late planting, dry planting increased maize stover yields by 53 % (significance $p = 0.05$) during the long rains season of 2009, followed by wet planting that led to a 19 % increase. During the short rains season of 2009, there was 27 % increase in the stover of dry planted maize while wet planting effect was not significant. There was no observed significant effect of planting dates on maize stover in long rains season of 2010 (LR10) probably due to relatively high amounts of rainfall. Due to early rainfall cessation in LR 2009, no grain yields were realised. In SR 09, dry planting increased grain yields by 77 % compared to late planting while wet planting effect was negligible (significance $p = 0.05$). In LR10, dry planting increased grain yields by 26 % while wet planting led to 24 % decrease probably due to the rainfall pattern during the onset of the season. The observed effects of planting dates were mainly caused by rainfall patterns and amounts. The study highlighted the importance of planting dates in relation to rainfall onset, pattern and amounts as a key farm management practice that has a direct impact on maize productivity.

Keywords: Agricultural productivity, dry planting, planting dates

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Intercropping Alfalfa with Maize is a Promising Agricultural Mode in Northeast Agro-Pastoral Areas of China

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In China, the northeast agricultural and pastoral area is an important grain commodity and animal husbandry base. However, there are a number of growing challenges to food and eco-environmental security as well as sustainable development of animal husbandry, owing to the unfavourable natural conditions and unreasonable utilisations of the population. It is crucial to find suitable intercropping modes between crops and legumes and to explore its advantages. Here, a field experiment was conducted as a completely randomised block design with five treatments: (a) maize monoculture in even rows; (b) maize monoculture in alternating wide and narrow rows; (c) alfalfa monoculture; (d) maize intercropped with 1 row of alfalfa in wide rows; (e) maize intercropped with 2 rows of alfalfa in wide rows.

Results showed that changing maize monoculture in even rows into alternating wide and narrow rows improved light intensity and transmission of the group, which promoted the growth and development of maize and enhanced its grain yield and output value by 6.8 %. Compared to monoculture, intercropping alfalfa with maize formed differentiation both in time and space, which optimised resource utilisation and enhanced comprehensive benefits of the composite group. The total yield of maize intercropped with 1 row of alfalfa and with 2 rows of alfalfa was respectively 1.7 % higher and 7.0 % lower than that of maize monoculture in wide and narrow rows and output value was correspondingly enhanced by 4.5 % and decreased by 3.7 %, whereas both total yield and output value were improved relative to monoculture alfalfa, respectively by 52.4 % and 48.6 %, 39.2 % and 36.9 %. Meanwhile, these two intercropping modes improved land use capability respectively by 28 % and 24 %.

It is concluded that intercropping alfalfa with maize has obvious advantages, and the optimal mode is maize intercropped with one row of alfalfa in wide rows. This mode is practicable and has a promising prospect in the northeast agro-pastoral zone of China.

Keywords: Accumulation and allocation of dry matter, comprehensive benefits, intercropping advantages, light environment

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Tiller Removal and Defoliation Prior to Grain Harvest of Pearl Millet in the African Sahelian Zone

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In order to gain fodder for draught animals, farmers in south-eastern Mali are harvesting pearl millet leaves (*Pennisetum glaucum* (L.) R. Br.) prior to grain harvest. Effects of this practice on grain yield were investigated under field conditions, thereby distinguishing between removal of tillers that up to flowering had not developed visible panicles (R) and partial or complete defoliation of reproductive tillers before the dough stage of the grain (D). The dry matter yield of the removed biomass was measured and at grain harvest the dry matter yield of stems, leaves and panicles and the number of panicles was determined. The forage quality of the removed biomass was also evaluated.

For the local cultivar Souna, treatment R reduced grain yield by 13 % and 19 % in two successive years. Yield reduction was due to fewer panicles per plant and decreased grain yield per panicle. The latter effect was more pronounced without fertiliser application, which indicates the importance of the vegetative tillers as a source of assimilates for the reproductive tillers. Effects of treatment D on grain yield were related to the number of leaves left on the stem and the growth stage at leaf removal; again, grain yield reduction was due to a smaller grain yield per panicle but in this case was not influenced by fertiliser application.

The fodder obtained through the two treatments was of relatively good quality, supplying maintenance feed for draught oxen. Depending on treatment, feed harvested from one hectare of millet supplied one Tropical Livestock Unit for 44 (D) up to 147 days (R).

Since the need for animal feed in sedentary agro-pastoral farming systems increases, selective removal of tillers and partial defoliation of millet plants offer possibilities for harvesting good quality forage that can be fed to selected animals during shortage periods. Based on the experimental results the appropriate timing for harvesting millet fodder prior to grain harvest should be identified, thereby accounting for the actual climatic conditions *viz.* physiological stage of millet during the growing season.

Keywords: Animal feed, biomass removal, maintenance requirements, *Pennisetum glaucum*, Sahel

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Linking Fallow Vegetation and Soil Fertility with Farmers' Criteria for Cropping Decisions in Shifting Cultivation

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Agriculture in the highlands of northern Thailand has been dominated by rotational shifting cultivation for centuries. However, fallow periods are shortened and intensive management practices are now used more often because of insufficient available land and increasing integration with cash crops. Land is not left fallow long enough to restore soil fertility and forest species start to become extinct in fallow areas.
This research aims at determining optimal fallow duration in different systems, sufficient for restoring soil fertility and maintaining biodiversity of forest species during cropping periods. To this end, the relationship between botanical composition of fallow vegetation and soil fertility is studied and scientific parameters are identified that could be used as indicators for fertile cropping areas. These criteria are compared with farmers' traditional knowledge and decision making criteria, when changing from the fallow to the cropping cycle. Soil fertility status and trees in fallow vegetation of different ages were studied in Nong Khao village and Bor Krai village in Mae Hong Son Province, where rotational shifting cultivation including different fallow duration is still practised by Karen and Lahu people. Data was collected from tree surveys conducted in false time series of 1-, 3-, 6-, 8- and 10-year fallow plots. Trees in 72 transect plots (6 m $\times$ 50 m) were measured for height, canopy width, girth at breast height, number of stem sprouts and identified botanically for evaluating biodiversity. For soil fertility analysis, soil samples from three different soil depths (0–30 cm) in 3 replicates were collected from rice fields, maize fields and 1-, 3-, 6-, 8- and 10-year fallow plots. Soil sample analyses included bulk density and pH, organic matter (OM), phosphorus (P), and potassium (K) as soil fertility indicators. Farmers' decision making data were obtained from focus group discussions and individual interviews using semi-structured questionnaires.
Existing links between plant biodiversity and soil fertility trends over time in crop-fallow rotations will be presented from both the scientific and the farmers' perspective and an outlook will be given how results of this study can be implemented as a decision-making component in biophysical Land Use Change Impact Assessment modelling.

Keywords: Farmers' decision making, rotational shifting cultivation, soil fertility, succession of plant community

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Crop Responses to Conservation Agriculture Practices in Sub-Saharan Africa: A Meta-Analysis of Existing Data

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Food security in sub-Saharan Africa (SSA) is often constrained by highly degraded and weathered soils, poor agronomic management and often exploitative farming systems. While there have been many attempts to devise more sustainable and efficient ways to increase agricultural production, widespread adoptions of the strategies that require changes to the farming system and some investment have been limited. Conservation agriculture (CA) is one innovation of high relevance to the rain-fed farming systems of SSA. CA works on three main principles thus reducing soil disturbance through minimal till or no till, maintaining permanent soil cover and crop rotation. CA aims at increasing crop yields whiles lowering costs of production. Many studies have shown that CA increases rainwater infiltration, reduces evaporation losses, improves organic carbon and nutrient content of the soil. Increase in crop yield under CA and rain-fed conditions are however variable and depends on a number of factors. We conducted a meta-analysis of published data sources from SSA to help in better understanding of the effects of tillage, residue retention and/or cover crop/intercrop practices on crop grain yield under contrasting soil textures, fertiliser input and climate. All of the studies used crop yield as response variable and majority of studies (60 %) were only one growing season and this poses a great challenge to the acceptance of CA by farmers since the benefits are mostly observed after several seasons. More of the literature (90 %) captured that CA performs better under fertiliser management. All studies used reported on soil characteristics but texture was only limited to the top soil (0–20 cm) and described by category (sandy, clayey etc.). Gaining adoption of CA by resource poor farmers in rain-fed farming systems will require clear messages about the expected productivity advantages as well as strategies to overcome the many other significant barriers to adoption.

Keywords: Conservation agriculture, crop rotation, meta-analysis, rain-fed conditions, zero tillage

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A "C4" Continuum for Sustainable Rice Production: Experiences from a Global Biodiversity Hotspot in India

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Sustainable rice production is still a whopping challenge for India, though the country achieved self sufficiency in food production way back in 1960s. This paper highlights with examples on how to create sustainable livelihoods by protecting the genetic wealth and water resource base in rice cultivated landscapes in a "biodiversity hotspot" and utilising the "commerce" strength of the urban society. MSSRF's C4 continuum wherein equal importance is given for (i) Conservation, which includes enhancement and sustainable use of biodiversity and comprises *in situ*, on-farm and *ex situ* conservation methods, (ii) Cultivation, that promotes low external input, sustainable agriculture based on principles of organic farming, (iii) Consumption, that covers food security and nutrition, revitalisation of traditional food baskets and (iv) Commerce, that creates an economic stake in conservation through options in livelihood security, turned out to be one of the practical strategies for establishing an efficient rural-urban continuum in rice production and food security. Intervention by MSSRF's community agro-biodiversity centre for sustainable rice production by adopting the C4 continuum in Wayanad district - the hottest hotspot of western Ghats is described in the paper. As an example, organic and specialty rice produced by farmers' groups and self-help groups facilitated in various parts of Wayanad and marketed through a community outlet in the city, directly reach the consumers by avoiding middlemen, ensuring a better price for the producers as well as for the customers. LEISA encouraged among the farmers by way of skill development trainings ensure low cost production, high profitability and less environmental harm. Similarly conservation taken care of by promoting dozens of "farmers' varieties" with special characteristics and produced through system of rice intensification (SRI) methods appealing to the end users promotes the genetic base of the rice *in-situ* on farm as well as saves water. This has evolved a practical business model for reaping the advantages of the rural-urban continuum.

Keywords: Global biodiversity hotspot, *in-situ* on farm conservation, C4 continuum, LEISA, specialty rice production, sustainable rice cultivation

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Agricultural Residues Increase Rice Yield and Soil Fertility in Suburban Agriculture in Cuba

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Suburban agriculture plays a great role for alimentation of people in Cuba. However, often the yields are low due to the shortage of fertilisers. Usually urea is applied as a dosage of 70 kg ha^{-1} N, whereas no P and K is given. Residues of crop and animal production can help to mitigate this problem. Rice husks are used in poultry production in Cuba to absorb the excrements (poultry rice-husk manure, PRH manure). This residue is commonly thrown away. The investigations were carried out under production conditions with the objective to evaluate the effect of the PRH manure alone and in combination with mineral N supply (urea). Rice (variety IACuba 30) was sown in an agricultural cooperative in a suburban area of the municipality of Santo Domingo, Villa Clara, in rainy season on a typical leached yellowish Ferralític soil (Kandiustalf, after USA Soil Taxonomy), which is characterised by natural poverty in nutrients and organic matter. PRH manure was applied at dosages of 0, 10 and 20 t ha^{-1} alone and combined with N, 70 kg ha^{-1}. A randomised block design with four replications was used. The results demonstrated that with 20 t of PRH manure plus urea N the highest yield was obtained (5,15 t ha^{-1}). However, the relatively high amount of N given in this treatment may result in high N losses. Yields of 3.85 t after urea and 3.83 t after 20 t PRK manure application implicated that the addition of 20 t ha^{-1} of PRH manure can replace an urea application at a rate of 70 kg ha^{-1} while providing organic matter and raising the P and K levels in soil at the same time. From the economic point of view the treatment with 20 t PRH manure was found to be the best. The results showed that the application of PRH manure can substantially increase rice yields and soil fertility.

Keywords: Manure, nitrogen, phosphorus, rice

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Mechanizing Tribal Rainfed Agriculture in India using Small Farm Machinery

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India the second most populated country in the world with 1.21 billion people, has since the 1950s an average annual population growth rate of 2.0 % (Census 2011). It is predicted that India will have 1.63 billion people by 2050 (Population Reference Bureau). The Indian economy continues to be dependent on agriculture and it contributed 12 % to the national gross domestic product (GDP), although there has been a steep fall in the use of labour in agriculture which fell from 60 % in 1999 to 52 % in 2009. Increased off-farm job opportunities with higher wages lead to migration of labour to the cities. Approximately 2 million people are shifting from rural to urban areas annually and about 22 million people have migrated since 2001. Per capita availability of agricultural land has declined from 0.48 ha in 1951 to 0.16 ha in 1991 and is projected to slide down to 0.08 ha in 2035. These have brought about visible changes in agriculture, notably mechanisation.

This paper is an attempt to show the introduction of small farm machinery - power tillers, threshers, row markers and pulverisers in three tribal locations in India: Koraput district of Odisha, Kolli Hills of Namakkal district in Tamil Nadu, and Wayanad district of Kerala and to highlight their implications. The majority of farmers in the locations are marginal and smallholders (ranging between 55.7 to 82.3 %), and are affected by shortage of labour. About 40.7 % of households from the Kolli Hills, 12.0 % from Koraput and 10.9 % from Wayanad have household members who undertake short term seasonal and long term migration to other locations including the major cities. Introduction of row markers has led to saving in labour, reduce drudgery among women and improve farm productivity. Traditional methods of food processing require ninety minutes to process one kilogram of grain compared to ten minutes using mechanical hullers, thereby reducing drudgery among women. Livestock and human labour were critical for rainfed areas in the past and introduction of small farm machinery like power tillers and threshers help farmers significantly in carrying out agricultural operations on time.

Keywords: Drudgery reduction, farm machinery, labour deficit, seasonal migration, smallholder agriculture in tribal areas

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Vegetable production

VegGIS – A Web-Based Collaborative Research Environment – Pilot Application in Research on Vegetable Production in Greater Bangkok, Thailand

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Urban and peri-urban vegetable production and marketing systems have the potential to contribute to poverty reduction, food and nutritional security, local economic and community development, social inclusion of marginalised groups and women in particular, as well as to enhance urban environmental management by increasing biodiversity and the productive reuse of organic wastes.

However, very often the complexity of urban and periurban vegetable systems is not fully understood by regional and urban planners, city administrators and policy makers, and hence, its potential for sustainable development of urban and peri-urban areas in developing countries has only be harnessed to a limited extent.

As part of the GIZ-funded project "Understanding urban and periurban vegetable production and marketing systems through GIS-based Community Food Mapping in Greater Bangkok, Thailand" a pilot web-based Collaborative Research Environment (CRE) was developed. The CRE supports research to better understand interlinkages between producers, marketeers and consumers. The core of the CRE consists of a central, spatially enabled database and a range of associated tools for distributed data entry, for remote and real-time monitoring of the incoming data, for data analysis, and last but not least for data presentation. The tools include the required Geographic Information System (GIS) functionality for spatial analysis and map-based visualisation.

In our pilot study the data included in the CRE comprises empirical data from different sources such as questionnaires and surveys, spatial information on production areas in relation to vegetable diversity as well as information on producers, traders and consumers.

As it is a web-based application, technical requirements for the users are low apart from having access to the internet. The multilayer food related data can thereby be presented, visualised, evaluated and analysed in a modern and straightforward way which helps to simplify the communication between scientific disciplines and the dissemination of findings to a broader public and to the policy level.

Keywords: Biodiversity, Collaborative Research Environment (CRE), food security, Geographic Information System (GIS), marketing, urban and periurban agriculture, web application

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Study on Crop Diversification of Joymondop Locality in Bangladesh: A Case of Cauliflower Cultivation

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Vegetables grown in Joymondop locality, Upazilla Singair, Manikganj District in Bangladesh are very much popular for the city dwellers as well as for the 3 star and 5 star rated hotels. Vegetable traders in Dhaka like produces of this area and buy them from the Joymondop Bazar at a fair price. Such access to wholesale market leads farmers switch to grow more vegetables in the area. The present study seeks to answer why the farmers changed their course of cultivation from cucumber to cauliflower as a cash earning crop.

Farmer's opinions and status of crop diversification were studied using qualitative methods of social domain research. Key findings of the study indicated that soil fertility, lower pest attack, good quality, better marketing facilities and high production with satisfactory economic benefits influenced farmers for switching to new vegetables like cauliflower. Farmers in the area started cauliflower cultivation 7–8 years ago. Before that they were intensively cultivating cucumber and carrot, but they encountered seed virus problems in cucumber and carrot. They also claimed that the syndication of the seed traders for hybrid cauliflower pushed them towards uncertainty. However, the big sized curd, curd quality and access to whole sale buyers at the farm gate or Joimondop market encouraged them to continue the cultivation of cauliflower. To ensure farmers benefits, and socio-economic development of the vegetable production, an active role of the local government was recommended for nullifying the syndication and seed problems in the area.

Keywords: Cauliflower, crop diversity, seed virus problem, social domain research, syndication of seed traders

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Challenges in Local Seed Systems — The Case of Vegetable and Legume Seeds in Western Kenya

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Locally adapted, quality seeds are the most critical input to secure good harvests and food security. Local seed systems can ensure that diversity of crops and varieties are available for small scale farmers. Most of the research focuses on major crops such as maize. The current study focused on assessed seed systems for traditional and exotic vegetables as well as legumes.

For this study, 20 structured interviews with small scale farmers were held in four different villages in two districts of Western Kenya. Farmers were purposely sampled out of 60 farmers who participated in a study on "Improving Nutrition through Agrobiodiversity" with baseline information about each farm being available. Criteria for selecting villages were distance to main roads, urban centres and local authorities. The interview included on-farm seed production, storage, selection as well as market seed availability and affordability. In addition, seven market inventories were conducted to gather information on availability and prices.

Diversity of crops ranged between 2 and 10 per farm for vegetables (mean= 5) and between 0 and 5 for legumes (mean= 2). Intra-species diversity was rather low: only one variety was grown for half of the crops investigated. The main reasons mentioned by farmers were directly related to seed availability in 57 % of cases, due to (i) seeds of other varieties being unavailable; (ii) lack of knowledge *e.g.* that other varieties exist; and (iii) lack of money to purchase other varieties. Seeds from own production were preferred by 15 farmers out of 20, mainly because of financial and quality reasons while only few favoured certified seeds (4) and informal markets (1). Fifty six per cent of farmers were of the opinion, that there was more seed and information exchange between farmers in the past compared to today, suggesting a decline of traditional exchange systems. The distance to the market may be an important determination of seed acquisition and this will be analysed.

It is proposed that improving marketing and availability of seeds as well as strengthening traditional exchange systems should be considered more strongly to provide high diversity.

Keywords: Agrobiodiversity, informal markets, Kenya, seed systems, small scale farmers, vegetables

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Developing a Domestication Priority Setting Approach for Wild Vegetable to Improve Food Security in Makawanpur District, Central Nepal

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Makawanpur district in Central Nepal is considered one of the richest biodiversity hotspots of the country. Numerous wild edible plant species of that area are traditionally used as vegetables and contribute to nutrition and food security of the local communities. However, abundance of many of these wild vegetables is decreasing which calls for domestication and cultivation of priority species. So far, no activities for priority setting are performed in the research area.This study aimed at documenting wild vegetables and their use to develop a priority list for future domestication efforts. Wild vegetables were surveyed in three agro-climatic zones (altitude range 500–2200 m a.s.l.) of Makawanpur district in natural forest, homegardens, farmer's fields, fallow land and markets. Information about local names, plant parts used, seasonal availability, mode of consumption, primary consumers and preference ranking for consumption and sale was gathered during forest/field walks and by semi-structured interviews of key informants (including men, women and children) of three ethnic groups. Priority setting was based on nine variables related to priorities for taste and sale, species' occurrence in homegardens, wide use among ethnic groups, broad altitude range, harvest season, level of threat as perceived by respondents, children's preference for consumption and possibility for processing. A total of 89 vegetable species were identified, including 66 herbs, 9 climbers, and 14 shrubs and trees. Forests and fallows were most important for collecting wild vegetables and only seven species were found in homegardens. As many as 20–46 wild vegetable species were ready for harvest per month from March to September, but only 3–8 species in the months October to February. Wild vegetables were mainly used for home consumption, but 26 species were also sold in markets. The priority setting resulted in a list of 17 species with high ranks, with *Bauhinia variegata* L., *Dendrocalamus hamiltonii* Nees & Arn. ex Munro and *Bambusa tulda* Roxb. being the most important as they were highly preferred for taste (even by children) and sale, used by all three ethnic groups and being available in all surveyed altitudes. The developed priority setting approach was considered as suitable for this location and could be recommended for testing elsewhere.

Keywords: Agro-biodiversity, consumption, ethnobotany, homegardens, seasonal availability, traditional knowledge

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Preliminary Selection of Early Bambara Groundnut for Urban Markets in Limpopo Province (South Africa)

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Bambara groundnut (*Vigna subterranea*) is an important food legume in many parts of Africa. In urban areas, it is consumed predominantly as fresh boiled nuts (snack) or processed dry grain. In the urban markets, early maturing cultivars are preferred since their availability coincides with the time of high demand but low supply, thus attracting good profit margins. Therefore, the objectives of this study were to identify and select for earliness in local landraces of bambara groundnut. Ninety-four accessions of the crop were evaluated under rain-fed conditions in Limpopo Province (South Africa) using an ecologically representative testing location at the University of Venda Experimental Station. The seed of each accession was planted in observation field plots during December at the beginning of the 2011/2012 cropping season and evaluated under rain-fed conditions for various agronomic traits including earliness, pod yield per plant and pod size. The study was repeated using thirty-five accessions that were selected from the first experiment as well as a local check variety during the 2012/2013 cropping season. Eighteen accessions that matured within 91 – 114 d were identified. The average grain yield among six of these early types was 1.11 t ha^{-1}. There were highly significant ($p < 0.01$) differences among the genotypes in terms of pod width, seed size and yield. Further selection of elite early types that possess large grains will be beneficial to both the growers and end-users in the region. There is merit for increasing the number of testing locations across the Limpopo basin in order to determine the stability of these varieties.

Keywords: Bambara groundnut, landrace, markets, maturity

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Protected Cultivation of Tomato to Enhance Plant Productivity and Reduce Pesticide Use

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Vegetable farming is an important source of income in mountainous areas of northern Thailand. Field cropping of vegetables or ill managed greenhouse production generates problems, especially the excessive use of agro-chemicals. In contrast, the production in state-of-the-art greenhouses, which are insect-proof, can reduce pesticide use, and improve water and fertiliser use efficiency. The aim of the presented study was to compare the overall pesticide use between greenhouse production and field cropping and investigate the influence of UV radiation on plant health and yield formation in tomato (*Solanum lycopersicum* L.). Three varieties were planted in a substrate from peat and coconut fiber and randomly arranged in 4 blocks with 8 plants of each variety in two greenhouses and in the open air. One greenhouse was covered with a UV opaque and another with a UV open plastic film. Photosynthetic active radiation and UV radiation were monitored continuously along with climatic data in each greenhouse and outside. Pest infestation was monitored visually and pest management was responsive. Plant growth and the number of fruit were monitored once per week. Ten weeks after planting, two plants of each block and variety were destructively sampled and analysed for nutrient partitioning. Tomatoes were continuously harvested starting from the eighth week and analysed for mineral composition and classified into marketable yield, undersized fruit and fruit affected by cracking and blossom end rot (BER). As expected, pesticide use inside the greenhouse could be reduced substantially, but crop damage which required pesticide spraying was caused by thrips. The infestation was lower under UV opaque foil due to lack in orientation of the pest insects in absence of UV radiation. In both greenhouses plant growth was enhanced as compared to outside. The occurrence of BER was slightly higher inside, possibly due to higher temperatures during an extraordinarily long dry season. An appropriate set up of greenhouses can substantially improve the productivity and reduce the use of pesticides. These findings need to be confirmed under conditions in the practice and the real yield potential under the conditions in northern Thailand must be analysed.

Keywords: Blossom end rot, greenhouse, *Solanum lycopersicum*, Thailand, thrips

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Vegetable Production and Consumption in Bamako, Mali

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The population in Bamako, Mali has an annual growth rate of 4.5 % – the highest in Africa – and the city ranks as the sixth most rapidly growing urban area in the world. Rapid urbanisation causes change in social relations and lifestyles, and increases demand for food. Fast urban growth can lead to malnutrition when poor people migrate from rural areas to cities and have no means to generate income or obtain a nutritionally complete diet. Our study aimed to understand the role of vegetables in the food supply of urban Bamako, and to explore the nutritional and other consumption-related knowledge among households. Focus group discussions on vegetable gardening activities and individual interviews were conducted in two districts of Bamako where poor people are concentrated. Twenty vegetable growers were interviewed for vegetable production and market aspects; 20 household women were interviewed for topics related to food availability, preparation, preference and consumption, as well as nutritional knowledge. Twelve small and medium enterprises in Bamako, two in the north of Mali, and 10 households in two districts of Bamako were interviewed. People in Bamako consumed three meals a day with cereals (rice, millet and sorghum) as the main staples. Vegetables were consumed daily during the main production season, in small quantities as a side dish. The most frequently consumed vegetables included onions, tomatoes, okra and eggplant. Various types of seasoning cubes were added to the vegetable dishes. Most of the vegetables were obtained from farmers' or households' own production. In Bamako, gardening plays an important role in improving income and the socioeconomic status of families. However, more people are eating outside the home. Family members, neighbours, television and radio broadcasts were the main sources of nutrition information; nutrition and health centres were mentioned as sources by only a few respondents. Markets for processed vegetables remain limited, as people in the area tend to prefer fresh produce. More investment in promoting urban gardening techniques, such as mobile gardens and vertical or roof gardens, promoting healthy diets, and improving the quality and acceptance of processed vegetable products will enhance vegetable availability and consumption.

Keywords: Consumption, garden, nutrition, urbanisation, vegetables

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Manure and Charcoal Effects on Soil Faunal Activity in Irrigated Vegetable Gardens in South-West Madagascar

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Nutritional provisioning is a central Ecosystem Service (ESS) in agriculture. Especially in the tropics and subtropics the amount and timing of nutritional provisioning are essential. Unlike in temperate regions here rapid nutrient turnover can become problematic as the availability of organic matter is often severely limited and seasonally heavy rainfall might lead to severe leaching losses of released nutrients. As the soil fauna is a key driver for this ESS effective soil management presupposes understanding and quantifying of decomposer processes and decomposer communities. In this study we investigated the effect of different soil treatments on soil faunal activity in irrigated vegetable gardens on the Mahafaly plateau in south-western Madagascar. The Mahafaly plateau is part of a semi-arid region, characterised by harsh climatic conditions with a long dry season, poor sandy soils and a poor, fast growing population. An experimental irrigation vegetable garden was installed to develop effective improved land management schemes to enhance the productivity and to have an additional food resource without threatening the natural soil biodiversity. Thus, the effects of manure and charcoal treatments on feeding activity of soil fauna was compared in irrigated vegetable gardens. Nine different treatments with four replications for each were used totaling 36 plots. To evaluate feeding activity of the soil fauna, bait-lamina tests were used. As expected activity was higher in the manure treated plots with (10 t ha^{-1} and 20 t ha^{-1}) and in charcoal treated plots with 2 t ha^{-1} compared to the control plots. However, in the elevated rate charcoal treated plots (5 t ha^{-1}) a decreased feeding activity was observed compared to the control plots. Consequently, feeding activity of soil fauna in irrigated vegetable gardens was controlled by the charcoal rate in the soil. The use of a suitable rate of charcoal between 2 t ha^{-1} and 5 t ha^{-1} mixed with manure (10 t ha^{-1} or 20 t ha^{-1}) stopped rapid organic material decomposition by the soil organisms and fostered longer organic material availability in the irrigated vegetable gardens.

Keywords: Bait-lamina technique, feeding activity, irrigate vegetable garden, Madagascar, Mahafaly plateau, manure and charcoal treatments, soil fauna

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Production Function of Irrigated Eggplant in Protected Environment

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Eggplant (*Solanum melongena* L.) is native to the Middle and Far East and has been cultivated for over 1500 years by the Arabs and Chinese. Currently, there has been an increasing demand for the vegetable due to its medicinal properties and richness of mineral and vitamins. The biggest drawback to eggplant production is the inappropriate soil moisture during plant cycle. Irrigation acts as a supplement to rainfall and keeps soil water rates at ideal levels for crop development, thus increasing plant growth, product quality and yield. Appropriate irrigation management can improve efficiency in water use, reduce energy consumption and promote optimal economic productivity. The point of maximum physical productivity can be achieved with production functions obtained from agricultural experiments, which evaluate effects of variation of inputs on variation of outputs. This study aimed to establish optimal strategies for crop irrigation of eggplant, Napoli cultivar, grown in protected environment in southern Minas Gerais, Brazil, considering water as a limiting production factor and different values for product price and electricity costs. Thus, an experiment was conducted in completely randomised design with 5 treatments and 6 replicates. Treatments consisted of 5 different irrigation depths, 50, 75, 100, 125 and 150 % of crop evapotranspiration up to field capacity. Results showed significant differences for all variables: stem diameter, plant height and yield. Total production (kg plant^{-1}) had a quadratic response to treatments, whereas cost showed a linear function. The treatment with 229 litres plant^{-1} showed the highest yield, while the one with 227 litres plant^{-1} provided the highest investment turnover. According to the analysed conditions, we concluded that irrigation can be performed to achieve maximum crop yield. Also, variation in price relationship (Pw/Py) did not proportionally affect the depth recommended to promote maximum economic efficiency.

Keywords: Eggplant, irrigation management, yield

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Utilisation of Agro-Industrial Wastes for the Cultivation of *Pleurotus tuber-regium* (Fries) Singer, a Nigerian Edible Mushroom

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In this study 16 agro-industrial wastes as well as simple organic and inorganic compounds were annexed for vegetative growth and fruitbody production of *Pleurotus tuber-regium*, a Nigerian edible medicinal mushroom. Utilisation of these wastes for mushroom growing will be helpful in their conversion to edible protein in terms of mushroom fruit bodies. Different wastes (substrates) were used to cultivate this functional food. Each investigation was carried out in three replicates and the experimental set up was in a completely randomised block design using standard methods. The results obtained were subjected to analysis of variance (ANOVA) using general linear model options of SAS, while test of significance was determined by Duncan´s multiple range test at 0.5 % level of probability.
Pleurotus tuber-regium produced different degrees of mycelia biomass on varieties of agro-industrial wastes used. *Khaya ivorensis* sawdust produced the best mycelia extension (65.0 mm), followed by *Terminalia ivorensis*, cotton wastes and rice straw ($p \geq 0.05$), while poultry manure stimulated mycelia extension by 3.0 mm, which was the least. Among different growth media used, malt extract agar stimulated the best growth of 98.3 mm, while potato dextrose agar produced mycelia growth of 95.0 mm, closely followed by yeast extract, sorghum, millet, and corn meal agar with mycelia extension of 87.7, 86.0, 85.0, and 80.0 mm, respectively. Sweet potato agar produced the least mycelia extension of 10.0 mm. Effect of organic carbon and nitrogen compounds on the growth of *Pleurotus tuber-regium* in submerged liquid culture showed that glucose and yeast extract were the best carbon and nitrogen compounds with 205.3 and 210,0 mg per 30 cm^3, respectively. Solid state fermentation of agro-industrial wastes showed that composted *Khaya ivorensis* sawdust produced an average of 15 fruitbodies after the first flush, while non composted sawdust of the same wood produced an average of 9 fruitbodies after the first flush.

Keywords: Agro-industrial wastes, cultivation, environment, *Pleurotus tuber-regium*, pollution

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Effect of Crude Oil on the Physicochemical and Microbial Characteristics of *Vigna unguiculata* and *Amaranthus* sp.

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Environmental degradation associated with oil exploration and exploitation is a major problem confronting oil-producing countries. Man's technological and scientific advances have caused environmental changes that are impossible to evaluate and fully comprehend. Our ability to change the environment has increased faster than the ability to predict the effect of those changes. Pollution of the environment is one of the major effects of man's technological advancement. Pollution results when a change in the environment harmfully affects the quality of human life, animals, micro-organisms, and plants. An experiment was conducted in the screen house to ascertain the effects of crude oil on the physicochemical and microbiological characteristics of agricultural soil. The response of cowpea (*Vigna uiguiculata*) and leafy vegetables (*Amaranthus* sp.) to the contamination with crude oil, as well as the slight alteration of the physicochemical, physical and microbial characteristics show the deleterious effects of crude oil on agricultural soil and the negative impacts it has on our environment in general. Comparing the results of chemical, physical and microbial impacts, it was deduced that cowpea reacted almost instantly (three days) after the introduction of the crude oil. This shows that cowpea has little or no ability to withstand crude oil spillage while *Amaranthus* sp. still exhibited some level of resistance to the crude oil especially from the least 5 % (w/v) to the highest 11 % (w/v) concentration. Microorganisms identified and isolated from soil samples were *Bacillus cereus*, *Bacillus megaterium*, *Clostridium sporogenes*, *Micrococcus luteus*, *Aspergillus fumigatus*, *Trichoderma viride*, *A. saprophyticus*, *Methylococcus capsulatus*, *Pseudomonas areoginosa*, *Acinetobacter calcoaceticus*, *Vibrio anguillarum*, *Penicillium notatum*, *Sporobolomyces salmonicolour*, and *Rhbizopus nigrican*. However, the contamination had no significant effect on pH, rather on phosphorus, sodium, potassium, magnesium, calcium, organic carbon, and organic matter content of the contaminated soils for *Vigna uiguiculata* compared to the uncontaminated, whereas for soils with *Amaranthus* sp there were no significant effects for sodium, rather on phosphorus, pH, potassium, magnesium, calcium, organic carbon, and organic matter content of the contaminated soils compared to the uncontaminated soil samples.

Keywords: Agricultural soil, crude oil, microbial community, physicochemical parameters, *Vigna unguiculata*, *Amaranthus* species

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Rhizobium and Mycorrhiza Inoculation Affect Yield Components in *Pisum sativum*

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In sustainable agriculture, *Pisum sativum* L. has a major environmental role to play through atmospheric nitrogen fixation. This legume crop can also form a mutualistic relationship with arbuscular mycorrhiza fungi to increase its phosphorus uptake. So far an important aim for most pea researchers is the increase of yield through breeding and the extension of the production areas. The importance of integrated agronomic practices such as microbial inoculations has received less attention. The purpose of this investigation was to evaluate the effects of double and/or single inoculation of *R. leguminosarum* bv. *viceae* and the mycorrhizal fungus *G. mosseae* on yield components of field pea. Our results indicate that there were significant differences ($p < 0.05$) in nodulation, mycorrhizal root colonisation, plant height, node number, internode length, leaf area and shoot dry matter yield of *Pisum sativum*. However, there were no statistically significant differences between the groups in root biomass production. The poorest results were obtained with the control group as compared to *Rhizobium* and/or mycorrhiza inoculants, and dual nitrogen and phosphorus (N and P) application. *Rhizobium* alone gave the best and similar results to the N and P group, whereas the co-inoculated treatment (myccorrhiza and rhizobia) did not show maximum synergetic effect on each yield components of field pea, although its plant height and leaf area were found to be statistically similar to the chemical fertiliser and other single microbial treatments. That might be resulted from their competition for space and resources such as carbon in the root system. The overall results demonstrate that similar increases in field pea yield components with rhizobia and mycorrhiza inoculation could lead to reduce or replace N and P fertiliser requirements. That might be particularly vital for the resource poor farmers and environmentally-friendly farming practices to increase field pea production under low soil fertility conditions but this needs to be verified by field trials.

Keywords: Mycorrhiza, *Pisum sativum*, *Rhizobium*, yield components

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Carrageenan Prototype Mapping and Food Product Development of Seaweed at the Salabangka Islands of Central Sulawesi Province, Indonesia

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Food product development is directed towards the consumer needs who nowadays concern more on the healthiness of their diet. Processed seaweed products are included in healthy food as semi-processed products such as carrageenan or as end-processed products such as candy, bread and cheese stick. The research objective was to get an overview of carrageenan levels of seaweed (*Eucheuma cottonii*) cultivated in different locations, as well as the opportunities to increase income for the coastal communities if they process seaweed to end products.

The results showed that carrageenan from the Karantu village has the best chemical, physical and functional properties while the seaweed contains 36.8 % of carrageenans, slightly higher than found in the Padabale village, 36.4 %. This finding is in line with the results obtained in a former coastal suitability study (2011) and meets the standards of FAO, FCC, EEC, and the EU (E407).

In order to evaluate the possibilities for local seaweed based end-products, three products were made on the base of seaweed puree: candy, bread and cheese-sticks and tested by a panel. The panel preferred cheese-stick, for candy and bread. Based on this organoleptic test the best recipes were introduced to women seaweed farmers at Salabangka Island, capital city of South Bungku District. The economic analysis showed that all end-processed products have an R/ C-ratio > 1 and therefore will be profitable for the local farmers.

Based on this carrageenan prototype analysis it can be recommended to take the two villages with the best carrageenan yield as a "nursery" for the development of seaweed. The end-processed seaweed based products favored by the panelists (sweets and cheese-sticks) should be further developed towards a locally based commercial production under supervision of the Central Sulawesi government.

Keywords: Formula product, income, local people, mapping

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Stomatal Behaviour of two Rose Cultivar under Different Levels of Shading

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Light is an important environmental factor that influences many aspects of plant growth and development. Plant morphology and physiology are strongly affected by light intensity. Light significantly influences the structural and physiological characteristics of plants in both agronomy and natural ecosystems. In plants, leaves in shade or light can completely be different regarding leaf area, leaf thickness, cuticle thickness, chlorophyll content, chloroplast orientation, and stomatal behaviour. Stomata opening and closure regulates plant gas exchanges as well as photosynthesis in plants. In this study, the effect of different levels of shading on stomatal behaviour of two rose cultivars was evaluated under greenhouse condition. Plastic nets were used to obtain different shades. Treatments were light intensities of 240, 520, 640 μmol m^{-2} s^{-1} and control with 1200 μmol m^{-2} s^{-1} (without application of plastic nets).The results, however, showed that length and width of stomata increased by light intensity up to 640 μmol m^{-2} s^{-1}, as the highest stomatal length and width was observed at this light level. Stomatal length was lowest at 240 μmol m^{-2} s^{-1}, but for width there was no difference among other treatments. Regarding stomata number there was no significant difference among different shading levels, despite plants in 1200 μmol m^{-2} s^{-1} showed the highest average for stomata number. Stomata number also was higher in rose cultivar of "Gulmira" rather than "Red one". Regarding stomatal conductance, there was not significant difference among shade treatments, however there was an increasing trend of stomatal conductance with increasing light flux. Nevertheless there was significant difference for this trait between two rose cultivars.

Keywords: Rosa hybrid, stomata length, stomatal conductance, Gulmira

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Assessing the Impact of Diazotrophic Isolates Variability on the Phenotypic Parameters of *Phaseolus vulagris* Genotypes

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Increasing the diazotrophic bacteria application and improving nitrogen fixation in legume crops are some of the main strategies to achieve sustainability in agricultural processes for countries which are dependent on low input farming. The present work aimed to determine the effect of *Rhizobium* isolates on nodulation parameters, biomass and nitrogen fixation of common bean genotypes. The phenotypic analysis of isolates was carried out under controlled conditions, where nodulation, morphological and biomass parameters and nitrogen fixation of the genotypes ICA Piajo and BAT-304 were evaluated. A complete randomized experimental design was applied to determine the effect of the isolates on the genotypes, comparing with a control treatment and the inoculation of *Rhizobium etli* wild type strain CNPAF512. The inoculations of all the strains were done at the moment of the seeds sowing. At forty-two days after inoculation the nodulation parameters were measured: total nodule number, fresh and dry weight of the nodules, as well as biomass: shoot and root fresh and dry weight and nitrogen fixation: total nitrogen content. The results showed that the isolated strains have the ability for abundant nodule formation in roots plant of both genotypes analysed. Among the strains, a remarkable beneficial effect was for the inoculation of *Rhizobium etli* isolated from two different regions and *Rhizobium pisi*. The genotypic variability showed the close positive correlation among these strains and the genotype BAT-304 compared with ICA Pijao. These results are crucial to improve the interplay among native strains and bean genotypes to achieve the efficiency of *Rhizobium*–legume symbiosis in this crop, increase grain production and to reduce the synthetic nitrogen applications. However, field experiments should be conducted to validate under natural conditions the entire benefit of the genotypic variation.

Keywords: Common bean, interplay, nitrogen fixation, *Rhizobium*, sustainability

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Abiotic stresses in plant production

Effect of Plant Water Stress on CO_2 Concentrations in the Rhizosphere

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Soil respiration consists of autotrophic root respiration and heterotrophic microbial respiration in the rhizosphere. Together with the gas exchange of the bulk soil, they represent the main carbon efflux from the terrestrial ecosystems and – about 25 % of the global carbon dioxide exchange at all. Soil temperature and soil water content are considered to be the two main factors, which can explain most of the alterations in carbon efflux. Many studies have been conducted as how soil temperature and soil moisture affect the soil respiration, but only few focused on the inter-linkages between CO_2 concentration in the soil and plant water stress. The seasonal and temporal variations in soil CO_2 concentration and its relationship with the plant water status remain uncertain.

The main objective of this study was to investigate the relationship among soil CO_2 concentration, soil water content, soil nutrient status, soil temperature, and plant water status of fruit trees. Before being applied in tropical crops like lichi and mango, preparatory field experiments were conducted at an apple orchard located near Nuremberg, Germany. Soil CO_2 concentration was measured with a newly developed soil CO_2 sensor (SCS). Soil water content and soil temperature were measured with dielectric sensors. Plant water status was monitored by stomata conductance (porometer), predawn leaf water potential (Scholander bomb) and canopy temperature (thermo camera) measurements. The SCSs were placed at different distances and depths from the tree's trunks. All the measurements were started at the beginning of the vegetative phase to investigate how the canopy development affects the soil CO_2 concentration. An empirical model for plant water status prediction based on soil CO_2 and soil moisture measurements was established as first step towards a novel plant water status monitoring system.

Keywords: Plant water status, soil respiration, soil water content

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Recurrence of Drought in Nigeria: Causes, Effects and Mitigation

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Nigeria is divided into six vegetation zones of coastal mangrove swamp forest, rain forest, southern Guinea, northern Guinea, Sudan and Sahel savannah. Drought is defined as the protracted absence, deficient or poor distribution of precipitation. It is the inability of rainfall to meet the evapo-transpiration demands of crops resulting in general water stress and crop failures. Rainfall in the Sudano-Sahelian region is characterised by considerable fluctuations and periods of diminishing annual totals especially in recent years. Drought or dry spells at the beginning or end of the season had a constant reoccurrence since the beginning of the 20th century. Large areas of northern Nigeria falling within the Sahel and Sudan ecological zones between latitude 9–14°N are prone to recurrent droughts in one form or the other. The area is estimated to be about 38 % of the total land area of Nigeria and it is the grain belt of the country populated by small scale subsistence farmers and nomadic livestock herders. The underlying cause of most droughts can be related to changing weather patterns such as low rainfall, reduced cloud cover and greater evaporation rates which are exacerbated by human activities such as deforestation, overgrazing and poor cropping methods, which reduce water retention of the soil, and improper soil conservation techniques, which lead to soil degradation. The impacts of drought in general include mass starvation, famine and cessation of economic activity especially in areas where rain fed agriculture is the main stay of the rural economy. Drought is the major cause of forced human migration and environmental refugees, deadly conflicts over the use of dwindling natural resources, food insecurity and starvation, destruction of critical habitats and loss of biological diversity, socio-economic instability, poverty and climatic variability through reduced carbon sequestration potential. The impact of drought could be reduced through irrigation, use of drought tolerant and early and extra early maturing varieties, reduction of post harvest crop losses, increased fisheries and micro-livestock production and strategic grain storage. The paper discusses in detail the causes, effects and mitigation of drought with special reference to Nigeria.

Keywords: Drought, effects, mitigation, Nigeria

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Whole-Plant Transpiration in Response to Variable Water Pressure Deficit and Nitrogen Supply

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Water and nitrogen (N) are essential resources for plants to maintain physiological activities. One crucial question is how transpiration is responding to variable N supply.

In this study whole plant transpiration of two C3 perennial grasses (*Leymus chinensis* (Trin.) Tzvel. and *Lolium perenne* L.) and two C4 annual grasses (*Chloris virgata* Swartz and *Setaira viridis* (L.) Beauv) were measured in response to increasing atmospheric water vapour pressure deficits (VPD) in a chamber based experiment. To study the effects of N availability on transpiration, plants were grown under different N levels (full water supply) ranging from deficient (0.01 mmol), normal (2 mmol), medium (8 mmol), high (16 mmol) N rates.

All analysed species revealed increasing transpiration rates with VPD. C3 plants showed a sharp increase of transpiration rates under the low VPD levels and a very low increase at higher levels indicating stomata response. In contrast C4 species showed a linear increase of transpiration rates throughout all VPD levels. N addition reduced transpiration rates of all species successively with increasing N levels. Chamber measurements were confirmed by δ^{13}C leaf analysis indicating less isotope discrimination under high N levels for the C3 species as a long-term proxy for less stomata gas exchange. Since biomass production of all species declined with increasing N limitation the water use efficiency consequentially decreased and nitrogen use efficiency increased. This was in turn confirmed by increasing biomass N concentrations with increasing N supply.

Our results are challenging the current view that well N supported plants transpire more water per unit leaf area compared to N deficient plants. One crucial point could be the whole plant transpiration dynamics, which not necessarily corresponds to the single leaf based gas exchange measurement practice. Furthermore standard leaf gas exchange analysis is usually not subjected to variable VPD levels, which turned out to reveal differences among species and treatments. Further implications of our results might affect management practices in the way that well N supported plants show water saving traits if WUE is considered. Most interesting to analyse next is how transpiration responds to different N levels combined with water limitations.

Keywords: C4, C3, δ^{13}C, nitrogen, transpiration, VPD

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Root Spatial Expansion Ability of *Leymus chinensis* in Response to Clipping and Salt Stress

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Root system expansion is a complex and important process for rhizomatous plant clonal growth and spatial resource exploration, which is mainly controlled by morphological integration. However, experimental evidences are still lacking to understand mechanisms for root spatial expansion ability (RSEA) of clonal plants under stresses. A 3×3 factorial greenhouse experiment was conducted with a simulated grazing gradient (0 %, 35 % and 75 % of shoot removal) under three levels of saline-alkali intensity (0, 100 and 200 mM) to determine the effects of clipping and salt-alkaline stress on belowground morphological integration of *Leymus chinensis*, a high palatable, dominant grass of the northern chinese steppe ecosystems.

Our results showed that plant biomass and relative growth rate were significantly decreased along the gradient of saline-alkali intensity, but clipping significantly facilitated plant compensatory growth. The interactions between salt-alkaline and clipping on clonal growth and RSEA were siginificant. Slight saline-alkali stress has positive impact on compensatory growth of *L. chinensis* at low clipping intensity pressure, resulting in high level of RSEA. But high salt–alkali significantly inhibited clonal growth by the limitation of bud outgrowth and rhizome expansion, regardless of clipping intensity. Furthermore, when the ranges of the fine root/shoot ratio are from 0.5 to 0.6, shoot compensatory growth of *Leymus chinensis* is mainly due to the stimulation of leaf bud growth; but when this ratio is higher than 0.6, *L. chinensis* invests more photosynthesate into rhizomes and clonal expansion, and shoot compensatory growth originates from the development of rhizome buds into daugther ramets.

We conclude that the rhizome grass *Leymus chinensis* shows a selective biomass allocation strategy under different environmental stress intensities. These plasticities translating into clonal integration are potentially important mechanisms in response to overgrazing and salt stress and may help to optimise grassland management towards improved forage regrowth.

Keywords: Clipping intensity, clonal integration, root/shoot ratio, salinity-alkalinity stress, songnen grassland

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Domestication of Socio-Economically Important Forest Food Tree Species: Effects of Light Intensities on Germination and Early Growth of *Chrysophyllum albidum* and *Irvingia gabonensis*

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Tropical forests contain many socio-economically important tree species with edible parts, most of which are currently endangered. This study investigated the effects of light intensities on germination and early growth of *Chrysophyllum albidum* and *Irvingia gabonensis* (var. wombulu) as a necessary step towards their domestication. Seeds of both species were sown in three screen houses that allowed the penetration of 40 %, 60 % and 100 % light intensities as well as controls (under forest canopy and open sky). Seed germination was monitored for 60 days after sowing the two species while early growth was monitored for 12 and 24 weeks for *C. albidum* and *I. gabonensis*, respectively. Light intensity significantly affected *C. albidum* seed germination but not *I. gabonensis* seeds. Early growth rate of both species was significantly affected by light intensity. Seedlings' height and diameter ranged from 8.9–15.2 cm and 0.25–0.44 cm, respectively, for *C. albidum* (after 12 weeks) and from 37.3–76.3 cm and 0.65–0.79 cm, respectively, for *I. gabonensis* (after 24 weeks), depending on light intensity. Both species performed poorly under forest canopy, indicating that they may not do well under heavy shade. *C. albidum* seedlings under 100 % light intensity and open sky died shortly after emergence, implying the seedlings need some shade for establishment and early growth. Although *C. albidum* seedlings under 40 and 60 % light intensities had statistically comparable growth parameters, the overall best growth and most stable seedlings were obtained under 40 % light intensity. *Irvingia gabonensis* seedlings performed well under moderate shade and high light environments. However, *I. gabonensis* seedlings under open sky had overall best growth results, thus they have the potential to survive when transplanted to the field.

Keywords: Domestication, early growth, forest food tree species, light intensity, regeneration, slenderness ratio

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Spatial Prediction of Soil Salinity in the Agriculture Lands using Remote Sensing Data

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One of the main causes of soil degradation in arid and semi-arid regions is salinisation that affects the growth of crops. The rate of salinisation is more than 2 million hectares a year worldwide. There are mainly two kinds of soil salinity: Primary salinisation or natural salin that is influenced by factors related to climate, topographic, hydrologic, and geologic and soil condition. Remotely sensed data and GIS are useful tools for mapping saline soils. The present study was performed in Bueinzahra area in Ghazvin province (21,506 ha). 42 surface soil samples were collected and the surface electric conductivity (EC) of soil was calculated. TM data were acquired in 2010 and geo referenced. With regards to factor analysis, two components were selected. The first component included NDMI, BI, SI1, SI2, SI3 with the variance 47 % and the second component included main bands with the variance 40 %. The results of OLS analysis showed that the first model is better, and had a stronger relationship to EC (R^2.adj of 0.6) and the model is EC1 = -12.078 + 60 NDMI - 1.99 BI+ 0.62 SI1 + 1.8 SI2– 0.24 SI3. Eight soil samples for investigation of map accuracy were applied (20 % samples). Moran's I of residuals was 0.02. The accuracy assessment of estimations using a validation set of 8 samples showed ME and RMSE of 0.08 and 2.53 dS m^{-1} respectively.

Keywords: Electrical conductivity, soil salinity prediction, TM images

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The Effect of Salinity on Plant Growth in *Brassica napus*

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Brassica napus is ranked at the second position among the sources of edible oil and bio-diesel, the seed gives 35 % to over 45 % oil of its weight. Soil salinity is one of the major abiotic stresses reducing the crop production. Worldwide, about 20 % of the cultivated lands are suffering from increasing salinisation. One of the most suitable approaches to overcome this constraint is the selection for salt tolerant varieties. Our objectives are the investigation of salinity effect on plant growth at seedling stage in a double haploid (DH) population of winter oilseed rape (*Brassica napus*). This population will be used later to detect QTL for salt tolerance as a prerequisite for marker-assisted selection (MAS).

Therefore, 13 parents acting as the founders of about 7 DH mapping population have been tested looking for diversity in salt tolerance at seedling stage. Based on the results a DH population consists of 140 lines derived from a couple of these founders was considered in our study. The experiment was conducted in the greenhouse using 200 mM NaCl for stress and 0 mM NaCl for control under the favourable conditions for *Brassica napus* growth at 20 °C at day and 15°C at night. To test for salt tolerance differences between the DH lines; plant fresh weight, plant dry weight, relative water content (RWC), chlorophyll content, plant sodium and potassium content were assessed.

There was a clear and significant difference between the DH lines in this population, giving an indication that this population is suitable for QTL analysis. The analysis of variance (ANOVA) was carried out by PLABSTAT 3.0 software.

Keywords: *Brassica napus*, quantitative trait loci, relative water content, salt tolerance

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Salinity Down-Regulates Transpiration Rate of *Medicago sativa* to Increasing Vapour Pressure Deficit

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Medicago sativa is perennial forage with high yield and good quality. Plants growing in arid and semi-arid regions are often subjected to soil and atmospheric water deficit as well as high soil salinity during their life cycles. Plant transpiration increases at elevated atmospheric vapour pressure deficit (VPD), C3 species are reported to have a breakpoint (BP), above which stomatal conductance declines and limits transpiration rate to a maximum. Soil salinity is likely to be involved in transpiration response by affecting root hydraulic resistance, leaf water potential and stomatal conductance in salt-treated plants. The objective of this study was to compare the transpiration response of *Medicago sativa* over a range of VPD at various salt concentrations to identify the tolerance mechanisms to confront atmospheric water vapour deficit and salinity. Seeds of *Medicago sativa* were cultivated in a greenhouse till 8 weeks old and subjected to five salt treatments of 0, 40, 80, 120, 160 mM ($NaCl : Na2SO_4$ = 1:1) for 14 days. Then plants were exposed to increasing VPD (0.5, 1.0, 1.5, 2.5, 3.5 kPa) in a controlled environment chamber.

Leaf area ratio (LAR) and specific leaf area (SLA) significantly decreased at 80 mM and higher salt treatment, meaning *Medicago sativa* developed leaf thickness with increasing salinity at the expense of leaf area per plant. Total biomass was significantly reduced by salt stress but slightly changed when salt concentration exceeded 80 mM. Transpiration rate (TR) in control plants increased linearly with VPD up to 1.0 kPa, above which TR declined markedly. Salt treatment increased BP along the salt concentration gradient to 2.0 kPa at 160 mM, reflecting a compromised sensitivity in stomatal regulation. Increasing salt levels resulted in stomatal closure and consistent decrease of whole-plant transpiration rate. The results suggest that *Medicago sativa* down-regulates transpiration rate to conserve soil water, while reduction of SLA is assumed to compensate for decreased CO_2 diffusion. *Medicago sativa* can effectively counteract negative effects of salinity and varying VPD in a semi-arid environment.

Keywords: *Medicago sativa*, salinity stress, transpiration rate, vapour pressure deficit

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Salinity Tolerance Mechanisms in Barley and the Role of Vapour Pressure Deficit

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Salt stress poses an increasing threat to barley production. Salt is taken up to and distributed within the plant via its transpiration stream and is thus directly related to stomatal responses to vapour pressure deficit (VPD), perceived as atmospheric drought signal. In this study, we seek to understand the morpho-physiological adaptation strategies in barley under salinity and VPD stress combination. Four spring barley accession differing in their genetic composition as well as responses to salinity and VPD (based on a preliminary screening at germination and early seedling establishment) were evaluated for dry matter accumulation, leaf area, ion (Na^+, K^+, Cl^-) uptake and distribution in the different organs of barley. The experiment was set up within a phenotyping facility in the green house of University of Hohenheim in a randomised complete block design with humidity levels as the fixed effect. Plants were hydroponically grown in a modified Hoaglands solution, at pH 7 under two salt treatments (0 and 150 mM NaCl) and two levels of VPD (0.73 and 1.85 kPa) for 36 days (18 days after transplanting, 28 days after sowing). Leaf appearance and elongation was scored every 3 days at the early vegetative phase. Routine harvesting was carried out to determine the rate of biomass accumulation and leaf area. Samples were analysed using flame photometer and auto chloride-analyser to determine the uptake and distribution of sodium, potassium and chloride (respectively) in the harvested organs. Preliminary results show differing genotype responses in biomass accumulation and leaf area measurements for the salt and VPD stress combinations. VPD had a strong influence on salt uptake within the roots, leaves and leaf sheaths however genotypic differences were observed. The baseline information obtained from this study is subject to further investigation towards understanding and exploring the interaction between salinity and VPD which is crucial for developing salt tolerant crop varieties.

Keywords: Atmosperic drought, *Hordeum vulgare*, ion uptake, salt tolerance, VPD

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Effects of Salinity on Growth of the African Baobab: Differences between Seedlings from Malian Provenances

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The African baobab (*Adansonia digitata* L.) is a widely used multipurpose tree species, growing in the dry regions of tropical Africa, with medicinal properties, numerous food uses, and bark fibers used for a variety of applications. In this way, the tree plays an essential role in the rural communities of western Africa as a supplement to the local diet, a buffer against crop failures and a support for the local economy. Although the baobab is used by millions of people on a daily basis, the species has not yet been given the right attention and is being underutilised at this moment. Over the last few years a lot of research has been done on the baobab and much is already known about its behaviour. However, little is known about the effects of salinity stress. Soil salinity is one of the major problems affecting crop productivity in arid and semi-arid regions. Throughout the world, hundred million hectares or five percent of the arable land is adversely affected by high salt concentration, which reduces crop growth and yield. Almost fifty percent of the irrigated land is affected by high salinity, often resulting from secondary salinisation due to inappropriate use of saline irrigation water. In warm and dry areas, salt concentrations increase in the upper soil layer due to high evaporable water losses which exceed precipitation. Therefore, the objectives of this study are to analyse the growth of African baobab seedlings from contrasting Malian provenances and to classify them in terms of salt tolerance, with the overall aim of improving baobab cultivation in saline environments. For this study baobab seedlings from contrasting Malian provenances will be used and tested for their salinity tolerance. Growth indicators of seedlings from the selected provenances will be compared after exposure to increasing salt stress.

Keywords: Baobab, Mali, salinity, soil

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Salinity Intrusion - A New Threat to Agriculture in the Vietnamese Mekong Delta

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Salinity intrusion is a challenge for agricultural development in a low-lying area like the Mekong delta of Vietnam. In order to prevent sea water from entering into agricultural land, a series of coastal embankments and sluice gates have been built to enable intensive rice farming. Despite some achievements from these investments, crops always face a high risk of salinity intrusion, especially with climatic changes and sea level rise in recent years. This study aims at exploring the trend of salinity intrusion in the coastal area of the Mekong delta in the period of 1995 – 2011 based on data from four gauging stations and analysing causes of crop damages by salinity hazard via expert interviews and focus group discussion with farmers in 2011. Results showed that salinity concentration tended to increase during the research period. It starts earlier in the year, intrudes further inlands and remains longer in the river and canal networks during the dry season. Salinity intrusion is a growing problem and affects crop development. Recently, there were heavy crop damages by salinity intrusion in 2011. Research during that year revealed that the crops were destroyed due to a bundle of related factors not only by natural causes like high salinity levels or dry weather but also other socio-economic drivers like high product market prices fostering rice expansion and intensification, saline water leakage through the dyke systems, and improper sluice gate operation. Therefore, one can conclude that salinity intrusion is a chronic hazard but difficult to predict and control, damages are often huge, particularly in case of abnormal years. Under the contexts of social, economic and environmental changes at regional as well as global level, the salinity related problems are likely to increase and threaten the crops and livelihoods of local people in the coastal areas. Hence, it is necessary to pay more attention to this new threat and rethink about adaptation strategies including both structural and non-structural options instead of focusing only on hydraulic infrastructure constructions for crop development purpose.

Keywords: Coastal areas, crop damages, Mekong delta, salinity intrusion

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Selection of Tolerant Crops to be used in Tropical Salt Affected Soils

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Saline soils make up between 40 to 50 % of the soils worldwide expand near 3 ha min^{-1}. Cuba has around one million hectares affected by this problem. In Granma province, there are 228 thousand hectares, which represents 23 % of the whole area on the island. In these areas, the introduction of salt tolerant genotypes is an alternative to recover the salt affected soils. A series of experiments with the aim to evaluate and select salt-tolerant crops of cowpea (6 genotypes), tomato (8 genotypes) and bean (40 genotypes) were carried out under controlled, greenhouse and field conditions. The effect of 4 levels of salt stress (0.02, 3, 6 and 9 dS m^{-1}) was evaluated in controlled conditions using the germination percent, length of radicle, height of hypocotyl and dry matter of seedling parameters. The second experiment was established in a greenhouse to evaluate the effect of two salt levels (0.02 and 6 dS m^{-1}) on crops and measured physiological and biochemical parameters. The number of leaves, leaf width, tendril length, root and shoot dry matter, proline and glycine-betaine content and osmotic and water potential were also measured. Under field conditions the crops were cultivated to investigate the effect of salt stress on yield parameters. The results showed that all varieties evidenced decrease of parameters in presence of salt stress and the seedling damage was moderate in 3 dS m^{-1} and severe in 9 dS m^{-1}. A linear, significant and negative dependence between salts levels and germination, physiological and biochemical parameters was found. Some affectations were found in the growth and biochemical variables due to the content of salts in all varieties. In relation to yield and its components, the results evidenced differences in tolerance levels to saline stress among varieties, being IT 86 D-715 (cowpea), Vita and Amalia (tomato), TR-VAM 2005 B-13 and TR-VAM 2005–14 (bean) the most tolerant ones. However, Cubanita-666 (cowpea), Vita and Amalia (tomato) and TR-VAM B-43 (bean) were strongly affected by salinity which revealed salt susceptibility. The results showed the great potential of these varieties to be used in salt affected soils.

Keywords: Crops, salt stress, tolerance

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Potential Effect of Global Warming on Germination of a Mexican Wild Species of Commercial Chili

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With an effort to understand potential impacts of global warming on a species of commercial wild chili in Northern Mexico, we tested germination in an elevation and a temperature gradient. While initial efforts have taken place for its cultivation, *Capsicum annuum* var. *glabriusculum* known as "chile piquin" is mostly harvested from wild populations. Here we tested the germination of *Capsicum annuum* seeds from different locations across a latitude and an elevation gradient. We predicted that seeds from more tropical and more downslope sites would germinate more under warmer and lower conditions. In our germination study at three elevations we found the highest germination at the lowest site (360 m a.s.l.), lower at the medium elevation site (550 m a.s.l.) and no germination at the point higher than the natural species distribution (1600 m a.s.l.). There was no influence of seeds collection elevation. In a separate experiment we tested several techniques to promote germination in order to get a sufficient number of germinating seeds for statistical analyses to determine the response of seeds harvested at different elevations and latitudes on increased germination temperatures. For this trial we mimicked the daily variations in temperature of the soil surface during the rainy season (September) for the control group and two temperature-increased treatments, one was 2°C higher and the other 5°C higher than the control. Germination using scarification techniques was higher in the control group and lowest in the 5°C increase. The results from this study imply that while current conditions do not allow germination of *Capsicum annuum* seeds at higher elevation than those of its current distribution, higher soil temperatures associated to global warming might decrease germination of *Capsicum annuum* seeds. These results provide useful guidelines for current management plans of wild populations and future agricultural development of the species.

Keywords: *Capsicum annuum*, chile piquin, climate change, seed

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Elevation of Soil Temperature Might Change N-Cycling of an Agricultural Cropping System

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It is predicted that air and soil temperatures will be increased by climate change. Although effects of temperature elevation on soil N cycling are mediated by various interactions with plants, such effects are poorly documented. In this regard, we focused on the impacts of elevated soil temperature on microbial N cycling in soil and N uptake by plants. The hypothesis was that elevated soil temperature would increase N mineralisation, N uptake and wheat growth. The field experiment was conducted in the Hohenheim Climate Change (HoCC) experimental site in Stuttgart, Germany. In this HoCC experiment, soil temperature is elevated by 2.5°C at 4 cm depth by the use of heating cables placed on the soil surface. In 2012, winter wheat (*Triticum aestivum*) was planted. C and N concentrations in soil and aboveground plant fractions, soil microbial biomass C and N (Cmic and Nmic), mineral N content (NH_4-N and NO_3N), potential nitrification and enzymes involved in nitrogen cycling (protease, tyrosine peptidase, alanine peptidase, leucine peptidase and N-acetyl-glucosaminidase) were analysed at soil depths of 0–15 and 15–30 cm from five sampling dates. Sampling dates were between March and July 2012 according to the distinct phenological growth stages of wheat (BBCH-code 22, 31, 49, 65 and 89). The plants were rated weekly for their phenological development and senescence behaviour.

We found that plant growth did not respond to increased soil temperature. Generally, microbial biomass and some enzyme activities (leucine and tyrosine peptidase) were slightly increased by elevated soil temperature treatment. Soil NH_4-N content and protease activities were significantly increased in response to elevated soil temperature. The results partly supported the hypothesis that climate warming will affect N cycling in soils in an agricultural cropping system.

Keywords: Climate change, elevated soil temperature, enzyme activities, microbial biomass, nitrogen cycle, winter wheat

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Assessing Drought Tolerance of five Improved Forage Legumes to Improve Smallholder Dairy Productivity in Uganda

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Livestock production is an important component of smallholder farming systems in Uganda. One main constraint to especially dairy production is the lack of sufficient quantity and quality feed on a consistent basis. Therefore, this study aimed to evaluate and identify forage legumes that are adapted to drought. An on-station experiment was established at the NaLIRRI research station in Tororo, an area experiencing prolonged dry seasons. Five improved forages were compared under rainfed and irrigated conditions in a complete randomized block design (five replicates): *Canavalia brasiliensis* (CIAT 17009), *Desmanthus virgatus* (ILRI 321), *Desmodium uncinatum* cv Silver leaf (ILRI 6765), *Lablab purpureus* (CIAT 22759) and *Macroptilium bracteatum* cv Burgundy. Herbage biomass was sampled five times at two-monthly intervals, while root biomass was measured once. Biomass estimates were consistently higher on irrigated than non-irrigated plots, especially during the dry season. *Lablab* (1269.2 kg ha^{-1}), *Desmanthus* (1257.6 kg ha^{-1}) and *Canavalia* (1267.9 kg ha^{-1}) were screened as promising forages with the highest herbage biomass on non-irrigated plots and thus potential candidates for dry season feeding. *Macroptilium* and *Desmodium* recorded 1011.2 kg ha^{-1} and 894.43 kg ha^{-1} of herbage biomass which was significantly lower compared to the other forages. Root biomass was assessed once and was highest for Desmanthus, followed by *Desmodium* (36 %) and *Canavalia* (26 %) while both *Macroptilium* and *Lablab* had root biomass of less than 21 %. Stable carbon isotope signatures (δ13C) are currently analysed to assess water use efficiency of the forage legumes.

Keywords: Drought resistance, herbage, tropical forage quality

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Screening Potato for Drought Tolerance by Linking Physiological to Morphological Traits

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Potato is after wheat, rice and maize the fourth most important food crop in the world. Potatoes produce more food per unit of water than any other major crop. However, even short periods of water deficit significantly reduce tuber yield in potato. Climate change renders rainfall patterns increasingly unreliable, particularly in potato growing regions in central Asia. Screening tools considering the multiple trait nature of drought tolerance in potato are urgently needed to identify genotypes suited for production under water limited conditions and to accelerate the breeding efforts.

An experiment was conducted between September 2012 and January 2013 at an arid coastal site in southern Peru. 30 potato clones were planted in split-plot design with three irrigation regimes: fully watered, alternate irrigation (resulting in a 50 % reduction of water input) and terminal drought (irrigation withheld 67 days after planting). Chlorophyll fluorescence, relative chlorophyll content (SPAD) and relative water content were determined thrice in 15 day intervals after withholding irrigation. Quantum Yield was measured once after 30 days of withholding irrigation. In addition, biomass accumulation, root architecture, yield, and harvest index were recorded.

Quantum yield was decreased under drought conditions but was not related to changes in SPAD values and no significant differences were found among the genotypes. In contrast, high and stable harvest index and a small reduction in root length under drought were preliminarily identified as promising traits for assessment of drought tolerance in 10 genotypes. For the development of an effective screening tool, the morphological traits identified need to be linked to physiological traits indicating plant water relations. Osmotic adjustment and relative water content in combination with chlorophyll fluorescence are promising candidates for linking physiological adaptation to drought with morphological traits. The effectiveness of such a screening tool will be discussed and preliminary results will be presented.

Keywords: Abiotic stress, monitoring, *Solanum tuberosum*, traits, water use

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Drought Reactions of Different Provenances of *Corylus avellana*

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Corylus avellana is an important landscaping plant. In Germany the use of trees and shrubs in the open landscape is regulated by law (Federal Nature Conservation Act § 40) due to supposed genetic differences between provenances (conservation of biodiversity) and their adaptation to specific habitats. It is assumed that this adaptation supports performance in the landscape.
Two years old plants from four provenances of *Corylus avellana* coming from climatically different parts of Germany were used in a drought experiment under controlled conditions. The plants were exposed to a slowly and quickly developing drought stress by controlled decreasing irrigation. Well irrigated plants served as control. The experiment was carried out in a completely randomised design with 6 resp. 8 replications per treatment. During the experiment pre-dawn water potential, relative water content and stomatal conductance were measured. Chlorophyll fluorescence was determined at the beginning and at the end of the experiment. The experiment was terminated when severe wilting was visible. This was the case after 13 days for the slowly developing stress and after 9 days for the quickly developing one. With the background of a high standard deviation the following trends developed.
Apart from one provenance, in the beginning of the stress period stomatal conductance calculated as percentage from the control decreased marginally followed by sharp decline. This was also reflected in the results of pre-dawn water potential which differed greatly from the control plants at the end of the stress period. There were no differences between the provenances. Drought reactions probably were interfered with a previous though hardly visible ozone damage, which however appeared with heavy necroses when the plants were subjected to drought. Again with a high standard deviation the provenances differed in the development of visible ozone damage symptoms coinciding with the drought symptoms. At the end of the experiment, provenances with severe symptoms showed lower chlorophyll fluorescence than those with moderate symptoms. The pre-damage by ozone might have also affected the reaction of stomates, since the provenance with an early closure of stomate had fewer symptoms.

Keywords: *Corylus avellana*, drought, provenance

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Finding Strategies to Mitigate Drought Stress in Grain Legumes in Semi-Arid Eastern Kenya

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The threat of climate change implies the urgent need to design flexible cropping systems which are more resilient to the impacts of increased rainfall variability and drought. This is of special importance for the mainly rain-fed based small-scale farming systems in semi-arid Eastern Kenya, where grain legumes are an important component. Although legume species such as lablab (*Lablab purpureus*) and cowpea (*Vigna unguiculata*) are more productive and adapted to drought, beans (*Phaseolus vulgaris*) are by far the most widely cultivated grain legumes. During the short rains of 2012/13, field trials were conducted at KARI-Katumani, in Eastern Kenya to compare the agronomic performance of local grain legumes and to evaluate their production potential under different watering regimes. Three legumes (beans, cowpea and lablab) were subjected to three watering regimes; rain-fed, partly irrigated (rain + supplementary irrigation 50 mm per week till bud formation) and fully irrigated (rain + supplementary irrigation 50 mm per week till physiological maturity). Response to water regimes was significantly different for the three species. Water-use-efficiency (WUE) of lablab was lowest (3 kg grain ha^{-1} mm^{-1}) and therefore yields were fairly stable over all watering regimes reaching 1.2 to 2 t ha^{-1}. In comparison to the yield of the fully irrigated treatment (1.9 t ha^{-1}), yield reduction in beans was 50% (1 t ha^{-1}) under rain-fed conditions. Cowpea displayed the biggest variation between treatments with yields of rain-fed (0.9-1.5 t ha^{-1}), partly irrigated (1.5-1.9 t ha^{-1}) and fully irrigated (2.5-3.1 t ha^{-1}) plots reflected in the highest WUE (5.3–5.7 kg grain $ha^{-1}mm^{-1}$). Results give evidence that beans have a relative advantage to escape drought due to their short growing period, whereas with rainfall over 450 mm cowpea would be a better intensification option. Lablab seemed to be less affected by long dry spells than cowpeas or beans. In order to stabilise production with increasing rainfall variability, getting the right mixture of different legume species on farm would be a sustainable risk management strategy to design resilient farming systems and increase food security. These options are investigated using crop modelling and via the analysis of long term weather data with further on-farm trials in the region planned for 2013/14.

Keywords: Drought tolerance, Kenya, farming systems, food security, grain legumes

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Growth and Photosynthesis Responses of Chihuahuan Desert Succulent Seedlings

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In arid and semiarid environments characterised by low and erratic rainfall as well as high solar radiation, plants are at high risk of mortality during the early stages of seedling growth. In general, seedling establishment is more successful under nurse plants due to microenvironmental conditions that allow for a more efficient use of resources. The mechanisms that allow succulent desert plants to establish their seedlings in arid environments are not known. We tested the hypothesis that shaded seedlings have higher growth and higher photosynthesis than seedlings exposed to direct sunlight. The study site was located in the town of San Juanico Chico, San Luis Potosí, San Luis Potosí, México. In here we studied the photosynthetic responses and seedling growth for seven species from two families (Cactaceae: *Echinocactus platyacanthus, Ferocactus histrix, Myrtillocactus geometrizans* and *Stenocactus coptonogonus*; and Agavaceae: *Agave lechuguilla, A. salmiana* and *Yucca filifera*) from the Chihuahuan Desert under direct sunlight conditions and under the shade of nurse trees for 105 days. All seedlings had the same age at the beginning of the experiment. The nurse plant was always a mesquite tree (*Prosopis laevigata*). Response variables evaluated were relative growth rate, photochemical efficiency of photosystem II and electron transport rate. Seedling relative growth rate was not influenced by light condition, while photosynthetic variables differed between species and light conditions. These results give us a better understanding of the mechanisms with which succulent seedlings survive under stressful environmental conditions. With these results we can determine safe sites for establishment and suggest suitable sites for reforestation for each species in rural and urban environments.

Keywords: Agavaceae, Cactaceae, photosynthetic efficiency, seedling growth

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Yield of Eggplant submitted to Different Water Tensions on Soil

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The brasilian agribusiness sector is responsible for at least 22 % of the Gross Domestic Product, and the sector of fruits and vegetables is responsible for 3.5 % of agricultural GDP. The annual Brazilian production of vegetables reaches nearly 12.5 million tons with growth projections mainly of those with phytotherapic properties as the ggplant (*Solanum melongena* L.), which is being cultivated in 1,500 hectares in Brazil. It is expected an increasing demand of eggplant due to the medicinal properties of fruits such as reducing cholesterol level and also good source of minerals and vitamins. The biggest drawback to eggplant crop production is inappropriate soil moisture during its cycle. However, irrigation acts as a supplement to rain and keeps soil water rates at ideal levels for crop development, thus increasing plant growth, product quality, and yield. Appropriate irrigation management improves efficiency in water use, reduces energy consumption, and keeps suitable conditions of soil humidity and phytosanitiy. Timing criteria for irrigation scheduling may be based on soil water matric potential, yet there has been little research to evaluate the ideal time for eggplant crop irrigation. Therefore, the purpose of this investigation was to assess the effect of different water tensions on soil, applied in two phenological stages, on productive bevahiour of eggplant. We carried out two greenhouse experiments with cultivar Nápoli in South Minas Gerais, Brazil. In the first trial we applied the treatments at post-transplant/bud opening phase, in the second one at fruit formation/harvest phase. Both used totally random experimental design with 5 treatments and 6 repetitions. Treatments consisted of 5 different water tensions: 15, 30, 45, 60 and 80 kPa. We used drip irrigation system managed with tensiometers installed at 12.5 cm depth in 15, 30 and 45 kPa experimental units. Watermark® was used in 60 and 80 kPa tensions. Results only showed significant differences for all assessed variables for treatments applied during fruit formation/harvest phase, which clearly demonstrated that this phase is more sensitive to high water tensions in soil, leading to decrease in crop development. Also, the highest yields were provided by irrigation under 15 kPa tension.

Keywords: Irrigation, vegetables, yield

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Determination of kc Values for *Acrocomia aculeata*

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Against the background of climate change and the accompanying decrease of available irrigation water in many parts of the world, efficient irrigation in agriculture becomes more and more important. The water consumption of plants can be calculated with the climatic water balance. Doing so, potential evapotranspiration (ETpot) of plants is estimated with measured climate data only. The needed irrigation height can then be assessed by balancing water input (precipitation) and output (ETpot).
In irrigation practice, ETpot is often calculated with the crop coefficient approach of the FAO (FAO irrigation and drainage paper No. 24 and No. 56). In detail, ETpot is obtained by multiplying a potential reference evapotranspiration (ETo) with a crop specific crop coefficient (kc value). For the calculation of ETo, climate information (air temperature, air humidity, solar (net) radiation, wind speed) must be available. The needed kc values are provided by the FAO. However, kc values for *Acrocomia aculeata*, were not reported so far.
The objective of the present study was to investigate kc values for *Acrocomia* in order to be able to estimate its water consumption and irrigation water need with the FAO crop coefficient approach. The investigations took place on the research station of the Universidad Católica "Nuestra Senora de la Asunción" in Paraguay. The investigated *Acrocomia* trees were planted three years ago in plastic containers (heigt: 130 cm, diameter: 80 cm) with identical soils. According to the calculation procedure, ETo and ETpot of *Acrocomia* are needed to calculate the corresponding kc value. For ETo calculation, weather data of a nearby weather station could be used. ETpot of the *Acrocomia* trees (height: 2 m) was set equal to the water losses from the plastic containers. In order to avoid water stress of the *Acrocomia* trees, soil moisture within the container was regularly monitored with tensiometers and irrigation started (5 liter per irrigation) at a soil water potential threshold of 200 mbar.

Keywords: *Acrocomia aculeata*, crop coefficient approach, kc value, potential evapotranspiration

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Field Screening of Variation for Heat Tolerance in a Large Set of Sweetpotato Germplasm Accessions

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Sweet potato is a robust crop with a wide range of adaptation to agroecological conditions, high yield potential, low input cultivation requirements, effective vegetative propagation and high nutritive value but storage root initiation and growth is adversely affected by temperature. Improved sweetpotato varieties with increased tolerance to heat could improve productivity and allow for the use of more marginal heat prone production areas. Sweet potato landraces and unimproved genotypes represent a valuable resource for heat tolerance in breeding programmes. The International Potato Centre holds the largest *in vitro* collection worldwide of sweet potato germplasm of which only a fraction has been evaluated for heat tolerance. This vast pool for future adaptative breeding has remained fairly untapped due to the lack of necessary evaluation data. The objective of this on-going study is therefore to screen a representative collection of sweetpotato for key prioritised traits: early bulking and heat tolerance.
The poster will present the first evaluation data of a large set (1973) of sweetpotato accessions presently being cultivated and evaluated for heat tolerance in the coastal desert of Northern Peru. Due to the scale of the screening trial non-invasive optical and fast throughput methods are used to detect the effects of heat on biochemical and physiological processes. Canopy temperature will be determined by infrared thermal imaging and chlorophyll content by using a portable chlorophyll metre measuring Normalized Difference Vegetation Index (NDVI). Agronomic data (*e.g.* early bulking, storage root yield, number of pencil roots, number of marketable roots, harvest index, and dry matter content) will be recorded at harvest. It is expected that NDVI and canopy temperature are correlated to storage root yields and thus may prove to be useful tools to fast screen for heat tolerance of sweetpotato and ultimately detect existing variation in large germplasm collections.

Keywords: Abiotic stress, fast screening methods, heat tolerance, NDVI, sweetpotato, thermal imaging

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Combing Ability Analysis for Stem Characters and Yield Components in Wheat (*Triticum aestivum*) under Drought and Heat Stresses

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The frequency, duration, and severity of heat and drought stresses singly or in combination could be significantly increased due to the effect of climate change. Under these stresses, the stored carbohydrates in stems play an important role in grain filling in wheat after anthesis. The objective of this study is to determine the gene effects and combining ability of stem traits and yield components in some wheat cultivars. A diallel analysis of wheat (*Triticum aestivum* L.) parents (n = 7) and their F_1 (n = 21) was conducted for stem traits: stem diameter (SD), stem weight (SW), stem density (SDN) and yield components: 1000 kernel weight (1000-KW) and grain yield per spike (GYPS) under favourable (F), drought (D), combined drought and heat stress (D+H) conditions. The reduction due to D+H was higher in GYPS (36.27 %) than 1000-KW (17.36 %). Moreover, GYPS showed higher reduction due to drought (19.23 %) than heat stress (17.03 %). The reduction in 1000-KW due to drought (8.73 %) and heat stress (8.89 %) was comparable. For all traits, the mean square of general combining ability (GCA) was higher than specific combining ability (SCA), indicating that additive genetic effects were predominant. The GCA effects of the parents indicated Gimmza-7 and Long stem-Long spike which possessed largest SD were good general combiners for 1000-KW and GYPS as well. A highly significant correlation was found between stem traits especially SD with 1000-KW and GYPS under F (r=0.57**, 0.38**), D (r=0.41**, 0.40**), and D+H (r=0.56**, 0.50**), respectively. The highest narrow sense heritability (h^2) was account for SD under F (0.88), D (0.85), and D+H (0.86). Our results indicated such strong associations of SD with 1000-KW and GYPS under stress demonstrated clearly an important role of this character in sustaining grain filling and supporting grain growth. It is possibly through providing greater stem capacity for storing assimilates that are formed before and then to be remobilised to grains after anthesis. In addition, selection for SD under stress is feasible and fruitful since it showed high h^2 compared with other stem traits.

Keywords: Combined heat and drought stress, combining ability, stem diameter, wheat

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Effects of Light Quality and Direction on Growth and Development of Rice

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Future increase in food demand challenge agricultural research to explore alternative production methods that contribute to productivity, sustainability, and reduce environmental risks. Although successful methods have been developed to cultivate plants in artificial and controlled production systems, little is known about effects of light quality in combination with direction and distribution on the photobiology of rice.
LED-based light sources are easily dimmable and can thus be used to adjust light quantity in artificial plant production systems. Furthermore, due to their high scalability, they can be integrated into smaller units located inside or under the canopy in order to manipulate directional lighting. Our research focuses on studying the effects of the light quantity and quality on photobiology and morphology of rice genotypes. In a first step, we determined the light requirements of rice plants in a single plant growth system. Subsequently, the light quantity was split and was provided to the plants in equal shares from above and below. For the below canopy light source, effects of light quality were examined.
The experimental system consisted of planting tubes (15 cm diameter) lined on the inside with highly reflective foil. Each tube was sealed with a lid consisting of a ventilator with a heat sink and a single white LED. This combined system provides a continuous airflow to the plant and that cooling to the LED. The LEDs for below plant lighting were thermally coupled to heat sinks that were immerged into the nutrient solution. To maintain a constant root zone temperature, the nutrient solution in turn tempered with a water cooler.
Parameters examined were leaf appearance rate, number of tillers, leaf area, biomass, biomass partitioning (root/shoot, leaf/stem) and chlorophyll density under different light quantities and light directions.
The effects on rice photosynthetic efficiency as well as on growth and morphology will be discussed in relation to the light quality and illumination direction provided to the plants.

Keywords: Indirect radiation, LED, light quality, lighting direction, rice

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Crop biotic stresses (DPG session)

Virus Diseases of Major Significance to Tropical Crop Production - From Diagnosis to Disease Management

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Viruses present a major constraint to plant cultivation in the tropics and those infecting food crops - tomato, cucurbits and leguminosae as well as cassava and banana - are most devastating. This significance is because of changing agricultural practices (intensification) and climatic conditions and is foremost a result of an increased abundance of insect vectors especially of *Bemisia tabaci* and *Thrips* sp. efficiently transmitting many viruses. In addition, changes of vector populations including invasion into new areas and, the indiscriminate use of infected planting material contribute significantly to virus dissemination and spread.

In tropical agricultures, begomoviruses cause major diseases with serious impact, yield reductions and losses. Whiteflies are very efficient in spreading viruses and diseases because these insects can reach enormous population densities. Once introduced by only few insects viruses spread rapidly and thus 100 % infection can be reached in affected fields. Virus populations also change over time and this is because new viruses are introduced and can establish in their original host or other susceptible crops. Newly emerging viruses threaten virus resistance in crops and this highlights the necessity of continuous surveillance and monitoring of pests and diseases in crop management.

In protected production, crop management options directed at virus diseases generally are targeted to the exclusion of insect vectors and prevention of population growth and the use of virus-tolerant/ resistant cultivars. Disease management is feasible by a combination of measures that also include bio-control agents and the sensitive application of pesticides. In open field production, many of these control measures cannot be applied and here virus disease control is predominantly based on insecticide applications which reduce population densities but do not prevent virus spreading. Virus resistance in crops is a main element of disease management strategies but for many crops resistant, cultivars are not available. Disease management in open fields requires a combination of elements and well defined crop management strategies based on a thorough understanding of the epidemiological and ecological factors driving vector populations and virus dynamics.

Keywords: *Bemisia tabaci*, begomovirus, disease management, insect-transmitted viruses, thrips, tospovirus

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Potential of Selected Plants as IPM Components against *Leptocybe invasa*

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This study was done to evaluate three herbaceous plants (*Leonotis nepetifolia*, *Schkuria pinnata* and *Tagetes erecta*) for their use in cultural control of *Leptocybe invasa* Fisher & La Salle (Hymenoptera: Eulophidae), a gall wasp that attacks eucalypts in western Kenya. Fifty cages were set in a completely randomised design within a greenhouse with each cage enclosing potted healthy *E. saligna* seedlings either with each one of the test plants or alone. The caged seedlings were infested with *L. invasa* insects then the set up was monitored for five months. Height (Ht) and root collar diameter (RCD) growth of *E. saligna* were measured weekly for five months while number of galls on leaf mid-rib, petioles and stems of the seedlings were recorded for three months from the onset of gall induction. Data were subjected to ANOVA and means separated by LSD using STATGRAPHICS Plus. Mean number of galls on leaf mid-rib, petioles and twigs were, respectively: enclosed alone, 11 ± 1, 5 ± 1, 3 ± 0.5 ($p < 0.05$); enclosed with *L. nepetifolia*, 10 ± 1, 4 ± 0.5 and 2 ± 0.4 ($p < 0.05$); enclosed with *S. pinnata*, 7 ± 0.4, 3 ± 0.3 and 2 ± 0.5 ($p < 0.05$); and enclosed with *T. erecta*, 4 ± 0.3, 2 ± 0.2 and 2 ± 0.1 ($p < 0.05$). The respective mean height (Ht) and root collar diameter (RCD) growth of *E. saligna* seedlings after week twenty (20) were: *E. saligna* with L. nepetifolia (Ht: 126 ± 4; RCD: 2.7 ± 0.1); *E. saligna* with *S. pinnata* (Ht: 124 ± 1; RCD: 4.3 ± 0.1); *E. saligna* with *T. erecta* (Ht: 56 ± 2; RCD: 3.7 ± 0); *E. saligna* that were enclosed alone (Ht: 85 ± 2; RCD: 26 ± 0); and control *E. saligna* seedlings (Ht: 140 ± 1; RCD: 5.0 ± 0.1). Pest control by each of the plants was as follows: *T. eracta* (58 %); *S. pinnata* (37 %); and *L. nepetifolia* (16 %). Recommendations on control of *L. invasa* have been made.

Keywords: *Leonotis nepetifolia*, *Leptocybe invasa*, *Schkuria pinnata*, *Tagetes erecta*

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Genotype × Concentration × Mycorrhiza Interactions on Early Maturing Maize under *Striga lutea* in Nigeria

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The yield losses in maize production in tropical Africa including Nigeria are threatened by a number of unfavourable biotic agents of which *Striga lutea* is included. The activities of biotic factors depend on genetic constitution of the cultivars and stage of growth at the time of infection. Therefore, field experiments were carried out for two years in humid climate of *striga* endemic locations in Nigeria, to investigate the interaction of quality protein maize genotype × concentration of arbuscular mycorrhiza fungi (AMF) on early maturing traits and yield related components under *striga* artificial infestation. The early and maturing traits include; number of days from sowing to: emergence (DSE), production of primary (DSP), secondary (DSS), tertiary leaflets (DST), tasseling (DT), 50 % silking (DSK) and yield related components: plant aspect, plant harvest, ear aspect, ear harvest and plant stand were evaluated using factorial split model according to the standard procedure. The genotypic and concentration influence produced highly significant ($p < 0.01$) effects for all the early and maturing traits except DSK and DSP in farm settlement. The interactive effect of genotype × concentration were significant for all the early maturing traits, but non- significant for DSE, DSP, DT and DSK in farm settlement. The genotype × concentration level of mycorrhizal interaction were significant for maturing traits except DSE, while significant effect were observed for DSS, DST and DT in farm settlement. The maize genotypes responded positively to the concentration of AMF and their interactions in most of the growth characters in arm settlement compared to Temidire. The level of concentrations in AMF treated plants also produced significant effect, but higher than uninoculated (control) in both locations. However, to improve maize production, selection of early maturing traits and concentration of bio-inoculants should be integrated into maize breeding programmes.

Keywords: Concentration, maize genotypes, mycorrhiza, striga

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Mass-Trapping of the Xylophagous Moth Species, *Zeuzera pyrina*, by UV-Light-Pheromone Sticky Trap

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The leopard moth, *Zeuzera pyrina* L. (ZP) (Lepidoptera: Cossidae), is a xylophagous species that has become a serious pest in the olive orchards in Egypt. It attacks a variety of trees and shrubs. More than 150 plant species of up to 20 taxonomic genera, such as apple, pear, plum, olive, apricot, chestnut, and vines, are attacked. Current control practices include either manual killing of larvae inside their galleries, which is time-consuming, labor-intensive and therefore costly procedure, or wide-spectrum insecticide applications against adults. Both chemical and biological control have scored poorly against this pest and additional methods are needed. A simple, durable, but efficient UV-light sticky trap ("Hegazi model") was devised. The binary blend of the pheromone components, (E,Z)-2,13-octadecenyl acetate and (E,Z)-3,13-octadecenyl acetate (95:5) was combined with the light trap for ZP mass trapping. Combination of light and sex pheromone was optimally attractive to ZP population in olive orchards. Greater reduction in total counts of active galleries was observed in mass-trapping plot compared with those recorded in the control field, where chemical sprays and manual killing were performed. In mass-trapping plot, the seasonal captures and active galleries diminished from one year to the next which may indicate the effectiveness of the method. The study strongly recommends the use of mass-trapping method instead of pesticides against the ZP moths, not only to control them but also to mass-trapping in the same time other olive pests, *e.g.*, the olive (*Prays oleae* Bern) and jasmine (*Palpita unionalis* Hub.) moths. Yield from trees in mass-trapping field was significantly increased in comparison to control trees.

Keywords: Leopard moth, light trap, mass trapping, sex pheromone

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Assessment of Farmers' Plant Disease Knowledge in Organic Cacao Cultivation

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The Alto Beni region on the eastern foothills of the Andes accounts for 90 % of certified organic cacao production in Bolivia and other tropical products for the city of La Paz. In the region more than 2200 households strongly depend on the cultivation of cacao. Cacao is cultivated on smallholder farms mostly in diversified agroforestry systems. These systems contribute to both the conservation of biodiversity and the food security of the farmers.

An outbreak of the frosty pod disease caused by *Moniliophthora roreri* in 2011 is now threatening these relatively sustainable production systems. Examples all over Latin America showed the abandonment and elimination of cocoa systems and the loss of biodiversity and local revenues after its attack. Frosty pod rot is an extremely invasive and destructive disease causing yield losses of 30–80 % after establishment in a region.

An efficient and applicable disease management strategy should address both, ecologic and socio-economic conditions of the entire agro-ecological system. Scientific knowledge must therefore be complemented with the local farmers' knowledge in general and especially their local knowledge on disease management. The aim of this qualitative study was to gather farmers' local disease knowledge to building a fundament for the participatory development of a disease management strategy. Data was collected by combined 24 in depth interviews with on-farm field visits.

We found that there is a certain lack of ecosystem knowledge among the ethnically diverse farmers group, which might be due to the recent colonisation of the area. Cacao cultivation knowledge is present on a basic level but is unequally distributed and the level of performance of disease prevention and control practices lags behind their level of awareness.

It was also found that the process of knowledge formation is ongoing and co-evolving with the active adaptation of the cultivation system. Most sustainable practices related to an additional labour input are strictly challenged by the lack of skilled labour and the migration out of the region into the bigger cities. These constraints should be considered when designing an efficient disease management strategy.

Keywords: Bolivia, local knowledge, *Moniliophthora roreri*, participatory technology development, *Theobroma cacao*

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GEOSIMCast Model: An Empirical Approach in Cundinamarca, Colombia

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The oomycete *Phytophthora infestans* is the cause of Late Blight, which is considered the most important disease worldwide in potato fields. In most cases, potato production relies on frequent fungicide spraying which rises production costs for farmers in emerging countries, being the main cause of crop abandonment. This study describes the climatic conditions of infected potato crops in Cundinamarca (Colombia) and this study helps to calibrate, standarize and validate the GEOSIMCast model for this region. Colombia is the third potato producer in Latin America, therefore, the results of this research contribute to the understanding of how climatic factors influence the biological cycle of this pathogen in potato fields in different parts of the country. The trial was conducted in eight commercial potato fields in three municipalities of Cundinamarca. Fertilisation and non-experimental fungicides and pesticides were applied according to the standard agricultural practices in the region. Fields were planted with differents potato varieties (common called R-12, Criolla and Suprema), which have different level of response to the disease. The sampling for the disease began at the emergence of the crop in each field and lesions were collected to estimate the number of sporangia and the proportion of the lesion in the leaf. Climate data were taken from a weather stations database provided by IDEAM (Instituto Hidrología, Meteorología y Estudios Ambientales de Colombia). Daily climatic data of those stations were interpolated in order to be able to apply the GEOSIMCast model, and the result of the modelling is a fungicide calendar map (risk map). Furthermore, the SIMCAST model (which it is included in the GEOSIMCast model) generates AUDPC graphics, which estimate the late blight progress in potato fields, during the growth stages of the potato crop. These graphics help us to compare the quality of the model predictions and the actual severity of the disease based on the AUDPC graphics created from our sampling.

Keywords: Climate, GEOSIMCAST, late blight, *Phytophthora infestans*, potato varieties

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Feeding Damage of *Pandemis heparana* induces the Release of Specific Volatile Compounds from Apple Plants

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Pandemis heparana Denis & Schiffermüller (Lepidoptera, Tortricidae) is one of the most widespread tortricid leafrollers in European apple orchards and is considered a key pest of apple plants. It is widely distributed in central and north Europe as well as parts of Asia and North America. Larvae of *P. heparana* cause damages primarily on the foliage of its host plants, although they may damage fruits as well. The aim of the present study was to find out if mechanically-damaged and *P. heparana*-damaged apple plants are able to release specific volatile compounds in response to the two different damages, as an indirect defence mechanism. Herbivore-induced plant volatiles (HIPVs) are in fact known to play a critical role in tritrophic interactions.

The volatile organic compounds (VOCs) released by the leaves of one-year-old apple seedlings were collected by closed-loop-stripping-analysis and characterised by gas-chromatography mass-spectrometry. Volatiles were collected for three subsequent days from undamaged, mechanically-damaged and insect-damaged seedlings in three replicates. The mechanical damage was caused on the first day of the experiment (single wounding event). In the case of insect damaged seedlings, 12 larvae were left on the leaves of each plant, feeding for three days.

Twelve VOCs were characterised in the undamaged apple seedlings. They included (Z)-3-hexenyl acetate, nonanal, decanal, 2-ethylhexanol and 8 linear and branched hydrocarbons, ranging from C14 to C20. In case of mechanically-damaged apple seedlings, 6 more volatile compounds were found, namely acrolein diethyl acetal, (E)-4,8-dimethyl-1,3,7-nonatriene, (Z)-3-hexenyl butyrate, (Z)-3-hexenyl benzoate, indole and alpha-farnesene. In case of *P. heparana*-damaged seedlings, we were able to detect a total of 25 volatile compounds. Among these, 8 compounds were specifically induced, namely the terpenes (E)-beta-ocimene, beta-caryophyllene, germacrene D, linalool, calamenene and cadalene, and the benzenoids benzyl cyanide and methyl salicylate.

Our experiments showed for the first time that apple plants strongly respond to insect damage in a specific manner. The volatile profile of *P. heparana*-damaged apple plants included several compounds that were not detected in either undamaged or mechanically-damaged plants. These HIPVs could be important for the development of new eco-friendly techniques of insect pest control in apple orchards.

Keywords: Apple volatiles, chemical ecology, *Pandemis heparana* herbivore-induced plant volatiles, plant-insect interaction

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Analysing Climate Impacts on Insect Pests using Phenology Modelling and GIS Implemented in the ILCYM Software

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Climate change is expected to exacerbate the already serious challenges to food security and economic development; especially on the African continent where people are already struggling to meet challenges posed by existing climatic variability. Change in temperature caused by climate change is considered the most important abiotic factor affecting the future distribution and abundance of pests. Early predictions of pest risks could help to adapt to climate change by developing and supporting farmers with adequate pest management strategies. The relationship between insect development and temperature is best described by process-based phenology models. The ILCYM software, an open-source computer-aided tool developed by CIP, supports the development of pest phenology models that can be used through simulations for estimating life table parameters (*e.g.*, net reproduction rate). In its GIS component, it estimates three risk indices (establishment (EI), generation (GI) and activity index (AI)) to map and quantify changes on global and regional scales using either actual (WorldClim database) or future temperature data (downscaled data of scenario A1B). Higher spatial (pixel size of 90 m) and temporal resolution (daily data) analysis for capturing insect potential distribution and abundance on small regional scales and variable altitude gradient can also be conducted. In a collaborative effort between CG-Centers (CIP, IITA) and its partners (icipe) the effects of temperature change are assessed on a wide range of insect pests (*e.g.*, cassava mealybug, maize stem borers, potato tuber moths) of important food crops. Preliminary results will be presented; the applied methodology is proposed as a very helpful tool for adaptation planning in integrated pest management.

Keywords: Adaptation planning, climate change, food security, insect life cycle modelling, integrated pest management, pest risk assessment

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Population Cycles and Economic Losses caused by *Zeuzera pyrina* in an Olive Orchard, Egypt

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The leopard moth, *Zeuzera pyrina* L. (ZP) (Lepidoptera: Cossidae), is an European species with an increasing importance in last few decades in Egypt. Seasonal trends in light-pheromone trap catches for ZP over the period 2002 to 2011 in badly infested olive plots are presented. The ZP moths occurred continuously from late April throughout the growing season and into fall beginning harvest. The ZP has annual biological cycle in olives. The results provided evidence of periodic behaviour in population densities. It seems that the bearing pattern generate periodic oscillation, *e.g.* larger number of moths in off-year and smaller one in on-year. The ZP reached outbreak densities in the 8th year of trapping study. The outbreak cycle may be within the range of 8–12 years. These findings are discussed in relation to bearing pattern of olive tree.

A three-year field experiment was conducted to show that olive strip cropping may reduce ZP infestation and crop losses in olive orchards. In the first two years naturally severely injured plots planted with the highly susceptible local varieties Sennara and Toffahi were observed. Yield losses were estimated at 2.6 to 3.1 t ha^{-1} for Sennara and 2.1 to 4.8 t ha^{-1} for Toffahi. The value of these losses is estimated at US$1608 to 1770 per ha for Sennara and 1433 to 3216 per ha for Toffahi. In the 3rd year we compared the response of eight olive varieties with different cropping systems (variety mixtures) to ZP incidence and their subsequent yield and value of losses. The results suggested that mixing olive varieties can assist in ZP control. Also, yield loss due to ZP damage is influenced by the companion variety and neighbouring vegetation.

Keywords: Economic loss, leopard moth, olive tree, population trend

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Cocoa Yield Development of Different Sites, Varieties, Production Systems and Years, in Alto Beni, Bolivia

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One of the most essential limiting factors of cocoa (*Theobroma cacao* L.) productivity worldwide is pests and diseases. Each of the major production regions has its specific pests and diseases. Reported yield losses range from minor to almost 100 per cent.
In Alto Beni, located in the Amazonian watershed of the department La Paz, Bolivia, the Research Institute of Organic Agriculture (FiBL) and its local partners are addressing several problems of cocoa producers using a participatory technology development approach. Problems were identified in a participatory way and are, in order of priority, i) to reduce the incidence of pests and diseases, mainly the cocoa mirid (*Monalonion dissimulatum*) and frosty pod rot (*Moniliophthora roreri*); ii) to evaluate the productivity of different cocoa varieties (local selections, introduced clones), and iii) to document the management practices and plantation layouts of high yielding cocoa farmers. In order to develop novel biological pest control measures, both the knowledge of cocoa yield development in the course of the harvest period, as well as the dynamics of pests and diseases are of great interest.
Data from three different research activities of the mentioned project are analysed for yield development, the appearance and the incidence of pests and diseases. The research data are from:
a) On-farm trials in multiple locations which were established in 2004. The performance of 16 cocoa varieties have been assessed for 3 years (2010–2012).
b) Four high yielding cocoa farmers' fields (2012 only).
c) A long-term field experiment assessing the sustainability of five cocoa production systems (2011 and 2012). The trial investigates the influence of monocultures and different agroforestry systems under organic and conventional management on the yield development, among other agronomic, economic and environmental parameters.

Keywords: Cocoa, diseases, pests, production-system, yield-development

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A Maximum Entropy Model for the Potential Distribution of *Striga hermonthica* in Africa

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The genus *striga* (Orobanchaceae) comprises parasitic weeds recognised as a major problem for crop production in sub-Saharan Africa. *Striga hermonthica* is an obligate parasite of pearl millet, sorghum, corn and other important crops in the semi-arid and arid regions of the tropics. Annually, this species produces millions of hectares of yield loses and a great impact on human welfare in the rural areas where it occurs.Under the present situation and the possible scenarios within the framework of climate change *Striga hermonthica*'s current and future distribution needs to be estimated urgently, in order to efficiently target available prevention and management strategies.

Based on data collected from the field and an extensive bibliographic search, we used the Maximum Entropy (Maxent) modelling approach to estimate the distribution of *Striga hermonthica* in the African continent. We focused on the species' present distribution and its prospection for the year 2050. We used the scenarios proposed by the IPCC 4th Assessment Report and their climatic models.

The results, based on the accessed data, arguably show the existence of two different sub-populations of *Striga hermonthica*. The sampled points representing the occurrence of *Striga* were first sorted according to their geographical location in the continent. Then a distribution model over the whole African continent was produce for each sub-population. The subgroup distributed in the western part showed affinity for sub-saharan climatic conditions and it is also likely to be present in southeast Africa. The eastern subgroup exhibited preferences for the climatic conditions found in the southern part of the continent and it could have a strong presence in North Africa if conditions are suitable.

Keywords: Africa, climate change, maxent, potential distribution, Striga

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Effects of Contrasting Soil Types, Organic Fertilisation and *Striga* Presence on the Abundance of the Biocontrol Agent *Fusarium oxysporum* f.sp. *strigae* in Soils

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The parasitic weed species *Striga hermonthica* is one of the major constraints to cereal production in sub-Saharan Africa affecting the livelihood of about 100 million people. *Striga* lives parasitically on cereal crops such as millet, sorghum, maize, rice and sugar cane where it can lead to up to 100 % crop loss in the field. The soil-borne biocontrol agent (BCA) *Fusarium oxysporum* F. sp. *strigae* (acronym: Foxy 2) has shown superior suppression ability of all growing stages of the weed *Striga* and seems to be a promising control tool for the African farmers. For the wide spread application in the field it is necessary to assess the control stability and therefore the persistence of the BCA under contrasting environmental conditions to investigate necessary re-inoculation times. Therefore a molecular detection tool based on quantitative polymerase chain reaction (qPCR) was developed to specifically quantify Foxy 2 in soil samples. In the presented study, a rhizobox experiment was performed with a *Striga* tolerant maize variety under controlled conditions in a climate chamber. Since the persistence of Foxy 2 can vary under different soil conditions and with presence or absence of the weed *Striga* we have included two contrasting tropical soil types, organic fertilisation with *Tithonia diversifolia* and *Striga* presence and absence in the experimental design. Foxy 2 was introduced via seed coating of the maize seed with 1.15*105 colony forming units per seed. Rhizosphere soil samples were obtained 14, 28 and 42 days after planting and further analysed on the abundance of Foxy 2.
The rhizobox experiment clearly showed that soil type and organic fertilisation have significant effects on the abundance of Foxy 2. The propagation ability of the BCA was significant higher in the sandy soil type compared to the clayey soil. The organic fertilisation treatment was clearly promoting the abundance of Foxy 2 in both soils and can therefore increase the effectiveness of the BCA which is particularly important under non favoured soil conditions of the BCA to provide stable control ability against Striga.

Keywords: Biological control agents, *Fusarium oxysporum*, *Striga hermonthica*

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Genetic Diversity of African *Striga hermonthica* Populations and Pathogenic Effects on Contrasting *Sorghum bicolor* Cultivars

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The root hemiparasite *Striga hermonthica* causes enormous yield loss in its dryland staple cereal host *Sorghum bicolor*. Striga-resistant sorghum cultivars could be an important part of integrated *S. hermonthica* control. For efficient resistance breeding, knowledge about the pathogenic diversity of *S. hermonthica* is essential. The aims of this study were therefore to (i) determine the genetic diversity within and between seven *S. hermonthica* populations from East and West Africa using 15 microsatellite markers and (ii) to assess pathogenic main effects and host-parasite interactions of these *S. hermonthica* populations grown on 16 diverse sorghum genotypes in a greenhouse pot trial.

Most of the observed genetic variance (91 %) assessed with microsatellite markers occurred within *S. hermonthica* populations. Only a small portion (8 %) was accounted to differences between regions of origin of the *S. hermonthica* populations. A positive correlation (R^2=0.14) between pairwise geographic and genetic distances reflected the slightly increasing differentiation of *S. hermonthica* populations with increasing geographic distance. East African *S. hermonthica* populations, especially those from Sudan, had significantly greater average infestation success across all sorghum genotypes than West African populations. Some specific host-parasite interaction effects were observed.

The applied markers detected only neutral genetic diversity. To identify any association between *striga* virulence and molecular markers, a high-density marker system covering the whole *striga* genome would be required and a very precise and representative phenotyping system.

The high genetic variation among individuals of each *S. hermonthica* population underlines the high potential adaptability to different hosts and changing environments, and points to the need to manage sorghum resistance alleles in space and time so as to hinder the parasite to overcome resistance.

Combining resistant varieties with an integrated management approach will be essential for effective *S. hermonthica* control.

Keywords: Greenhouse pot trial, microsatellite markers, *striga* aggressiveness, *striga* genetic variability, *striga* resistance in sorghum, striga-sorghum interaction, witchweed

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Evaluation of Okra Accession in Treatment Combinations of Mycorrhiza Fungus, Mushroom Compost and Poultry Manure

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Okra *Abelmoschus esculentus* L. (Moench) is one of the most widely cultivated vegetables by rural farmers of Nigeria due to its high nutritional value. The potentials of biofertiliser as an alternative to inorganic fertilisers in crop production has been identified. Therefore, the growth and yield response of five okra accessions viz NG/TO/02/12/156, NG/OA/03/12/157, NG/OA/05/12/159, IJ-OND Okr 1 and IJ-OND Okr 2 to sole and combinations in treatment of spent mushroom compost (SMC), *Glomus mosseae* and poultry manure (PM) were investigated at on-farm trial conducted at the research farm of Botany Department, University of Ibadan, Nigeria from December to April, 2013. The experiment was laid out factorially in a complete block design with eight treatments and three replicates. The Arbuscular mycorrhizal fungus (AMF) G. mosseae, mushroom compost and poultry manure were inoculated to 8 kg soil at the rate of 1.67 g, 2.5 g and 5 g each per plant, while the control had 0 g.The result showed that the interactive effect of replicates, treatments, week after planting and replicate × treatment were highly significant ($p < 0.01$) for most of the agronomic parameters, but non-significant at replicate × week after planting level. The effect of treatment × week after planting was also significant for number of leaves, leaf length and leaf width, but non-significant for plant height. Again, *G. mosseae* + PM treated plants produced the highest mean number of leaves of 9.66 and were significantly different from other treatments and control. *G. mosseae* + SMC had the highest value of plant height (41.93 cm), leaf length and leaf width compared to other treatments and control. The mean interactive effect of replicates, replicate × treatment were non significant for fruit length and width, fruit weight per plant, total number of fruit, but highly significant ($p < 0.01$) for dry weight and seed weight per plant at treatment level. The highest cumulative total number of fruit and fruit weight were recorded for *G. mosseae* inoculated plants. Therefore, these bio-inoculants should be integrated into organic agriculture.

Keywords: Bio-inoculants, growth, okra, yield

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Pest Status and Farmers' Pest Management Practices in Sweetpotato Cropping Systems of Uganda

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Sweetpotato (*Ipomoea batatus* (L.) Lam.) is the third most important food crop in Uganda. Although it is considered a food security crop, its productivity is far below its potential. This study assessed the pest status and farmers' perception and management practices of the most economically important insect pests of sweetpotato, *i.e.* the sweetpotato weevils *Cylas* puncticollis Boheman and *C. brunneus* F. and the sweetpotato butterfly *Acraea acerata* Hew.

A total of 192 rural farm households of the districts Kabale, Kasese, Gulu, Masindi, Soroti and Wakiso were interviewed using a structured questionnaire. Additionally, the abundance, infestation rate and intensity of infestation of all three pests was assessed and the root yield loss caused by *Cylas* spp. quantified over two growing seasons in the districts of Kabale and Masindi.

Over 80 % of farmers grow sweetpotato for home consumption, emphasising its importance as a food security crop. *Cylas* spp. and *A. acerata* were ranked as the first (57 % of the households) and second (37 % of the households) most damaging insects to sweetpotato. The prevalence of *A. acerata* larvae was generally low (8–25 %) and its larvae caused very little defoliation (1–25 %). For *Cylas* spp., the abundance was relatively high (40–97 %), with a consequential high yield loss (37–51 %) of marketable root weight. Farmer management practices of *A. acerata* included use of chemical insecticides (24 % of households), ash application (3 %) and hand picking (2 %). However, 65 % and 87 % of the households did not apply any control measure for *A. acerata* and *Cylas* spp., respectively.

All pests are a big constraint to sweetpotato production in Uganda. Thus, appropriate integrated pest management (IPM) strategies must be designed, particularly for *Cylas* spp., if the food security and livelihoods of farmers who depend on this crop is to be improved.

Keywords: *Acraea acerata*, *Cylas* spp, farmers´ perception, IPM, *Ipomoea batatus*, sweetpotato butterfly, sweetpotato weevil

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Comparative Efficacy of Various Botanicals against Potato Leaf Roll Virus in Relation to Environmental Conditions

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Research was carried out to identify resistant source against potato leaf roll virus (PLRV) on the basis visual symptoms and ELISA test. Out of twenty-nine varieties/lines only two 394021–120 (line) and Orla (variety) was resistant to PLRV and ten varieties showed moderately resistant response categoried on the basis of visual symptoms. These results were confirmed through ELISA test. All other varieties/lines fall in the susceptible to highly susceptible range. The disease incidence was highly significant correlated with maximum and minimum air temperature and relative humidity. While on the other hand there was also a significant correlation of maximum and minimum air temperature, relative humidity and wind speed with number of aphids per plants. There was increasing trend in disease severity with one degree increase in maximum temperature. The critical rang for temperature at which maximum disease was recorded was 22–24°C with a relative humidity range of 60–70 %. For the successful management plant extracts, neem (*Azadirachta indica*), datura (*Datura stramonium*), garlic (*Allium sativum*), onion (*Allium cepa* L.), allovera (*Aloe barbadensis*), eucalyptus (*Eucalyptus globulus*) and two bio products i.e Imidacloprid and Vampire were evaluated in the field. All the treatments were replicated thrice by following a complete randomised block design. All the treatments showed a significant reduction in disease by lowering the aphid population. Among the two bio products Imidacloprid proved to be the best by decreasing the disease incidence up to 36.10 %. Among plant extracts datura (*Datura stramonium*) and neem (*Azadirachta indica*) were proved equally effective by lowering the disease incidence up 38.14 % and 37.72 % respectively.

Keywords: Correlation, ELISA, leaf rolls virus, management

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Evaluation of Safe Pesticides and Varieties for Management of Insect Pests in Snapbeans in Kenya

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Studies were undertaken from December 2009 to January 2011 to assess varieties and the efficacy of some neonicotinoid formulations used in snap bean production as seed dressings and soil drenches against snap bean pests. In the first experiment, four neonicotinoid seed dressing (Gaucho, Monceren, Cruiser, Apron Star) and two soil drench formulations (Actara and Confidor) were tested on Amy variety in a randomised complete block design replicated three times. Seed dressing chemicals were applied on site just before planting whereas the soil drenching chemicals were applied twice on the third and 13th day after emergence. In the second experiment, seven commercial snap bean varieties (Amy, Alexandra, Bravo, Serengeti, Paulista, Tana and Mara) were tested with and without a pesticide (Confidor) in a split plot design. Confidor pesticide formed the main plots and variety the sub-plots. Data was collected weekly on number of plants per plot, bean fly maggots, whitefly nymphs, bean fly ovipuncture marks, number of thrips on leaves and flowers and finally on pod yield.
The number of bean fly maggots was significantly ($p < 0.001$) lower in plots treated with Confidor, Actara, Gaucho, Monceren and Cruiser than in Apron Star and non-treated control plots. Plots treated with Confidor and Actara had significantly ($p < 0.001$) lower bean fly infestations and gave significantly ($p < 0.001$) higher yields. Thus neonicotinoid treatment with Cruiser, Monceren or Confidor in snap bean production can effectively reduce bean fly infestation and increase yields hence offering great benefits to snap bean growers. On host plant resistance, the varieties were significantly different ($p = 0.001$) in the number of plants as well as in marketable ($p = 0.001$) and total pod yields ($p = 0.001$). Alexandra and Serengeti variety had higher plant stand and yields than Amy variety, the commonly grown variety in Mwea. Treatment with Confidor further improved plant stand and increased pod yield. Some degree of resistance was noticed in Alexandra and Serengeti varieties against bean fly which was enhanced by treatment with Confidor. Alexandra and Serengeti varieties could be recommended to snap bean growers in areas like Mwea which experience high pest infestation.

Keywords: Beanfly, pesticides, seed dressing, thrips

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Effectiveness of Biological Control Agents for the Successful Management of Chickpea Wilt caused by *Fusarium oxysporum* f.sp. *ciceris* (Padwick)

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Chickpea wilt caused by *Fusarium oxysporum* f.sp. *ciceris* (Padwick) is a devastating disease of chickpea around the globe wherever this crop is grown. For the successful and environmentally friendly management six biological control agents were evaluated against the pathogen *in vitro* assay, glass house assay and in the field. Among the six biological control agents *Pseudomonas fluorescens* was proved to be very effective by inhibiting the mycelia growth of fungus up to 70.94 % inhibition over control on PDA medium. *Trichoderma harzianum* was proved to be second best followed by *Rhizobia* spp. and *Bacillus subtilis* with 63.95 %, 60.79 % and 57.68 % growth reduction over control, respectively. When seeds were treated with bio-control agents all the antagonists were effective in managing the disease. In this case *Pseudomonas fluorescens* proved to be most effective on a moderately resistant variety (Noor 91) and two susceptible varieties (Pb2000 and ICC131–21) and showed significant disease reduction percentage with mean 76.78 over inoculated control in glass house. While *Rhizobium* spp was proved to be second best fallowed by *Trichoderma harzianum* with means disease reduction percentages 69.44 and 57.73 respectively. *Bacillus subtilis* was least effective against the disease. The overall and individual effect of all treatments was highly significant on moderately resistant variety (Noor 91) as compared to other two and inoculated control. Field trail under sick plot condition showed that when chickpea seeds of four varieties were treated with *Pseudomonas fluorescens* it reduced the disease incidence up to 69.89 % over control. When seeds of chickpea were treated with *Rhizobium* sp., proved to be second best fallowed by *Trichoderma harzianum* with disease reduction percentage mean 66.76 and 57.17 respectively on all four chickpea varieties.

Keywords: Chickpea, chickpea wilt, *Pseudomonas fluorescens*, *Trichoderma harzianum*

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Tree crops and plantation trees

Rubber Cultivation in Mainland Southeast Asia: Dimension and Potential Consequences for Crop Production

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One of the major natural resources needed by emerging world markets and economies, especially in Asia, is natural rubber (*Hevea brasiliensis*), used for high quality products, mainly for vehicle and airplane tires (68 % of world production). At present, more than half (57 %) of the global natural rubber is produced in the Greater Mekong Subregion (GMS), a geographical region and an economical association of the Mekong bordering states (China, Cambodia, Laos, Myanmar, Thailand, and Vietnam). China is projected to use 30 % of the world rubber production by 2020. Cultivation of rubber is strongly increasing in the GMS countries and is accompanied by major problems and threats, including a reduction of the natural forest cover and changes in land use, as well as changes in important ecosystem services and functions. Furthermore, rubber monocultures reduce agrobiodiversity of traditional land use systems and affect pollinator services for relevant food crops. Rubber cultivation represents a profitable opportunity for smallholders, but the abandonment of traditional land use systems in favour of a single tree crop implies a higher liability to climatic, disease and economic risks without flexibility for rapid adaptations. The loss of traditional systems is accompanied by a strong reduction in crop diversity, and smallholder rubber producers have meanwhile suffered livelihood vulnerability from excessive rubber cultivation. Rubber plantations in Yunnan have also eroded the capacity of farmers to manage ecologically diverse landscapes and to participate in market networks. Solutions to reduce such effects are addressed in the BMBF-funded project SURUMER (Sustainable rubber cultivation in the Mekong region) with the development of alternative mixed cropping rubber cultivation systems with crop plants generating added value to the farmers and access to new markets. Problem statement, concepts and approaches of the project are presented in detail.

Keywords: China, crop production, ecosystem services, rubber cultivation, Yunnan

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An Integrated Modelling Approach to Determine Environmental Services and Trade-Off Effects under Land Use Change

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In South East Asia large scale conversion of tropical rainforest into rubber monocrop plantations is taking place at accelerated rates. Such land use change can curtail ecosystem functions and reverse carbon sinks into potential C sources through burning, clearing, and increased rates of run-off, erosion, sediment transport in rivers, soil respiration and leaching. Due to the high latex demand and high profitability an increasing trend to even convert food crop areas into monocrop rubber plantations is ongoing. On the other hand, alternative land use or management options may have the potential to mitigate these impacts and combine food crop production with utilisation of renewable resources.

The assessment of the impact of such land use changes on food production, C dynamics, biodiversity and water cycles will be done with the spatially explicit dynamic Land Use Change Impact Assessment (LUCIA) tool. Plot and watershed level measurements from experiments in a case study area of Xishuangbanna, South-West China, will form the basis for parameterisation, calibration and validation of LUCIA. LUCIA is an integrated assessment tool able to simulate, besides C sequestration, the effect of land use intensification on environmental services such as habitat fragmentation, changes in hydrological cycle and agro-ecosystem productivity. One relevant module to be implemented in this context is LUCIA-Choice, which shall simulate farmers' decision-making based on soil fertility and cropping rules, taking into account behavioural components (*e.g.* crop profitability, farmers cultural preferences, distance to fields, or cost-benefit calculations). Through the dynamic simulation of the effect of land use change at landscape level LUCIA is able to assess the environmental impact and changes in environmental services and hence estimate trade-off effects with productivity and welfare. Model concepts and first results of the model will be presented.

The improved LUCIA model and modelling outputs will serve as tools for future land use planning purposes and also serve as a tool to interact with local stakeholders to jointly assess trade-offs between environmental services and agricultural intensification and to develop improved and acceptable land use options.

Keywords: Environmental services, land use change, LUCIA, rubber, trade-off

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Socio-Economic Aspects of Rubber Cultivation in Southern China

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The Xishuangbanna Dai Autonomous Prefecture of Yunnan Province in Southwest China has experienced widespread and dramatic land use changes mainly through the conversion of rainforest areas. Socioeconomic studies indicate that given high international product prices rubber is a profitable crop also for subsistence smallholder farmers who mostly belong to various ethnic minority groups. The adoption of rubber cultivation has resulted in profound changes. The altering of land and labour allocation towards permanent monoculture agriculture is accompanied by higher climatic and economic risks. In addition, the loss of agro-biodiversity can have potentially negative implications for food and nutritional security of the rural population. So far little quantitative information is available on the economic and natural resource implications of rubber cultivation in Southwest China. In early 2013 a large scale socio economic survey has been conducted among some 612 rubber farmers in 42 villages in Xishuangbanna. The survey instruments consisted of a village level and a comprehensive household questionnaire including information on household characteristics, different farm and non-farm income sources, shocks experienced and expected risks. A rubber module that included detailed information on inputs and outputs over one entire production period on a plot level was central to the survey.

This paper provides a first quantitative analysis of the economics of rubber cultivation in Xishuangbanna. Differences in the net revenues from rubber and total household income among different locations, household types and ethnic groups are shown using descriptive statistical analysis. The findings of this study provide a better understanding of the socio-economic implications of the introduction of rubber cultivation into smallholder farming. A number of policy issues will be identified that provide entry points and hypotheses for subsequent analysis using positive and normative economic models.

Keywords: China, rubber cultivation, socio-economic, Xishuangbanna

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Sustainable Rubber Cultivation in Southwest China: Approach to Stakeholder Involvement and Dialogue

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Natural latex is – for example as component of car tyres – a fundament of industrial, mainly urban development. Meanwhile rubber (*Hevea brasiliensis*) cultivation became the utmost important "driving factor" in many rural areas of the greater Mekong Subregion which is part of the "Indo-Burma biodiversity hotspot". In Xishuangbanna prefecture, Southwest China, the rapid expansion and intensification of rubber cultivation is coupled with dramatic losses of ecosystem functions and services.

The Sino-German project "SURUMER: Sustainable rubber cultivation in the Mekong region" is looking for an integrative, applicable, and stakeholder-validated concept for sustainable rubber cultivation, which can provide a wider application across the Mekong region. This implementation-oriented goal is demanding a high level of interdisciplinary integration, and transdisciplinarity, *i.e.* communication and cooperation of researchers and stakeholders from praxis.

The objective of this presentation is to discuss the concept and preliminary results of the SURUMER approach on stakeholder involvement with its interrelated measures of process facilitation on the one hand and stakeholder and communication network analyses on the other. Three key stakeholder groups have been identified so far, namely innovative rubber farmers (often the village heads), regional decision-makers from administration and rubber companies, and provincial politicians. Discourses amongst these groups – on future scenarios of rubber cultivation and on trade-offs of different land use strategies – will be facilitated by local and scientific partners of the consortium. Discourses are co-learning processes consisting of various elements such as information (exhibition, newsletter), informal talks, workshops and village meetings. Communication measures include a baseline survey on communal level, an in-depth analysis of stakeholders' problem perception, their interests (goal conflicts and synergies), and their formal and informal communication networks.

Keywords: Discourse, participation, stakeholder, sustainable rubber cultivation, transdisciplinarity

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Cultivation Potential of Different Mango Varieties in Kenya, Considering Likely Impacts of Climate Change

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Agroforestry can potentially help smallholder farmers adapt to climate change. Trees, including fruit trees, are less prone to water stress than annual crops, and they provide valuable products for subsistence and income generation. Mango (*Mangifera indica* L.) production is an integral component of rural livelihoods in many parts of Kenya, but farmers' ability to grow this tree crop may be compromised by future climate change. These impacts are currently difficult to gauge, because the diversity of cultivated mango varieties, their distributions across Kenya's agro-ecological zones and their climatic requirements are poorly understood. Such information is needed for modelling future suitable ranges and for identifying areas in need of new, better adapted mango varieties. This study sought to establish the spatial distribution and performance of mango varieties along an elevation gradient across a broad spectrum of agro-ecological zones. Farmers' opinions about the future prospects of mango cultivation were documented. On 228 spatially-randomly selected farms, all mango varieties were inventoried and semi-structured questionnaires completed together with farmers. Qualitative response models were used to analyse and evaluate farmer's success following the adoption of different mango varieties. The survey identified 28 mango varieties, which varied widely in occurrence and abundance along the elevation gradient. Abundance, number and type of varieties also varied with gender of the household head, labour availability, farmers' income sources, availability of profitable and reliable markets, and the degree of market orientation of mango production. Respondents observed that they had made decisions related to mango cultivation based on changes that they had observed in rainfall and temperature during the past 15 years. The next step in this research will be the production of suitability maps for the different mango varieties for future climate projections. Results will be used to develop recommendations on suitable mango varieties, including the identification of locations where currently grown varieties will experience reduced climatic suitability. The developed approach can contribute to enhancing farmers' resilience to climate change through selection of mango varieties that can be expected to perform well under future climate conditions.

Keywords: Adoption, agroforestry, modelling, resilience, suitability maps

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Rehabilitation Approach for Quick and Sustainable Regain in Cocoa Production in Declining Full Sun Plantations

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In Malaysia an intensively managed high input full sun cocoa plantation can reach high yields of 1.5 to 2 t dry beans per ha. Following a high production period of 10 years the yields often decrease markedly. Focusing on leading depleted cacao plantations sustainably back to full production a research project was initiated in June 2011 using a diversification approach with agroforestry systems. The experimental site is located on a large commercial farm in the humid tropical lowlands of peninsular Malaysia, in the region of Kuala Lipis. In a field trial with a strip-split-plot design, three different production systems, mainly characterised by diversification levels (mono culture to high diversity agroforestry) and accordingly different external input levels (high to low), are compared under two tree age conditions: newly planted and old rehabilitated cocoa trees, after the removal of the original canopy back to the leader structure. The existing twenty-two-year-old plantation with the original canopy and a high input level serves as control treatment.

When cacao yields decline after the initial high production period trees are often replanted. This results in a non-productive phase lasting several years before the young trees start to develop pods and even longer before yields reach a remunerative level. Rehabilitating old low producing trees on the other hand, as practised in the present experiment, is expected to re-establish higher yields more quickly than re-planting.

The first full harvest in the trial started in September 2012, 15 months after the rehabilitation pruning. Between September 2012 and March 2013 (main harvest) an average of 462 kg dry beans per ha were harvested in the control treatment. The yields of the common practice treatment already amounted to 24.9 % of the control. This is a very promising result, especially in view of the development of young trees which will take at least another year before the first pod development. Yields in the agroforestry systems increased less quickly as tree development under shade and with lower fertiliser input is inherently slower.

Keywords: Agroforestry, cocoa, rehabilitation, south-east asia, sustainable yield increase

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Morphological and Genetic Diversity of Cacao (*Theobroma cacao*) in San Alejandro, Peruvian Amazon

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Peruvian Amazon is the centre of origin of cacao (*Theobroma cacao* L.), which is an important crop in the region as it is an important source of income especially for smallholders. With the introduction of exotic hybrid germplasm, concerns of loss of the original genetic diversity and superior properties of original cacao varieties in the area emerge, as farmers give preference to high yielding hybrid varieties. This study assessed the morphological and genetic diversity of cultivated cacao in San Alejandro in Peruvian Amazon. Using two quantitative and eight qualitative morphological descriptors, 54 accessions were characterised and 84 accessions were fingerprinted by eight microsatellite loci. Mean Shannon-Wiener diversity index for the qualitative traits of morphological descriptor reached 0.95. Principal component analysis results showed qualitative descriptors of fruit form (apex form, fruit rugosity and basal constriction) and quantitative floral traits (sepal and style length) as the most distinctive. All microsatellite loci were polymorphic, with totally 77 identified alleles and 9.63 alleles per locus in average. Expected heterozygosity ranged from 0.571 to 0.844 and mean value 0.729. Mean value of allelic richness reached 4.03. Although neither analysis revealed any structure among the accessions, the results clearly showed that the study area harbours a highly diverse population of cacao with a number of original upper Amazon Forastero varieties. This high level of diversity can be explored for selection of superior clones. Farmers should be encouraged to preserve existing original varieties *in situ* in on-farm conservation programmes and further improve varietal deployment to prevent genetic erosion and loss of valuable germplasm.

Keywords: Descriptors, genetic diversity, microsatellites, morphological diversity, *Theobroma cacao*

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Biodiversity of Small Mammals in Cacao Agroforests in Peruvian Amazon

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A large proportion of the deforestation of tropical rain forests is caused by small-scale farmers. Traditional slash-and-burn systems with prolonged fallow periods are no longer feasible in most parts of the tropics. However, agroforests could have great potential to increase the productivity of farming systems and sustain continuous crop production. Cacao (*Theobroma cacao*) agroforests that maintain a high proportion of shade trees in a diverse structure is being viewed as a sustainable landuse practice. The basic hypothesis was the question if the cacao agroforests are able to support the biodiversity of small mammals in Peruvian Amazon. The main objective of this study was to assess the impacts of the forest conservation on small mammal communities by comparing tree species richness, diversity and composition between primary and secondary forests, cacao agroforests and slash-and-burn fields in San Alejandro, Peruvian Amazon. We trapped small mammals in 16, 25×25 meter plots on the four land-use systems using Sherman and Tomahawk traps during three months. 31 individuals were trapped of 14 different species. All of them were rodents or marsupials mammals. According to the species diversity indexes, the species composition of cacao agroforests is comparable with the secondary forest. From the observations a different species composition in primary forest was obvious, but the cacao agroforests seems to be a better alternative for conservation of biodiversity than traditional intensive agriculture. In this context our study forms a good scientific background for further monitoring of ecological changes in the human modified landscape of the Peruvian Amazon region.

Keywords: Amazon basin, neotropical mammals, Sherman trap, species diversity, species richness, *Theobroma cacao*, Tomahawk trap

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The Impact of Cacao Agroforests on Insect Biodiversity

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Nowadays, the topic of biodiversity loss is much addressed. Scientists try to quantify changes in landscape due to human impact and look for feasible solutions how to improve negative situations. Agroforestry systems are currently being viewed as an alternative land use system that can conserve original biodiversity. Our investigation dealt with the impact of cacao agroforests on beetle (Coleoptera) and true bug (Heteroptera) biodiversity in Peruvian Amazon. We compared the species richness and diversity among four habitat types: primary and secondary forest, cacao agroforest and annual crop production systems. Insects were collected on 20 plots (5 in each ecosystem) using pitfalls and window traps during 24 h repeated three times (in total 690 trapping days) in the dry season (August-September 2012). In total 1,295 beetles of 574 morphospecies and 48 heteropteran morphospecies were captured. Results contained 60 beetle families and 17 true bug families. In general, all biodiversity indices were relatively high in all habitats, showing that even with a high human disturbation of natural forest the insect diversity still remains high, although the species composition changed substantially. Species composition of cacao agroforest was the most comparable with the secondary forest. Window traps at two different highs in primary forest suggested large differences in species composition. Most of the primary forest species of the family Curculionidae (39 species) with subfamily Scolytinae (21 species), are predominantly forest demanding species and are negatively affected by the transformation of the forest to other habitats. Cacao agroforests can serve as reservoir for insects.

Keywords: Biodiversity, cacao, coleoptera, heteroptera, land use, pitfall trap, window trap

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The State of Ghana's Cocoa Landscape and Yield Trends: Evidence from Sefwi Wiawso District

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Ghana is one country that comes to mind when cocoa is mentioned. Cocoa constitutes 85 percent of the foreign export earnings from the agricultural sector and employs over 800,000 smallholder farm families. The current trend indicates that cocoa farmers in Ghana are drifting from shaded cocoa to the no shade. This practice is a major contributing factor to deforestation, input demanding, short productive life and low yield over the production period. Farmers and policy-makers faces trade-offs between shorter-term economic maximisation and long-term ecological sustainability. It is quite apparent that with dwindling forests for new planting, cocoa agroforestry holds the key to future outputs and productivity in cocoa production.

The research therefore aims at determining the state of Ghana cocoa landscape and its associated yield trends. The multi stage sampling technique was employed to selected 200 cocoa farmers in the study area. Data obtained from the respondents were analysed using descriptive statistics and inferential analysis. The yield curve model was also adopted to determine the yield trend under the various cocoa agroforestry systems.

From the analysis, the R square value obtained under the no shade, low shade, medium shade and heavy shade are 77, 61, 53, 56 percent, respectively. All the R squares of the various agroforestry systems are greater the 50 percent, indicating a significant relationship between cocoa yield and age of cocoa. The highest average yield per hectare was attained for the no shade in year 16 (794 kg ha^{-1}), for the low shade in year 22 (696 kg ha^{-1}), for the medium shade in year 19 (735 kg ha^{-1}) and for the cocoa under heavy shade in year 15 (546 kg ha^{-1}). The no shade cocoa system had the highest yield level among all the cocoa agroforestry systems but had a sharp fall in yield over time (after year 16).

The conclusion of the study is that, although the no shade cocoa system has higher yields, it is input demanding, environmentally unfriendly and has short productive life. The medium shade cocoa agroforestry system is the most effective way of optimising ecological, economic, and social outcomes and therefore need to be promoted in Ghana

Keywords: Cocoa agroforestry, Ghana, yield curve model

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Social-Ecological Resilience in Cocoa Farming Systems in Alto Beni, Bolivia

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Cocoa based small scale agriculture is the basic livelihood of most farming families in the region of Alto Beni in the Bolivian Andes. Cocoa cultivation is affected by climate change impacts, soil degradation, pests and plant diseases, and insecure cocoa prices. From a sustainable development point of view, cocoa farms need thus to become more resilient. Resilience refers to the ability within a farming system to reduce the sensitivity to stress factors while maintaining productivity, the capacity for self-organisation, to learn, and to adapt to change. Resilience can be subdivided in the three features buffer capacity, self-organisation, and adaptive capacity. This study addresses differences in resilience of organic and non-organic cocoa farms, and the most important features that influence social-ecological resilience in cocoa farming systems.

Indicators for resilience were defined in a transdisciplinary process with local experts and cocoa farmers in a workshop and focus groups. Indicators for buffer capacity were tree diversity, crop diversity, and the diversity of income sources of the farming family. Indicators for self-organisation were the interaction with farmers' organisations, their subsistence level, cocoa yields, and the annual family income. Adaptive capacity was assessed by inquiring the number of courses on cocoa cultivation family members had participated in, and the number of information sources they had. We interviewed 52 certified and non-certified households and conducted an in-depth participant observation with 15 households from the sample.

It resulted that organic farms in the research area were more diversified (tree species in cocoa plots: 4.4 vs. 1.9, crop diversity: 8.4 vs. 6.7 crop varieties on cocoa farms), and had higher cocoa yields (506 kg ha^{-1} yr^{-1} vs. 335.8 kg ha^{-1} yr^{-1}, both without external inputs). Annual family income was significantly higher on organic farms with 7530.2 vs. 6044.4 USD. Organic farmers had participated in more courses on cocoa cultivation which may be the main reason for the better performance of their farms. We conclude that resilience building was enhanced by local organisations that organise organic certification and go further than basic organic certification principles by providing extension services, tree seedlings, capacity building, and certain social insurances.

Keywords: Adaptation to climate change, agroforestry, Bolivia, cocoa, organic agriculture, social-ecological resilience

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Comparison of Canopy Openness in Different Cocoa (*Theobroma cacao*) Production Systems in Alto Beni, Bolivia

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Cocoa (*Theobroma cacao* L.) grows naturally as an understory tree in tropical forests and produces well under shaded and non-shaded conditions. It is cultivated by small scale farmers in South America under various conditions, ranging from monocultures to different kinds of agroforestry systems. While in monocultures it is exposed to direct sunlight, one or various tree species shade the cocoa in agroforestry systems. Also organic cocoa cultivation is becoming more and more popular due to premium prices and increasing ecological consciousness. In Alto Beni, Bolivia, the Research Institute of Organic Agriculture (FiBL) and local partners have established a long-term field trial to compare cocoa production systems. The bi-factorial randomised block design includes management and biodiversity factors combined to the following five cocoa treatments: monoculture and agroforestry systems both under organic and conventional management, and successional agroforestry system (high plant species diversity) under organic management and for further comparison fallow plots of same age as the cocoa plots. Research is done in all fields of agronomic, economic and environmental interest.

This study focuses on the comparison of the canopy openness of the different cocoa production systems and fallow plots. Knowledge about the canopy openness enables the estimation of light entering the production system, especially on the cocoa layer (photosynthesis relevant) and also on the soil as canopy openness influences the microclimate in the plantation. Another aspect of the canopy is the impact on the throughfall within the plot. Over the time, variations in the canopy structure indicate the production of biomass, of nutrient enrichment by throughfall (rain-wash and nutrient leaf leaching in the canopy) and may indicate pruning necessities when the plant cover above the cocoa exceeds critical values.

To estimate the canopy openness, in the years 2012 and 2013 hemispherical photography was taken with fisheye lenses in the different cocoa production systems and in the fallow plots. The photos were analysed with the programme Gap Light Analyser. First results of canopy openness between the cocoa systems will be shown and discussed for leave area index and potential microclimate differences.

Keywords: Agroforestry, canopy openness, cocoa, system comparison

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Leaf Biochemical Composition of Baobab Seedlings from Different Provenances Grown in a Common Garden

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The leaves of the African baobab (*Adansonia digitata* L.) are eaten fresh as a leafy vegetable or added in the form of dried powder as a soup thickener. The leaves are known to be rich in minerals and vitamins. Because leaves are available on adult trees only during a short rainy season, the trees are completely defoliated and the leaves are dried and stored to be used during the extended dry season. In order to mitigate the effects which complete defoliation may have on adult trees and the regeneration of the species, baobab seedlings are now being cultivated as a garden vegetable. It has been reported that baobab leaves harvested from different climatic zones differ in terms of mineral content leading to the conclusion that soil properties play an important role in nutrient composition of baobab plant parts. The aim of this experiment was to test whether baobab seeds from different climatic zones in Senegal (Coki in the Sahel zone, Gnibi in the Sudanano-Sahel zone and Diana Malari in Sudanian zone) and Ghana (Wa and Zebilla both Sudanian zone) have the same nutritional composition when grown in a common garden. Results showed that the micro and macronutrients contents were not significantly different between the different provenances, agro-climatic zones and between countries except for mucilage which was significantly higher in Senegalese compared to Ghanaian baobabs. Leaf nutrient content from baobab seedlings compares well with those from adult trees and seems to be even better since average protein content was two times higher than in the leaves of adult trees. The similar nutrient content in leaves from seedlings from different provenances support the results of earlier studies which concluded that biochemical characteristics of baobab plant parts are influenced by soil physic-chemical properties.

Keywords: Baobab, leaf, nutrient content, provenance

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Diversity and Size Class Distribution of Baobab (*Adansonia digitata*) in Kordofan, Sudan

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Indigenous wild fruit trees (IFTs) are of great importance in arid and semi-arid Africa, where other fruit species cannot easily be cultivated. Recognised as Africa's 'upside-down tree', the majestic baobab (*Adansonia digitata* L., Malvaceae, subfamily Bombacoideae) is a fascinating tree. The edible leaves, pulp and seeds are identified as good sources of vitamins and minerals. Recently, baobab fruit pulp has been approved for sale in the EU and USA, and has thus entered the formal international food market.

Within the baobab, there is evidence indicating the existence of a number of local forms differing in habit, vigour, and fruit and leaf morphology. However, little is known about morphological fruit diversity in Sudan. Furthermore, several authors have observed a lack of natural regeneration in different countries indicating a general senescing of baobab populations in Africa.

The morphological variation in fruits of selected baobab trees in Kordofan, Sudan, was evaluated by sampling fruits and assessing their characteristics. Furthermore, locations and stem diameter at breast height of 240 baobabs were mapped for a stand in Kordofan.

Our preliminary results indicated a high diversity in fruit phenotypes. Ventricose, crescent-shaped, globose and fusiform fruit types were identified. Fruit shape varied between trees but was consistent within each individual tree. Percentage of fruit pulp varied between the different fruit types with 14, 15, 18, and 21 % recorded for ventricose, fusiform, crescent-shaped and globose fruits, respectively. Interesting was also the observation of baobab morphotypes that retained leaves during the dry season. Variation in leaf morphology could also be recognised. Measurements of baobab trees revealed a density of 0.72 individuals ha^{-1}. Stem diameters ranged from 0.06 to 4.77 m. The size class distribution (SCD) showed an inverse J-shaped curve with a SCD slope of -0.57 which indicates a viable regenerating population.

Based on the results recorded, enhancement of scientific research activities on the almost unstudied baobabs in Kordofan, Sudan is highly recommended.

Keywords: *Adansonia digitata*, baobab, domestication, fruit characteristics, population structure, regeneration

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Growth and Photosynthetic Response of the African Baobab (*Adansonia digitata*) to Partial Defoliation

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Baobab (*Adansonia digitata* L.) seedlings are cultivated in home gardens where their nutritive leaves are harvested for food consumption. The aim of the study was to investigate the effects of partial defoliation on the physiology and growth of baobab seedlings. To attain this objective, baobab seedlings from different were grown in a garden in Senegal. The seedlings were partially defoliated by removing about 60 % of the leaves starting from the bottom of the crown. Two weeks after the first defoliation, the plants were defoliated a second time. Gas exchange and leaf water potential measurements were performed one and two weeks after each defoliation event. Stem height and diameter, and stem, root and total plant dry weight were measured two weeks after the first and second defoliation events. The first defoliation did not influence stem height and diameter, and stem, root and total plant dry weight. The second defoliation, however, had a negative impact on these parameters, thus indicating that baobab seedlings are tolerant to a single defoliation but not to multiple defoliation events. Photosynthesis (A) and stomatal conductance (gs) increased in defoliated plants compared to control plants 24 hours after the first defoliation. This compensatory increase in A was maintained up to one week after both defoliation events but lasted less than 2 weeks after both defoliations. Leaf chl content increased following defoliation while Leaf N concentration decreased. Lack of a significant and strong positive correlation between A and foliar chlorophyll (chl) and N contents proves that the increase in A is not related to the changes in foliar chl and N contents. Soil-to-leaf hydraulic conductance (Kp) was also significantly higher in defoliated compared to control seedlings one week after both defoliation events, indicating an improved water relations in defoliated plants. There was a significant positive correlation between Kp and gs one week after both defoliation events. Strong correlation between gs and A indicated that the increase in A was driven by an increase in gs which resulted from an increase in whole-plant water relations after partial defoliation. These results contribute to understanding the photosynthetic up-regulation which often occurs following defoliation.

Keywords: Baobab, photosynthesis, plant hydraulic conductance, stomatal conductance

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Socio-Economic Role of *Acacia senegal* to Sustainable Development of Rural Areas in the Gum Belt of Sudan

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Gum arabic from *Acacia senegal* (Hashab) trees is major product of rainfed agricultural sector in Sudan. It contributes significantly to household income of gum farmers and foreign exchange earnings of country. Hashab trees provide fodder, fuelwood and diverse valuable social-environmental benefits.

Since inception of 1970's drought years and recently traditional gold mining and civil war, gum production decreased and bush-fallow crop rotation system that traditionally involves Hashab tree is affected. Under such conditions, gum farmers have to decide on allocating limited resources available in trial to achieve their objectives and cope with problems.

The study was planned to identify socio-economic conditions of gum farmers that influence their decision on retention of Hashab stands and develop mechanism for evaluating farmers' decision on Hashab stands. The study covered carefully selected parts in Kordofan and Blue Nile. Target groups were found homogenous and perform same economic activities that combine crop, livestock and gum production. Primary and secondary data were generated through field survey that involved distribution of pre-structured questionnaires to randomly chosen gum farmers and some key-informants besides visiting nearby markets. Suitable statistical packages were used for data analysis.

The Study identified socio-economic aspects of gum farmers that influence decision on gum producing stands in terms of willingness to retain gum trees as component of farm system as well as preserved and annually tapping areas. Economic performance of household farmers was analysed with emphasis to total family income and expenditure.

Logistic regression model expressing probability of farmer's decision on Hashab stands as component of farm system was derived based on independent explanatory factors. Covariance and regression mathematical models that estimate Hashab area and gum production as function of significantly verified influential variables were built.

Per-hectare total real financial benefits to farmers were found positive in many diverse systems. Gum trees add to improve land quality and save considerable high costs of supplying fertilisers. Estimated total household family income is no longer enough to cover household consumption for the majority of smallholder farmers. Therefore the study recommends gum credit systems that lead to the improvement in total household family income and insure retaining old traditional practice of land use.

Keywords: *Acacia senegal* (Hashab trees), covariance and regression mathematical models, gum arabic, household income and expenditure, logistic regression model, rainfed agriculture, social-environmental benefits, traditional bush-fallow crop rotation

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Rural Trees Species for Rural Development in Sudan

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The vast majority of Sudan forests are situated in poor rural areas; nevertheless rural populations are not benefiting much from them. Despite the great diversity of tree species in Sudan, the utilisation of wood resources is traditionally concentrated on a few species only. Most of the indigenous hardwood tree species in Sudan are used as charcoal, firewood and fuel wood due to the lack of information on their properties. There is an urgent need to study the wood properties of the local raw material in order to suggest alternative uses. This would not only reduce wood imports, but also promote rural development, alleviate poverty and improve livelihoods of local communities.

The present study investigated the wood fiber characteristics of different tree species growing in rural areas of the woodland savannah of Sudan. Wood materials from thirty-two hardwood species belonging to eighteen families, collected from southern Kordofan and Sennar states were used for this purpose. Several fiber characteristics were investigated such as: length, diameter, lumen diameter and double wall thickness.

The results revealed that the wood fiber characteristics of several of the selected species (for example *Adansonia digitata*, *Ceiba pentandra*, *Sterculia setigera* and *Ficus sycomorus*) qualify for advanced industrial utilisations like pulp, paper and fiber board. The results of this study could enhance the establishment of wood processing industries in the rural areas of Sudan.

Keywords: Fiber characteristics, forests based industries, rural areas, Sudan

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Domestication Potential of some Important NTFP Tree Species: Farm-Level Tree Growth Characteristics, Fruit Phenotypic Variation and Economic Assessment

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Tropical forests contain many indigenous tree species that produce locally important non-timber forest products (NTFPs) with immense nutritional, economic, ecological, social and cultural values. Farm level tree growth characteristics, fruit phenotypic variation and economic potential of *Chrysophyllum albidum*, *Irvingia gabonensis* and *Garcinia kola* in rainforest and derived ecosystems of Nigeria were assessed. Growth measurements were made on 50 trees of each species selected from five villages in each ecosystem, resulting in 300 trees for the study. Two sets of questionnaires were used to obtain information from farmers and marketers of the species in three randomly selected urban and rural markets from each ecosystem. Depending on ecosystem and species, mean tree age varied from 19.5–43.5 years, with trees in rainforest being older than those in derived savannah. Most (92.3–100 %) *C. albidum*, *I. gabonensis* and *G. kola trees* were found within farmlands in both ecosystems. Between 40–80 % of the trees in derived savannah were planted by farmers while only 2–6 % in rainforest were planted. *C. albidum* and *I. gabonensis* trees in rainforest were significantly older, taller, with larger dbh and deeper crowns than those in derived savannah ecosystem. *I. gabonensis* fruits contained one seed, while *C. albidum* and *G. kola* fruits had 4–5 and 1–4 seeds, respectively. A wide variation was observed in the phenotypic characteristics of the fruits and seeds. While farming of fruit trees is male dominated (76.2–92.3 %), marketing of their products is female dominated (60–100 %). Annual income from sale of *C. albidum*, *I. gabonensis* and *G. kola* ranged from US$300 to over US$1300, with income highest and lowest at farm gate and urban market, respectively. This income contributes between 20–60 % to total family annual income. The old age of a high percentage of the trees and the high income derived from sale of their products underscores the necessity for their domestication. Since domestication of indigenous fruit trees is a farmer driven exercise, farmers should be encouraged and/or assisted in their domestication efforts.

Keywords: *Chrysophyllum albidum*, derived savannah, domestication, economic potentials, *Garcinia kola*, growth characteristics, *Irvingia gabonensis*, rainforest

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Rubber Agro-Forestry Systems – A Review

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Natural rubber production shifted from an exploratory approach based on the tapping of wild trees in the Amazon basin towards the establishment of uniform monocultures in South and South-East Asia. Due to the thriving economy of the emerging markets, especially China, rubber currently experiences a boom resulting in the transformation of large tracts of forests but also traditional crop lands into rubber plantations. Together with the growth and extension of urban settlements into their hinterland – resulting in the sealing of remarkable areas of valuable crop land – this will affect crop production for rural but also urban population.

Nevertheless, there are also initiatives to diversify rubber production systems, partly to increase income during the initial, unproductive years of the plantations, but also to mitigate the negative impacts of mono-cropping on ecosystem functions and services. Intercropping of corn or pine apple is a common practice to enhance the plantations' economy during the first years when trees cannot yet be tapped and there is still enough light in between the trees for annual crops. The intercropping of leguminous creepers as Pueraria has been suggested to maintain soil fertility but also to cover the soil and to reduce the prevalent erosion especially in hilly areas. But there are also many other intercropping options from perennial herbs to shrubs and trees, from food crops to medicinal plants, and even timber trees.

In this study we review the available data on rubber agro-forestry systems, try to evaluate their potential contribution to ecosystem services and benefits, and suggest a classification.

Keywords: Agro-forestry, ecosystem functions, ecosystem services, food plants, intercropping, medicinal plants

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Soil and Carbon Loss within Watersheds Affected by Rubber Cultivation in Xishuangbanna, South-West China

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Soil erosion is a hazard traditionally associated with agriculture in tropical and semi-arid areas. It affects long term soil fertility and sustainable land use thus decreasing agricultural food production and threatening human livelihood. It is estimated that soil carbon stock, being a main determinant of soil fertility and agricultural productivity, can be reduced due erosion by 25–50 % over several years. Among different erosion types, water erosion plays an important role with more than 10 Mha soil being lost through water erosion worldwide per year. Deforestation and other land cover/land use changes strongly accelerate erosion, as in our study case, where rapid expansion of rubber plantations modifies carbon dynamics at landscape level. In Xishuangbanna, South-West China rubber plantations increased by 175 % during last decade and the spread continues. This study aims at analysing soil loss in the watershed of a small Naban River tribute in Xishuangbanna based on sediment load of stream and surface runoff estimations. A hydrological station was built in 2013 on the outlet of the Naban River tribute to continuously monitor its water level, turbidity and local precipitation. Soil and carbon loss through the stream out of the watershed will be estimated based on the relationship between water level and discharge, water turbidity, suspended solids, and carbon content,. Surface runoff and soil erosion were estimated over 4 months for 6 bounded plots built on mid-age and young rubber plantation, so that canopy development effects on soil erosion rate can be estimated. The collected samples will be analysed for its texture and carbon content. Data on precipitation, surface soil erosion and carbon export by stream will be used for the validation of the LUCIA (Land Use Change Impact Assessment) model in order to estimate carbon losses accross the landscape depending on land use change and specifically to assess the effect of rubber expansion on carbon dynamics and soil fertility.

Keywords: Carbon loss, China, land use change, rubber plantations, soil erosion

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Assessment of Ecosystem Services and Conflict of Goals in Rubber Cultivation via InVEST

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SURUMER - Sustainable Rubber Cultivation in the Mekong Region – is a new project which operates in Xishuangbanna Dai Autonomous Prefecture, Yunnan Province, PR China. The aim is to develop an integrative, applicable, and stakeholder validated concept for sustainable rubber (*Hevea brasiliensis*) cultivation.
For this purpose, ecosystem functions and ecosystem services are studied in detail by various thematic subprojects to investigate differences in the ecosystem service provision of natural forests in comparison to rubber plantations. Each subproject is concentrating on a single ecosystem service. For decision-makers however, an integrated ecosystem service assessment analysing multiple ecosystem services is important. This is a precondition for trade-off analyses between different ecosystem services and important to provide a holistic view about the consequences of future land use change. Further, ecosystem service assessments allow studying off-site effects on urban populations. This information is valuable for regional policy makers for the development of policy mechanisms which aim at improving livelihoods and rural development in the region and at the same time accounting for ecosystem services provided by certain land use types.
The toolbox InVEST (Integrated Valuation of Environmental Services and Trade-offs) is developed by the Natural Capital Project (NatCap), a partnership among Stanford University, The Nature Conservancy, the World Wildlife Fund, and the University of Minnesota. InVEST provides various deterministic models to evaluate different ecosystem services biophysically and monetary. In our study we will use InVEST to model and assess abiotic ecosystem services *e.g.* carbon storage and sequestration, hydropower production, water purification / nutrient retention and sediment retention. First results of project outcome will be presented and visualised during the conference.

Keywords: Agro-ecosystem, ecosystem service assessment, environmental system, *Hevea brasiliensis*, InVEST, rubber

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Assessing Intercropping Strategies for Smallholder Rubber Plantations in Northern Thailand using the WaNuLCAS Model

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Thailand is the largest producer of natural rubber in the world with a production of about 3.35 million tons in 2010. More than 90 percent of rubber is grown by smallholders. Recently, the establishment of new rubber plantations has been promoted especially in the North (4.7 % of total rubber planting areas) and Northeast (11.9 % of total rubber planting areas) of Thailand. Farmers in the northern parts of Thailand nowadays replace short-term cash crops by monoculture rubber plantations, although these areas have less favourable growing conditions. Hence, rubber plantations competing with food crops may affect rural livelihood, environmental services and food security. Therefore, this study aims to evaluate and understand the impact of crop management based on intercropping scenarios and minimum of competition among associated crops. The intention is to reduce pressure on natural resources and develop sustainable production systems with economic options for smallholder. The Water, Nutrient, Light Capture in Agroforestry Systems (WaNuLCAS) model was used to predict crop and rubber productivity under various management scenarios of intercropping and monocropping in the Phitsanulok province (16°55' N, 100°32' E), one of the 17 northern provinces of Thailand. Annual precipitation is about 1200 mm. Model scenarios were simulated for rubber (clon RRIM600) spacing of 2.5 m × 7 m, 3 m × 7 m and 3 m × 8 m under sole cropping and intercrop with maize and upland rice. The yield of maize and rice is significantly influenced by rubber-tree spacing in the intercropping systems. Rubber intercrop with maize or upland rice with recommended chemical fertiliser plus organic input together with pruning was the best way to mitigate competition between rubber and crop. In long term, rubber tree diameter and wood volume of sole cropping are higher than rubber intercropped systems. With higher rubber tree density, the rubber tree diameter increases slower. WaNuLCAS model can be used as a tool to support knowledge relating to land use and decision-making for the benefit of smallholder rubber plantation in northern Thailand.

Keywords: Intercropping practice, rubber, smallholder, WaNuLCAS model

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Welfare Economic Valuation of a Sustainable Rubber Production in Southeast Asia: An Exemplary Study in SW-China

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The fast encroachment of rubber plantations into tropical forests in Xishuangbanna Prefecture, Yunnan Province, has led to severe damages of the local environment. This drastic shift in land use from tropical forest to large-scale rubber plantations has led to a pollution of local water resources, a change in local climate as well as to the possible extinction of rare animal and plant species. Starting from this status quo the interdisciplinary Chinese-German research project SURUMER develops strategies for a more sustainable rubber cultivation in Xishuangbanna (XB).

While such a change in land use obviously causes implementation costs and additional economic costs in terms of forgone profits the social benefits accruing from such a project are rather hazy. The paper proposed here presents an attempt to assess these benefits using the Contingent Valuation Method (CVM). The CVM is an interview-based assessment technique aiming at the elicitation of people's willingness to pay (WTP) for the realisation of an environmental project like the one discussed here. In a previous research project the WTP for a more sustainable rubber plantation of the permanent residents of XB has already been assessed. In a follow-up study the WTP of two other stakeholder groups, *i.e.* tourists visiting XB on the one hand and people living far away (*e.g.* in Shanghai) on the other, for environmental improvements in XB is assessed. We want to find out how much people not living permanently in XB care for the environmental problems there and for their mitigation. First survey results show that not only tourists but even people who never visited XB are concerned about the environmental deterioration taking place there and that they are willing to contribute personally to improve the situation. These findings show that the social importance of a more sustainable rubber planting strategy in XB is not restricted to the local population and that the social benefits accruing from the implementation of such a strategy are much higher than expected. We suggest that for a rational decision on the practical implementation of such a programme the overall social benefits should be considered and compared to the programme costs.

Keywords: Contingent valuation method, rubber cultivation, willingness to pay

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Impacts of Climate Variation on Land Use Change in Major Fruit Production Area of Thailand

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The study aimed at analysing impacts of land use change due to climate variability in Thailand's major fruit production area – Tha Mai district, Chan Tha Buri province. The study used the CropWat model to estimate impacts of weather variables on actual crop yield and comparative cost-benefit of crop production. The study calibrated the positive quadratic programming model to land use of the study area in 2010 which includes 11 major crops consisting of rubber, dragon fruit, pepper, salacca, rambutan, mangosteen, durian, *Lansium domesticum*, pineapple, rice and cassava. After that, the model with the changes on cost-benefit of crops was used to examine how land use change due to climate variability. The analysis used secondary data which consists of GIS land use data of 2010, climate data from 1951–2010, crop production data surveyed in 2010 from 292 farm samples by the Office of Agricultural Economics, and crop coefficients required for CropWat model from FAO and published literature. The results showed that climate variability, in terms of significant variables as *e.g.* rainfall, and temperature, varied significantly during so-called La Niña years and induced a reduction of the average net crop return of 160 US$ ha^{-1} and a reduction in cropped area of 524.38 ha as compared to the baseline. Also, pepper, *Lansium domesticum* and durian were the three crops with a sensitive response to climate variation. The results under El Niño climate variability showed that net crop return and crop area would be reduced by 190 US$ ha^{-1} and of 504.44 ha, respectively. However, *Lansium domesticum*, mangosteen and rubber crop area would have positive responses under El Niño climate variability. Pepper and durian were also under El Niño counted as the most sensitive crops to the climate variation. To alleviate crop yield change under La Niña conditions, adaptation of farmers would cost 1,697 US$ ha^{-1} which consists of 577 US$ ha^{-1} for input cost, 704 US$ ha^{-1} for labour cost and 544 US$ ha^{-1} for irigation cost. Adaptation costs to alleviate the impacts on El Niño weather conditions were lower and consisted of 501 US$ ha^{-1} for irrigation. It can be recommended that policies to mitigate climate variability should be pursued in pepper and durian as first priority while further fund support will be needed when the climat variability tend to be more in the direction of La Niña weather conditions.

Keywords: Climate variation, land use change, positive quadratic programming

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Water Use of Young and Mature Rubber (*Hevea brasiliensis*) Trees during Wet Season in Xishuangbanna, China

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Rubber was introduced in South China in the early 1950s. Since then, tropical rainforests have been rapidly converted into rubber plantations. In Xishuangbanna, the area of rubber cultivation increased by 100 % between 2002 and 2010, occupying 18 % of Xishuangbanna's landscape, and is expected to further expand. Hence, rubber trees, known as huge water consumers, have been blamed to cause a downwards trend in fog frequency and a decrease of the water table. Although rubber are regarded as forest in China, the impact of rubber plantation on hydrological services, compared to natural rainforest, has not been reported yet. Information about transpiration of *Hevea brasiliensis* is, therefore, fundamental for the assessment of ecosystem services as modified by land-use change. In order to quantify the water requirement of rubber trees and assess the impact of rubber plantation on local water balance, this study reports the local water budget by evapotranspiration of rubber at a tree level and the macro-climate induced condition of a secondary rainforest stand. Experiments were conducted in Menglun, Xishuangbanna, Yunnan, China during the wet season. Measurements were performed on young (13 years old) and mature (22 years old) rubber trees. Gas-exchange measurements for transpiration, assimilation and stomatal conductance in response to abiotic factors (light, diurnal variation, vapour pressure deficit (VPD), and soil water content (SWC)) were conducted. Additionally, xylem sap flow (Fd) and canopy dynamics were recorded to estimate transpirational water loss, changes in soil water potential, and estimates of root water uptake. Furthermore, air temperature and relative humidity, SWC and canopy dynamics at rubber plantations and secondary rainforest were compared to assess the modification of microclimate induced by land-use changes. For young and mature rubber trees, measurements indicated an increase of Fd with increasing VPD and fluctuation of SWC in response to high Fd was different. Additionally, high VPD was associated with a decrease in stomatal conductance and thus assimilation rate. The results indicate a high water use of rubber trees and a possible refilling process at high VPD. Further information is needed to explain the micro-climate and SWC differences between the secondary rainforest and the rubber plantation.

Keywords: Gas exchange, rubber, sap flow, transpiration, Xishuangbanna

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Carbon Stock Changes Evaluation in Naban River National Nature Reserve using Rapid Carbon Stock Appraisal

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Terrestrial carbon pools play an important role in global carbon cycle. The measurement of biomass and productivity of vegetation is considered as one of the goals of the International Geosphere – Biosphere Programme (IGBP). In most tropical countries, the largest source of green house gas emissions is from deforestation and forest degradation. Therefore, the monitoring of land use change induced carbon stock variation could serve as a good indicator for carbon sink and source identification. In the context of Xishuangbanna (China), the largest land use change is the transition of tropical rainforest and fallow land to rubber (*Hevea brasiliensis*). A lot of studies have been conducted in Xishuangbanna to evaluate forest carbon stock change induced by rubber plantations' intensification. The available protocols include process based modelling, forest inventory survey, Eddy covariance and semote sensing. However, few of them are easily practical in a cost-effective and time-efficient matter for guiding local resources management. Therefore, a case study was conducted in Naban River National Nature Reserve (NRNNR), Xishuangbanna to evaluate the impact of land use change on carbon stock by using RaCSA method (Rapid Carbon Stock Appraisal). Within NRNNR, six land use systems are surveyed, namely secondary forest, young rubber, mid-aged rubber, old rubber, rubber intercropping and crop land. Time series of land use and land cover maps (2002, 2007 and 2012) were prepared from IKONOS, SPOT, RapidEye and Landsat data. The time averaged carbon stock value was used for upscaling plot level measurement to landscape level carbon density and carbon emission map. The result of this study could be used for guiding sustainable land use management on a regional scale.

Keywords: Carbon stock change, land use change, rapid carbon stock appraisal, rubber, time averaged carbon stock

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Using Life Cycle Assessment Tools to Evaluate the Environmental Impact of Rubber-Based Production Chains

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Currently all natural rubber for industrial purposes originates from the tropical tree *Hevea brasiliensis*. However, alternative sources are needed given the emerging environmental concerns of Hevea cultivation and the rising global demand of natural rubber. The shrub Guayule (*Parthenium argentatum*) represents one of the potential candidates to partly replace Hevea-based rubber products. This depends on the available rubber yield, produced greenhouse gas emissions (GHG) and energy required during the production cycle among others. Life cycle assessment (LCA) has become an indispensable tool to assess environmental impacts of industrial production chains. The strength of a LCA lies in its holistic consideration of all processes and production steps which are necessary to manufacture a selected product. The presented study aims to evaluate if Guayule-based rubber can be a potential competitor to Hevea rubber with regard to GHG emissions and total energy balance. The chosen system boundary extends from crop cultivation to the processing of rubber-sheets. LCAs were computed for Hevea- and Guayule-rubber production chains individually (baseline), and compared to a series of yield and co-product use scenarios. LCA computations revealed that the baseline Guayule production chain emits 7.74 Mg CO_2-Equivalents per ton of produced natural rubber compared to 0.67 Mg of CO_2-Equivalents emitted by Hevea-based rubber. Once Guayule co-products such as bagasse are considered, a decrease of GHG emissions by 0.46 Mg CO_2-Equivalents compared to a Hevea production chain without co-product utilisation occurs. When Guayule rubber yields increase from 0.32 to 1 Mg ha^{-1} a^{-1}, GHG emissions decrease to 0.37 compared to 0.43 Mg CO_2-Equivalents for the chosen Hevea production chain. Overall, both production chains show a positive energy balance, although Guayule requires 108.148 MJ more energy compared to Hevea-based rubber sheets. The study revealed that Guayule is a potential competitor of Hevea rubber, if co-products can be utilised as internal energy source during the production chain. Further research could focus on field-based studies to evaluate Guayule's yield potential under different agronomic regimes, as well as on technical improvements to reduce the energy demand during the cultivation and production steps of Guayule-based rubber.

Keywords: Guayule, *Hevea brasiliensis*, life cycle assessment, *Parthenium argentatum*, rubber-based production chain

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Finding Mango Mother Trees: Developing an Interactive Mapping Approach of Mango Motherblocks in Kenya

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Mango growing is of great economic importance for farmers in Kenya where mangoes ranked second in production volume, and third with regard to production area and monetary value. However, the full potential of mango cultivation has not been reached and production is mainly based on seven cultivars. Contrarily, numerous mango varieties exist in motherblocks managed by governmental institutions in Kenya but are, for the most part, severely neglected. Genetic resources are neither documented nor used efficiently in the different agro-ecological zones.

The objective of this study was to record the names, characteristics, and geographic locations of the different mango varieties available in Kenya and to develop an interactive map, connected to a database.

In 21 mango mother blocks managed by the Kenyan Agricultural Research Institute (KARI) and by prison farms in five provinces of Kenya all mango tree individuals were mapped. Google Earth® was first used to develop a rough sketch of each of the motherblocks. This sketch was filled by data on the geographic location of each of the individual trees measured by a handheld GPS and by recording the variety name. The detailed information was then used to develop the interactive map based on Google Earth®. Information on the different varieties and their performance in the respective location was collected through interviews of the orchard managers and added to the created map.

In total, 62 different mango varieties were found and 7401 trees mapped. Varietal diversity was low in motherblocks in Western Province (2–5 varieties per motherblock), while Central Province had the most diverse motherblocks (11–35 varieties per motherblock). The difference in diversity was correlated to the level of importance attributed to mango as a food and cash crop in the various provinces.

The developed interactive map tool can help private investors, extension workers, agricultural development organisations, and other key stakeholders to further develop the mango value chain in Kenya by offering a wealth of information on the locally available genetic resources. The map can also contribute to conserving genetic resources and related knowledge contained in the field gene banks of the surveyed mango mother blocks.

Keywords: Conservation, database, gene bank, genetic resources, mango

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Morphological and Genetic Diversity of *Persea americana* Mill. (Avocado) in two Regions of Ghana

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Persia americana Mill (avocado) is a tree crop which originated from the tropics of the western hemisphere and has developed varieties, adaptable to a wide range of climatic conditions. It has three general ecological varieties: Mexican, Guatemalan and West Indian. Its fruit is pear-shaped and the edible part is a thick layer of greenish-yellow pulp, high in protein and fat. The avocado plant is important for economic, nutritional and medicinal reasons. Studies have shown that its leaves could be used to manage high blood pressure.

In Ghana, avocado is widely grown in the closed forest region, but it can be found in all regions. Despite the high nutritional content of avocado, malnutrition is prevalent in most rural communities in Ghana, and its potential medicinal use has not been fully investigated. Avocado has the potential to contribute immensely to the economy of Ghana if cultivated on commercial scale. We therefore investigated the distribution, uses, morphological and genetic diversity of avocado in the Ashanti and Central regions of Ghana.

Ethnobotanical surveys were carried out in 14 districts, while morphological and genetic diversities were determined among the accessions in eight districts. Microsatellites markers were used for genetic diversity studies.

Growth of avocado was better in the Ashanti region than the Central region. It thrived best in old cocoa farms and was cultivated on small scale. The plant was used for various medicinal and economic purposes.

Morphologically, they were mainly of Western Indian origin. However, accessions from the Ashanti region were more diverse in plant and fruit characters than those from Central region. Microsatellites analyses revealed 115 different amplification fragments, ranging from 5 to 22 alleles per locus, with an average of 11.5 alleles per locus. All microsatellites were highly informative with both genetic diversity and polymorphic informative content higher than 0.5. Using the unweighted pair group method with arithmetic averages, the genotypes were clustered into seven major groups.

The wide genetic diversity among the accessions indicates a wide genetic base for improvement of avocado through breeding and selection.

Keywords: Avocado, diverse, ethnobotany, genetic markers, microsatellites, morphology, nutrition

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Environmental Impact Analysis of Palm Oil Based Products using Life Cycle Assessment Tools

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The growing concern of the exhaustible source of fossil fuels and the growing environmental impacts such as greenhouse gas emissions caused by combustion of crude oil based energy, have led to an increased interest in alternative fuels since the beginning of the 21st century. One promising alternative is palm oil-based biodiesel, which is currently produced in large quantities. However, instead of increasing the area of palm oil plantations, underutilised sources of biodiesel should be explored as alternative sources of biodiesel. Hence, the objective of this study is to investigate the environmental impacts caused by the production of biodiesel using palm oil compared to rubber-seed based biodiesel using Life Cycle Assessment (LCA) methodology. Both LCAs are than compared to the reference system fossil Diesel based on the functional unit of 1 MJ per produced gram of biodiesel. The results show, that palm oil-based biodiesel can mitigate up to 76,61 % of the CO_2-emissions compared to fossil Diesel, and rubber seed-based biodiesel can mitigate the emissions even further by 76,82 %. Different scenarios were conducted to see the effects of different transport distances, yield variations, fertiliser variations and the recycling of by-products. The evaluation showed that yield variations have the biggest effect on GHG emissions, with a total difference of 9,75 g CO_2-Equiv./MJ PME for palm oil-based biodiesel and 77,61 CO_2-Equiv./MJ RSME for rubber seed-based biodiesel between the highest and lowest scenarios. Results of the fertiliser scenarios showed, that decreasing the amount of applied fertiliser bears a large mitigation potential with up to 27 % in case of rubber seed-based Biodiesel, and 9,05 % in case of the palm oil-based biodiesel compared to the baseline. The usage of by-products was found to further mitigate the emissions of both biodiesel production processes in a range of 1,94 to 50,80 %. The findings were used to identify process parameters with large environmental impacts and are used to discuss further optimisation potentials in plant-based biodiesel production.

Keywords: Biodiesel, *Elaeis guineensis*, environmental impact assessment, GHG emissions, *Hevea brasiliensis*, LCA, oil palm, palm oil methyl ester, rubber seed oil methyl ester, rubber tree

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Dramatic Fruit Fall of Peach Palm in Subsistence Agriculture in Colombia: Epidemiology, Cause and Control

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The fruits of *Bactris gasipaes* (B.g.) are the main cash-crop of the South Pacific mangrove coast of Colombia, which encompasses a 250 km long and 60 km wide region with the rivers Cajambre, Yurumangui, Naya, Micay, Saija and Bubuey, with a yearly rainfall of 5,262 mm in the estuaries increasing to 18,784 mm at river heads. Rainfall and tides cause inundation of the river banks and low luminosity, limiting crops to taro *Colocasia esculenta*, B.g., plantain, low-sugar sugarcane, borojó (*Borojoa patinoi*) and coconut. The 20,000 inhabitants subsist on 5 ha agro-forestry sites at river banks. Transport in the region is only by boat taking up to 3 days to Buenaventura with access to inland markets.

The stems of up to 20 m high B.g. have 4-5 cm long hard spines and produce twice yearly 1-2 fruit bunches each with up to 70 highly valued fruits enduring storage and transport to Buenaventura. Fruit abscission started in mid 1980s in the central coast and invaded the south region in 1990s with 100 % abscission reducing cash income from US$ 400/year to less than US$ 100. Investigation of fruit fall was difficult because assessing fruits on palms was impossible until a climbing device was developed. Fruit abscission follows pollination of the inflorescence involving approximately 11 insect species. No pathogens were detected on B.g. palms and fruits, but small apodous larvae were present on fruits fallen to the ground. Larvae in attached fruits were from 2 tiny weevil species of the subfamily Baridinae (1) *Parisochoenus* sp. with 2 mm length and (2) a weevil of 2.5 - 3.6 mm length identified as a new species *Palmelampius heinrichi* sp. nov. O´Brien. Assays on B.g. fruit abscission with 11 variants and 30 repetitions were performed in the lower, middle, and high part of the rivers and included nutrient supply, contact-insecticides, stem injected systemic-insecticides, fruit-protection with 0.5 mm mesh bags and insecticide impregnated polyethylene bags. The 2 last methods significantly reduced fruit abscission. A further trial included bagging of inflorescence at different times after aperture, application of insecticides prior to bagging and also trials on the effect of different net bag designs and shaking of inflorescence instead of killing weevils with insecticides prior to bagging.

Keywords: Agroforestry, *Bactris gassipaes*, Colombia, fruit fall, IPM, peach palm, weevils

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Nutrition in monogastric animals

Effect of Feeding Graded Levels of *Moringa stenopetala* Leaf Meal on Carcass Traits and some Serum Biochemical Parameters of Koekoek Chickens

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The productivity of poultry in developing countries has been grossly limited by the scarcity and consequent high prices of conventional protein sources. The aim of the present study was to evaluate *Moringa stenopetala* leaf meal (MLM) as alternative cheap feed ingredient in the diets of poultry and its effect on the carcass characteristics of Koekoek chickens by replacing soybean meal. The feeding trial was a completely randomised design consisting of five dietary treatments with four replications. Ten unsexed day-old chicks of Koekoek breed were randomly assigned to each of the four replicates. The dietary treatment diets were the control diet (T1) and diets containing MLM at the levels of 50 g kg^{-1} (T2), 80 g kg^{-1} (T3), 110 g kg^{-1} (T4) and 140 g kg^{-1} (T5) replacing the soybean meal in the control diet. The results indicated that chickens fed on T3, T4 and T5 diets had significantly ($p < 0.01$) higher weights of dressed carcass, thighs, drumsticks and wings than those of the control diet (T1). Significantly ($p < 0.01$) higher slaughter weight was obtained from chickens fed T3 and T4 diets than those of T1. Chickens fed T4 and T5 diets had significantly ($p < 0.01$) higher dressing and breast yields than other treatment diets. Weights of slaughter, dressed carcass, thighs, drumsticks, wings, liver, heart and gizzard were higher ($p < 0.01$) in male birds, while female chickens had significantly higher breast yield than males. The values of liver, heart and gizzard were not affected by the inclusion rates of MLM diets. The levels of total serum protein and triglyceride increased ($p < 0.05$) in MLM fed chickens as compared to those of control diet. The activity of serum alanine transaminase and concentration of serum urea reduced ($p < 0.05$) in chickens fed T3 and T4 diets. In conclusion, the substitution of soybean up to 140 g kg^{-1} MLM could be an alternative feeding strategy in rural and peri-urban chicken production practices in *Moringa* growing tropical regions of the developing nations by replacing expensive protein feed sources. The results obtained from this study further suggested that dietary *Moringa* leaf meal has no deleterious effects on some physiological indices studied.

Keywords: Biochemical parameters, carcass traits, Koekoek chicken, *Moringa stenopetala* leaf meal

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Energy Metabolisability and Ileal Digesta Viscosity of Broilers Fed Diets Containing Fungi Biodegraded and Enzyme supplemented Malted Sorghum Sprouts

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Two hundred (200) day-old broiler chickens (Marshall strain) were allotted (40 per treatment, four replicates of ten birds each) to five diets – diet 1 (Control), diet 2 [malted sorghum sprouts (MSP) + *Aspergillus niger* (An)], diet 3 [MSP + *Trichoderma viride* (Tv)], diet 4 MSP + (An + Tv)) and diet 5 (MSP + commercial enzyme containing amylase (EC 3.2.1.1), beta- glucanase (EC 3.2.1.6), cellulase (EC 3.2.1.4), pectinase (EC 3.2.1.15), protease (EC 3.4.21) and xylanase (EC 3.2.1.8) added at the rate of 20 g /100 kg diet). At day 28 and 58, apparent metabolisable energy (AME), AME corrected for nitrogen retention (AMEn), true metabolisable energy (TME), TME corrected for nitrogen retention (TMEn) were determined. At day 58, ileal digesta viscosity (four birds per replicate, 40 birds in all) were also determined using Brookfield DV-E viscometer. Data were analysed using ANOVA. Significant means were separated using Duncans multiple range test. Highest ($p < 0.05$) values of AME and AMEn were obtained for diet 4 and diet 3 respectively. TME was highest ($p < 0.05$) in birds fed diet 4 at the starter phase but the highest value for this measurement at the finisher phase was for diet 3. TMEn was not significantly different ($p > 0.05$) at the finisher phase. Ileal digesta viscosity did not follow a particular pattern at 60 rpm and 100 rpm but for 50 rpm, highest value was obtained for birds fed diet 4 ($p < 0.05$), while diets that contained MSP + commercial enzyme (diet 5) elicited the greatest reduction in ileal digesta viscosity.

It is therefore recommended that when birds are of tender age (0-4 weeks) inclusion of MSP degraded with combinations of An + Tv (diet 4) will produce the best result, while at finisher phase (5-8weeks) degradation of MSP with only Tv in their diets (diet 3) will be sufficient for optimum performance.

Keywords: *Aspergillus niger*, broilers, energy metabolisability, Ileal digesta viscosity, malted sorghum sprouts, *Trichoderma viride*

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Preceacal Digestibility of Phosphorus and Crude Protein of Sesame Seed Meal with Phytase Supplementation in Broilers using Regression Method

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In practical poultry diets excess of phosphorus (P) and crude protein (CP) over requirement is often encountered because plant legumes, which are used to formulate poultry diets, contain phytate-phosphorus. Thus supplementation with P sources is often practised. This leads to excretion of the undigested P and CP (as nitrogen) into the environment. Supplementation of diets in which plant legumes are components with phytase can result in increased digestibility and utilisation of P and CP.

A study was carried to investigate the effects of phytase supplementation on the performance and apparent digestibility of P and CP of sesame seed meal (SSM) in broiler chickens. Seven dietary treatments were formulated: Diet 1 was the control diet and contained no SSM; Diets 2, 3 and 4 had SSM in place of soybean meal (SBM) at inclusion levels of 200, 250 and 300 g kg^{-1} diet with no phytase added. But diets 5, 6 and 7 contained the same levels of SSM, respectively but with 1500 FTU phytase (Ronozyme NP, DSM Nutritional products, Switzerland Basel) added. Titanium dioxide was added at the rate of 5 g/kg diet as an indigestible marker. Two hundred and ten one-day-old broiler chicks were wing-branded and fed a starter diet till d 14 when they were weighed and assigned in a complete randomised block design to the seven diets with five replicates per diet and six birds per replicate. The birds were fed for a further seven days. At d 21 the birds were sacrificed to obtained ileal digestea from the precaecal section for estimation of nutrient digestibility.

Results showed that phytase supplementation of the SSM diets significantly ($p < 0.05$) improved the weight gain, feed intake and feed conversion ratio. The apparent digestibility of P and CP were significantly ($p < 0.05$) increased by phytase supplementation. Interaction of SSM and phytase significantly ($p < 0.0001$) improved the response criteria. The slopes of the curves when digested P or CP (g/kg DMI) was regressed against P intake (g/kg DMI), which were estimates of digestibility of P and CP of SSM, were 82 and 95 %, respectively. It can be concluded that phytase supplementation of SSM in place of SBM in diets of broilers improved performance and digestibilities of P and CP.

Keywords: Broilers, crude protein, digestibility, phosphorus, sesame seed meal

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Evaluation of Neem (*Azadirachta indica*) Leaf Meal on Growth Performance, Haematological and Serum Biochemical Characteristics of Broilers

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Neem (*Azadirachta indica*) a tropical medicinal plant, containing flavonoid, nimbosterol and nimbin, is currently gaining attention as an ideal growth promoter in animal production. This study was conducted to evaluate the effects of dietary inclusion of neem leaf meal (NLM) on the growth performance, haematological and serum biochemical characteristics of broilers. One hundred and twenty day-old broiler chicks of the Anak strain were used in the 28 days study. The NLM was added (0, 5, 10 or 15 %) into the maize-soybean basal diet to constitute treatment 1, 2, 3 and 4, respectively. Thirty birds were allotted to each treatment with three replicates of ten birds in a completely randomised design. The birds were raised on a deep litter floor with strict adherence to standard management practices. Feed and water were provided *ad libitum* throughout the experiment. Data obtained from the growth performance, haematological and serum biochemistry of birds were subjected to the one-way ANOVA. Results on growth performance indicated significant ($p < 0.05$) decreases in broiler performance as the level of NLM increases. At 5 % NLM, daily weight gain, feed intake and feed conversion ratio were comparable to the control group. Whereas, 48.8, 21.9 and 52.9 % decreases were recorded in average daily weight gain, feed intake and feed conversion ratio, respectively in birds fed 15 % NLM diet. The haematological (erythrocytes, leucocytes, packed cell volume, mean corpuscular haemoglobin, lymphocytes and neutrophils) and biochemical (total protein, albumin, globulin, cholesterol, urea and creatinine) parameters also decreased ($p > 0.05$) following dietary inclusion of 10–15 % NLM in the ration, suggesting that the health status of the birds were compromised. This present study therefore concludes that dietary inclusion of NLM above 5 % could have negative impacts on the growth performance and blood characteristics of broilers.

Keywords: Broiler, haematology, neem leaf meal, performance, serum biochemistry

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Performance and Egg Quality Characteristics of Egg-Type Chickens as Influenced by Fluted Pumpkin (*Telfaria occidentalis*) Leaf Extract

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A total of 120 sixteen week-old point of lay birds of the Isa Brown strain were used for the experiment to determine the effect of fluted pumpkin (*Telfaria occidentalis*) leaf extract (FPLE) administered orally on laying performance, egg quality characteristics, blood chemistry-haematology and serum chemistry for a 12 week period. The birds were randomly assigned to five treatment groups: control group with no FPLE; 30 ml FPLE per litre of drinking water; 60 ml FPLE; 90 ml FPLE and 120 ml FPLE, respectively, at three-day intervals. Feed was given *ad libitum*. Eggs were collected at two-week interval to determine external and internal egg qualities. Blood sampling was carried out at the twelfth week of experiment. The results show that FPLE significantly ($p < 0.05$) increased hen-day with birds in group with 120 ml FPLE l^{-1} water having higher values than other groups. Exterrnal egg qualities were not influenced by FPLE inclusion. Internal egg qualities like shell weight and haugh unit were significantly increased by FPLE with birds in group with 120 ml l^{-1} FPLE having the highest significant values than births in control and other groups. Haematology results show that for packed cell volume (PCV), haemoglobin were not similar for all the groups in this experiment. However results for red blood cell count (RBC) and white blood cell count (WBC) and differential were increased with FPLE intake with birds administered 120 ml l^{-1} of FPLE having the highest values for RBC and WBC. Serum chemistry results show similarities for serum total protein, albumin, globulin, total cholesterol and serum alanine transaminase (SALT). FPLE has been proven to be a haematinic in rats and broiler chickens; this present result further strengthens this assertion though the results for blood analysis are contrary to that obtained by the authors for meat-type chickens. It can therefore be concluded that up to 120 ml l^{-1} of drinking water can be tolerated by egg type chickens from point-of-lay phase to early laying phase.

Keywords: Egg, fluted pumpkin, haematology, serum biochemistry

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Dietary Potassium Diformate in Sows during Pre-Farrowing Till Weaning: Effects on Piglet Performance in Thailand

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Potassium diformate (KDF) has been shown in numerous trials to improve health and performance in piglets, growing-finishing pigs and sows. It is furthermore the only zootechnical additive with EU-approval for use throughout the whole pig production chain. The effects of potassium diformate are often described as strong antimicrobial and digestibility enhancing. Most of the data available on the use of KDF in sows are from trials performed at universities and research institutes in Europe. The objective of the present study was to assess the subsequent effects of KDF, fed to sows, on their piglets under practical conditions in Asia.

The study was carried out with 49 sows during late gestation. The experiment was conducted on a commercial farm in Bureerum province in Thailand. The sows were randomly allotted to 2 treatment groups. Group 1 served as a control in which sows were fed a complete diet, mainly based on corn, rice bran, soybean meal and fishmeal without supplemented antimicrobial agents. Sows in group 2 were fed the complete diet containing 2 kg t^{-1} KDF. The experimental feeding of sows started 5 days before farrowing and finished at weaning (26 days after farrowing). Feed was available in mash form, while water was available ad libitum. Data on weight and number of piglets (born and "born alive") were recorded and analysed using the t-test. The results are given as mean $\pm$ SD and a confidence level of 95 % was defined for these analyses. Feeding KDF to sows did have significant effects on the new-born piglets. There was a numerical ($p = 0.11$) increase in the number of piglets born alive. The number of weaned piglets however, as well as the total weight of weaned piglets per sow were significantly increased ($p < 0.05$). Losses during weaning were therefore reduced.

These results show that the inclusion of KDF into the diet of sows can enhance performance in piglets. This is in general agreement with observations made in Europe. It can be therefore concluded that the use of KDF in sow diets under Asian conditions will be able to improve pig production.

Keywords: Piglet performance, potassium diformate, sows

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Effects of Dietary Black Cumin Seeds (*Nigella sativa*) on Performance, Carcass Traits and some Blood Parameters by Broiler Chickens

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This experiment was carried out at the faculty of agriculture and veterinary medicine, department of animal production in Thamar University, Yemen. As known, the use of antibiotics as growth promoters is banned in many countries due to the residual side effects and growing resistance to antibiotics of disease caused by bacteria by animals and human. So, feed additives of plant origin such as essential oils or extracts of aromatic plants have received considerable attention as alternatives to the traditional antibacterial feed additives. Thereby it was conducted to examine the effects of black cumin seeds (*Nigella sativa*) on growth performance (average body weight, weight gain, feed intake, feed conversion), carcass traits and some blood parameters (glucose, cholesterol, total protein, albumen) in broiler chickens. A total of 144 seven-days-old Hubbard strains were divided into four treatment groups with three replicate pens per treatment group (12 birds each). The dietary treatments were a control diet without black cumin seeds (T1) or with 1.5 % (T2), 2.5 % (T3) or 3.5 % (T4) of grounded black cumin seed (BCS) in the diet. The study lasted for 35 days.
It was found that BCS in the diet improved the final body weight compared to the control diet. Significant differences ($p < 0.05$) were observed between treatment T3 (2.5 % BCS) and T1 (control). The feed intake was increased ($p < 0.05$) for birds receiving T3 or T4 as compared to T1. On the other hand there were no significant effects of BCS among all treatments regarding the feed conversion ratio. Also, no significant effects ($p > 0.05$) of dietary BCS were observed on the dressing percentage and the percentage of the edible inner organs. Serum total protein and albumin were increased by BCS feeding and was significantly higher by birds receiving T3 and T4, whereas cholesterol and glucose were decreased significantly (P<0.05) by increasing the BCS in the diet. It can be concluded that feeding of BCS tended to improve body weight by increasing feed intake and also the BCS increased the serum total protein.

Keywords: Black cumin, blood parameters, broiler, performance

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Nutrient Intake and Pre-Caeca Amino Acids Digestibility of Broiler Chickens Fed Differently Processed Soybean Meal

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Effects of differently processed soybean meal (SBM) and bird's age (BA) on nutrient intake, energy utilisation and pre-caeca digestibility of amino acids (AA) of broiler chickens were evaluated in a 3×3 factorial arrangement. Soybeans were subjected to 3 processing methods (PM): cooking, roasting and defatting and each were included in the diets for broilers of age 0–3, 4–6 and 7–8 weeks. Six hundred and forty eight day-old chicks (Ross 308) were divided into three groups. The first group was subjected to feeding trial at age 0–3weeks, the second group was raised on a commercial diet till they were three weeks and raised on the experimental diets (4–6 weeks), while the third group was raised on commercial diet up to six weeks and placed on the experimental diets (7–8 weeks). The cooked soybean, roasted soybean and defatted soybean meal were included in diets A, B & C, respectively at the same level of 25 % inclusion in each phase. Titanium oxide was included as indigestible maker. At the close of each phase birds were slaughtered and digesta collected from the gastro-intestinal tract between Meckel's diverticulum and 2 cm anterior to the ileo-caeco-colonic junction, pooled for all birds from the same pen, freeze-dried and analysed. The DM, CP, NFE and ash intakes were significantly ($p < 0.001$) affected by PM and BA. The energy intake was only significantly ($p < 0.001$) influenced by PM. Also, the interactions between PM and BA for all the nutrients except the fat intake and energy intake were significantly affected. Only the digestibility coefficient of threonine, glutamic acid, and valine were not significantly ($p > 0.05$) influenced by PM while lysine, histidine, threonine, glutamic acid, proline and valine were not significantly influenced by the BA. Interactions between PM and BA were significant ($p < 0.05; 0.01; 0.001$) for all the AAs except for histidine and valine. It could be concluded that the bio-utilisation of SBM by broiler chickens depends on the processing methods adopted and the age at which they are fed to the birds as interactions between the processing methods and age of birds were significant in most cases.

Keywords: Amino acid digestibility, broiler age, differently processed soybean

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Performance and Meat Quality of Chickens Fed Diets Containing Palm Oil Sludge Supplemented with Garlic

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The performance and meat quality of broiler chickens fed diets containing palm oil sludge (POS) in partial replacement of the dietary energy from maize (0, 20 and 40 %) with/without garlic supplementation (0 and 5000 mg kg^{-1} diet) were assessed for 4 weeks in a 3×2 factorial arrangement. Two hundred and sixteen (216) started broiler chickens (Marshal Breed) were randomly assigned to the six experimental treatments with 12 birds per replicate of 3 replicates. Feed intake and weight gained by the birds were recorded weekly. At the end of the feeding trial, two female birds were selected per replicate and humanely slaughtered. Blood samples were collected for serum cholesterol analysis. The moisture and lipid contents, oxidative stability and organoleptic characteristics of selected muscles were also determined. The results showed that the final live weight, total weight gain, total feed intake and feed conversion ratio were not significantly ($p > 0.05$) influenced by POS, garlic and the interaction between POS and garlic. Although the serum cholesterol content of the birds increased numerically with higher level of POS in the diets, supplementary garlic significantly ($p < 0.05$) reduced it. Moisture content of meat was not significantly influenced by dietary treatments. Garlic supplementation significantly ($p < 0.05$) reduced the meat lipid content and increased its oxidative stability. The acceptability of thigh meat from the birds increased with increased level of POS and garlic due to increase in muscle fat by POS and enhanced flavour by garlic. Garlic aroma increased ($p < 0.001$) with increased level of dietary garlic supplementation. To reduce the high cost of feed, up to 20 % of the dietary energy from maize could be replaced with that of POS without adverse effect on the performance characteristics of broiler chickens. Also, garlic supplementation of diets containing palm oil sludge would improve oxidative stability and acceptability of meat from the chickens.

Keywords: Garlic, meat quality, palm oil sludge, performance, serum cholesterol

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The Effects of Tagasaste (*Chymancytisus palmensis*) Leaf Meal Supplementation on Feed Intake, Growth Performance and Carcass Characteristics of Rhode Island Red Chicks

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The effects of feeding varying levels of tagasaste leaf meal on performance and carcass characteristics of Rode Island Red chicks were evaluated. Tagasaste was introduced to Ethiopia in 1984 by Minister of Agriculture from Western Australia. For this experiment, fresh tagasaste leaves were collected from Holetta Agricultural Research Institute of Ethiopia and sun-dried. One hundred sixty dual-purpose Rhode Island Red chicks with an average initial weight of 65.5 ± 8.9 g were allocated to 16 pens, with ten chicks each in a completely randomized design. Four isonitrogenous and isocaloric diets were formulated to contain tagasaste leaf meal at the rate of 0 % (T1), 5 % (T2), 10 % (T3) and 15 % (T4) of the total diet dry matter (DM). At the beginning of the trial, eight chicks were selected and slaughtered for chemical analyses to determine nutrient retention. At the end of the trial, a male and a female from each replicate were slaughtered for chemical analysis and carcass trait measurement. The average daily DM intake for T4 (48.9 g ±1.03) was higher than that of T1 (45.9 g ± 1.04). The highest ($p < 0.05$) ash (11.4 g ±0.15, calcium (1.03 g ± 0.01) and crude fiber (4.57 g ± 0.09) intake was observed in chicks fed T4 diets. The average crude protein intake was higher ($p < 0.05$) in supplemented chicks compared to the non-supplemented one (8.13 g vs. 7.55 g). The metabolisable energy intake was similar ($p > 0.05$) among treatment groups. The protein, energy and calcium retention decreased ($p < 0.05$) as the level of tagasaste leaf meal increased in the diet. The average daily gain was highest (6.22 g ± 0.23; $p < 0.05$) for T1 diet but it was similar (5.3 ± 0.26; $p > 0.05$) among other treatment groups. The slaughter revealed that drumstick, thigh, back, breast and carcass weights were highest ($p < 0.05$) for T1 and lowest for other treatments. The dressing percentage was similar ($p > 0.05$) across treatment diets ranging from 58.0 g ± 1.03 in T2 to 60.5 g ± 1.05 in T3. It is concluded that tagasaste leaf meal could be considered as a good source of both protein and energy for smallholder farmers where other conventional supplements are not available.

Keywords: Carcass characteristics, growth performance, Rhode Island Red chicks, Tagasaste leaf meal

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Effect of Probiotics and Yacon Extract (*Smallanthus sonchifolius*) on the Performance of Broilers Cobb 500

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This study was conducted with the aim of evaluating the effect of supplementation of probiotic strains and Yacon extract (*Smallanthus sonchifolius*) on performance of broilers (Cobb 500 line). Yacon storage roots are traditionally used by farmers at mid-elevations on the eastern slopes of the Peruvian andes. However, recently it has been reported that these tubers have high content of fructooligosaccharides, an indigestible polysaccharide that have a prebiotic effect. Two hunderd and thirty four one-day old chickens were used under a completely randomised design in three treatments (T0: Antibiotic growth promoter (Zinc bacitracin), T1: *Lactobacillus* strains, T2: *Lactobacillus* strains and Yacon extract). Treatments were supplemented in drinking water every five days. Chicken weights were taken weekly until 47 days. Total feed intake, total weight gain, conversion rate, cost benefit, mortality rate, carcass and breast yield were evaluated. ANOVA and Duncan test (α=0.05) were performed for quantitative traits and mortality was analysed using Fisher test. The final weights achieved were similar between treatments ($p > 0.05$), 2873.1 $\pm$ 79.06; 2894.6 $\pm$ 65.19; 2839.92 $\pm$ 44.72; for T0, T1 and T2, respectively. The higher food intake was obtained by T0 with 5758.0 $\pm$ 85.42 g, followed by T2 and T1 with 5662.5 $\pm$178.80 g and 5611.9 $\pm$135.50 g, respectively, with no significant differences ($p > 0.05$). Feed conversion was similar between treatments ($p > 0.05$), 2.03 $\pm$ 0.03, 1.98 $\pm$ 0.05 and 1.99 $\pm$ 0.03 for T0, T1 and T2, respectively. Likewise, no significant difference was found for mortality ($p > 0.05$), but there was numerical difference, where T1 and T2 (4.5 % and 2.5 %) achieved lower mortality *vs.* T0 with 7 %. Likewise for carcass performance and breast yield there were no significant differences ($p > 0.05$). We conclude that although the evaluated parameters were not significantly different among treatments, probiotic strains alone or its combination with yacon extract could replace antibiotic growth promoter, as a similar performance was obtained.

Keywords: Broilers, performance, probiotics, *Smallanthus sonchifolius*

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Use of Drinking Water Acidification to Enhance Poultry Performance in Rural Thailand

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Organic acids, in particular formic acid and its salts, are well known to improve productivity in animal nutrition. By acting against pathogens, they help to decrease pressure on the animal's immune system, thus more nutrients will be available for productive functions such as growth. Furthermore, securing a low pH in the gizzard and proventriculus, may improve protein digestibility. Its use via the drinking water will therefore not only create hygienic conditions in the water itself, but also lead to improved performance parameters in the bird.

In a recent trial, conducted at a broiler farm in the Chonburi province, Thailand, drinking water acidification with a liquid acidifier consisting of formic acid and hexamethylenetetramine (ADDCON XL) was tested at two different dosage scenarios (1 ml/1000 ml for 7 h a day; 1 ml/1000 ml for 20 h a day – both dosages for the last 24 days before slaughter) against a negative control. 13,500 birds were randomly selected and divided equally into three treatment groups with 4,500 chicks each. Feed and water were available *ad libitum*. The effects of the acidifier on performance (daily weight gain, feed conversion) and mortality was examined after 42 days. The results are given as mean and a confidence level of 95 % was defined for these analyses.

Despite the short inclusion of the drinking water acidifier, average daily weight gain and feed conversion were improved significantly ($p < 0.05$). Mortality remained below 5 % in all groups without any differences between the groups. The European broiler index was highest in the group with 20 h access to the acidifier; however no statistical analysis is available for this parameter.

This study demonstrates that including water acidification in broiler production has beneficial effects on bird performance and may be considered as a low-cost option to improve production parameters in general.

Keywords: Broiler performance, formic acid, hexamine, water acidification

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Cheaper Alternative Feedstuffs for Sustainable Cockerel Production: An Admixture of Rural-Urban Resources and Preferences

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The cockerel aspect of poultry production can be encouraged and sustained in a rural-urban setting with cheaper alternative feedstuffs like cassava tuber wastes (CTWS). This is because the integration of livestock production with agro-industrial by-products allows for efficient recycling of resources especially at rural-urban interface. A twin effect of cheaper animal products that will alleviate protein malnutrition among the rural populace and get rid of such agro-industrial wastes and their inherent environmental hazards could therefore be achieved. This hypothesis was put to test by conducting a sixteen week study on 210 day-old cockerel birds fed fermented cassava tuber wastes (CTWs) collected from rural communities of Akure metropolis in Nigeria. The CTWs were subjected to solid substrate fermentation using a combination two lactic acid bacteria (*Lactobacillus delbrueckii* and *Lactobacillus coryneformis*) and a cellulolytic fungus (*Aspergillus fumigatus*) in order to achieve nutrient enrichment and crude fibre degradation of the wastes. Seven standard cockerel diets were formulated, in which diet T1- the control had no inclusion of CTWs, T2 contained 20 % microbially fermented cassava peel (MFCP), T3 contained 40 % MFCP, T4 contained 60 % MFCP, T5 contained 20 % microbially fermented cassava starch residues (MFCSR), T6 contained 40 % MFCSR and T7 contained 60 % MFCSR.
The results revealed that final weight and total weight gain per bird were similar ($p > 0.05$) in T1, T2, T5 and T6, also total feed intake showed no significant differences ($p > 0.05$) at both starter and finisher phases but birds fed the CTWs diets consumed more feed than those fed the control diet. The cost of feed per kg and the cost of feed consumed per bird decreased with increasing level of inclusion of CTWs in both phases except in birds fed the T7 diet. It could be concluded that the inclusion of 20 % MFCP and up to 40 % of MFCSR in cockerels' diet would not adversely affect growth and economy of production.

Keywords: Cassava tuber wastes, cockerel, cost, fermentation

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Egg Production and Quality of Laying Hens Fed Leaf Composite Mix as Alternative Premix for Commercial Premix

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A 16-week feeding trial was conducted to evaluate the effects of partial and total replacement of commercial layer premix with the leaf composite mix (LCM) produced from the mixture of five locally available edible tropical leafy vegetables: Moringa, African basil, cassava leaf, fluted pumpkin and bitter leaf on production performance and some internal egg qualities. Three hundred Isa brown point-of-lay birds were randomly allotted to six dietary treatments of 50 birds per treatment having five replicates of ten birds per replicate in a completely randomised design. The commercial premix in the basal diet was reduced by 0, 20, 40, 60, 80 and 100 % and replaced with 0, 10, 20, 30, 40 and 50 g kg^{-1} LCM and designated diets I, II, III, IV, V and VI, respectively. Feed conversion ratio (FCR) was significantly ($p < 0.05$) influenced by the dietary treatment with birds fed 20 g kg^{-1} LCM-based diet having the best FCR (1.71) but not statistically different from those fed 30–40 g kg^{-1} LCM-based diets. The hen-day production (74–89 %) of birds fed LCM-based diets was significantly ($p < 0.05$) higher than those fed the control diet (61 %). The cholesterol levels of eggs of birds fed on LCM-based diets were reduced by 88.3–92.8 units over those fed control diet while egg yolk colouration increased progressively with increased LCM inclusion level in the diets. The egg pH though significantly ($p < 0.05$) affected by the dietary treatments did not follow a particular trend. Thus, it could be concluded that the inclusion of leaf composite mix from the five leafy vegetables under study could be a veritable substitute for commercial premix in laying birds in developing countries and this could increase egg production and consumption among the resource poor in the third world countries, especially in the rural areas where access to commercial farm input is limited.

Keywords: Cholesterol, commercial premix, leaf composite mix

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Environmental Emissions from Broiler Houses in Bursa, Turkey

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This paper is a case study conducted in Bursa, northwest of Turkey and describes the pollutant gases such as ammonia (NH_3), hydrogen sulphide (H_2S), methane (CH_4), carbon dioxide (CO_2) concentrations and emissions measured in winter and summer seasons from three broiler houses. In this study, pollutant gas concentrations, temperature, relative humidity and airflow rate were continuously recorded for four sequential days. The average daily mean (ADM) house concentrations of pollutant gases in winter and summer seasons were measured as 31.77 and 4.78 ppm for NH_3, 19.75 and 21.32 ppb for H_2S, 2.56 and 15.68 ppm for CH_4, 2495 and 895 ppm for CO_2, respectively. The average daily emissions of NH_3, H_2S, CH_4, and CO_2 were 442, 279, 15.88 g h^{-1} and 82.71 kg h^{-1} in winter season for all three houses while average daily emissions of NH_3, H_2S, CH_4, and CO_2 were 169 g h^{-1}, 604 mg h^{-1}, 557 g h^{-1} and 221 kg h^{-1} in summer season from all three houses, respectively. Emission models for all pollutant gases monitored were also developed. There was a clear diurnal pattern among pollutant gas concentrations rather than emissions at the end of the study.

The average emission rates calculated per bird were 20 mg NH_3 d^{-1} $bird^{-1}$, 29 μg H_2S d^{-1} $bird^{-1}$, 19 mg CH_4 d^{-1} $bird^{-1}$, 10 g CO_2 d^{-1} $bird^{-1}$ and thereby lower than the emission rates obtained in similar studies in the USA. However, our results were comparable with the concentrations and emissions calculated in European studies as house design, ventilation system and bird diet applied in Turkish broiler farms are very similar to those employed in European countries.

Consequently, the concentrations and emissions for some pollutant gases were higher than optimum thresholds for birds and workers. Especially, NH_3 concentration in the broiler houses was a main problem for indoor air quality. Mitigation techniques such as diet formulation, biofilters and wet-dry scrubbers were recommended to reduce NH_3 concentrations in the broiler housing. In future studies, we will search which mitigation techniques are most appropriate for Bursa region.

Keywords: Ammonia , broiler!housing, confined animal feeding operations, environmental emissions

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Antimicrobial and Antiparasitic *in vivo* Activity of *Syzygium aromaticum* Extract "clove" in Weaned Guinea Pigs

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In this study, antimicrobial and antiparasitic activity of the *Syzygium aromaticum* k-loveëxtract was assessed in weaned guinea pigs. The experiment was conducted in a experimental farm in the district of Trujillo, Peru. Thirty animals were used in a randomised design with 3 treatments (T0: Application of 0.03 ml of saline; T1: oral dosage of 25 mg Sulfadimidine + trimethoprim kg BW^{-1}; T2: Dosing with 0.5 ml of *Syzygium aromaticum* extract). For counting of oocysts of *Eimeria caviae* and *Enterobacteriaceae*, fecal material and rectal swabs were collected before and 7 days after application. Statistical analysis included analysis of variance and Duncan test ($\alpha = 0.05$). T1 reduced fecal *Enterobacteriaceae* from $6.0 \pm 1.73 \times 10^6$ CFU g^{-1} to $0.63 \pm 0.37 \times 10^6$ CFU g^{-1} of fecal material , whereas T2 from $5.0 \pm 1.52 \times 10^6$ CFU g^{-1} to $0.54 \pm 0.44 \times 10^6$ CFU g^{-1} fecal material, a highly significant difference compared with T0 ($p < 0.01$). T1 had the highest reduction of *Eimeria caviae* in fecal material, decreasing from 90035.9 ±36627.3 to 1462.4 ± 872.44 oocysts g^{-1} fecal material (98.38 %), More than T2 that reduced from 85896.6± 55531.5 to 5755.5 ± 3727.9 oocysts g^{-1} fecal material (93.30 %, $p < 0.05$). Both significantly reduced the excretion of *Eimeria caviae* compared to T0 ($p < 0.01$). The cost per dose was lower in T2 (S 0.04) compared to T1 (S 0.08). The cost of reducing 10,000 *Eimeria caviae* oocysts was lower in T2 than in T1 (S 0.005 and S 0.009). To present the clove extract orally is a cost-effective alternative for controlling enteric diseases and *Eimeria caviae* in guinea pigs.

Keywords: Antimicrobial, antiparasitic, guinea pigs, *Syzygium aromaticum*

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Performance and Haematology of Weaner Rabbits Fed Diets Containing Culture Fermented Cowpea Husk

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In order to develop new, more efficient contemporary diets for growing rabbits, upgraded agro-industrial by-product, cowpea husk (CH), was tested in diet formulations for rabbit. Performance and haematology were used as response criteria. Seventy weaned rabbits (average weight of 550 g) were allocated to seven dietary treatments of five replicates each and two rabbits per replicate. Six dietary groups received diets containing fermented CH while the seventh group was placed on unfermented CH. Cowpea husks were collected from designated centres, sundried (DM $\geq$ 90 %) and appropriate weights of milled (1.0 mm sieve) CH were measured into six different double layered polythene bags. The cowpea husks were moistened with distilled water (2.5 l kg^{-1}) and spore solutions of respective fungi species were added at the rate of 200 ml kg^{-1} as follows: *Aspergillus niger* (ASP), *Rhizopus oligosporus* (RHZ), *Trichoderma reesei* (TRI), *A. niger* + *R. oligosporus* (ARH), *A. Niger* + *T. reesei* (ATR) and *T. reesei* + *R. oligosporus* (TRH) and the content of each bag mixed thoroughly. The crop residues were afterwards allowed to ferment anaerobically for 96 hours. Dried fermented and unfermented CH (DM $\geq$ 90 %) were then incorporated into respective rabbit rations to supply 10 % fibre. Rabbits were fed for ten weeks to monitor performance indices such as weight gain, feed intake and feed conversion ratio. At the end of the feeding trial, four rabbits were randomly selected from each dietary group for blood collection. Haematological parameters such as packed cell volume, red blood cells, white blood cells, haemoglobin concentratio, blood glucose and total blood protein were determined. Data collected were analysed using ANOVA in a SAS software package. Rabbits on TRH performed better ($p < 0.05$) than other treatments in terms of weight gain and feed conversion ratio. The haematological measurements indicated that the fermented cowpea husk was well tolerated by the rabbits. These results have shown the potential usefulness of fermented cowpea husk as a source of fibre and to a lesser extent as a protein source in practical rabbit feed.

Keywords: Fermentation, haematology, performance, rabbit

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Animal health and production

Reproductive Performance and Growth Ability of Thamary and Tahami Sheep Breeds and their Crossbreds in Yemen

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The aim of this study was to evaluate the effect of crossbreeding of Thamary and Tahami purebred sheep and their crossbreds on production and reproduction performance including the effect of litter size, sex, dam age and year of rearing on lamb birth weight, weaning weight, daily weight gain, mortality rate, fertility rate and the rate of twins. In total, 447 two to six-year old multiparous ewes of two breeds were allocated to three groups [Thamary, (Th; n = 100), Tahami, (T; n = 110), F1 Thamary × Tahami (F1ThT; n = 121), F1 Tahami × Thamary (F1TTh; n = 126)]. The study was conducted at the Regional Research Station of the Central Highlands in Yemen, located in the northern part of Yemen at an altitude of 510 m a.s.l. and annual rainfall ranging from 300–2000 mm. The results of this study indicate that the effect of genotype on production performance was highly significant($P \leq 0.01$). Lamb birth weight, weaning weight of lambs were greater ($p < 0.05$) in the F1ThT and F1TTh group (2.74, 2.59 kg at birth, resp., and 11.43, 12.28 kg at weaning, resp.) as compared to the T group, which amounted to 2.21 kg at birth and 8.66 kg at weaning. In general, the results of this study demonstrated that F1 crossbreeds ThT and F1 crossbreeds TTh had a positive effect lamb weight at birth, at weaning and on daily growth rate as compared to the local sheep Althammeh.

Keywords: Crossing, effect, growth ability, reproductive performance, sheep

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Does Organised Boran Cattle Breeding Increase Productivity? A Case Study on Ol Maisor Ranch, Kenya

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Ol Maisor is a working beef cattle ranch in semi-arid Laikipia District of Kenya. The ranch has a population of 3000 head of Improved Boran cattle (mother cows, offspring and fattening stock) in a herding system and is recording cattle performance – reproduction and growth – on a file card system since over 30 years. Registering a foundation stud herd with the Boran Cattle Breeders Society of Kenya (BCBS) and developing an own Ol Maisor line is intended by the rancher. The aim of this study was to assess the beef cattle characteristics desired by the rancher in the given environment, compare these with the BCBS breed standard, and select - based on the existing performance records - the founder population to be presented for registration to BCBS. The study then aimed at comparing future herd demography and herd productivity of the selected founder population with the overall ranch population.
Records on reproductive performance (dates of births, deaths, cullings, sales and acquisitions) and growth (birth weights, weaning weights) of all living mother cows (n= 953) were transferred into a computer database and imported to the commercial herd management software COW SENSE(® Midwest Microsystems L.L.C.). Interviews were held with the rancher and neighbouring Boran cattle breeders to define selection criteria. After setting selection criteria with the rancher COW SENSE was used to identify the 100 top performing cows (n = 100). Visual pre selection of these cows was done at the crush with Ol Maisor herdsmen to ensure consideration of fitness traits and scale of points of BCBS. Of these, a subset of 60 were registered and branded by a BCBS inspector. Model calculations with a bio-economic livestock herd/population model (PRY/HerdLife) will be presented on herd demography (population structure, growth and potential offtake at different culling and disposal regimes) and productivity (total output value per dry matter intake) comparing the registered subpopulation with the initial overall population. Results will indicate whether conscientious breeding according to BCBS standards has the potential to increase productivity in beef cattle ranching when compared with beef production as traditionally practised by ranchers in the region.

Keywords: BCBS, beef cattle, herd demography, herd productivity, improved Boran, stud herd registration

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Providing Animal Health Services to the Poor in Northern Ghana: Rethinking the Role of Community Animal Health Workers?

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Livestock keeping supports the livelihoods of about 70 % of the world's poor in developing countries. Yet, poor livestock keepers often lack access to affordable animal health services. In Ghana, the veterinary sector has experienced declining government support as a result of fiscal challenges. In view of this, the government promoted private practice and ceased the automatic employment of veterinarians (service providers with University Degree in animal health training) and of para-vets (service providers with Diploma in animal health training), which has reduced the number of trained service providers. However, private practice has flourished in the intensive production systems but not in marginal areas. As a result, the Community Animal Health Workers (CAHWs, community members with limited training) have been promoted in marginal areas to fill the gap in livestock health services. The paper uses the concepts of accessibility, affordability and transaction costs to examine the perceptions of livestock keepers about the various animal health service providers. The empirical analysis is based on a survey of 120 livestock keeping households in the Tolon-Kumbungu and Savelugu-Nanton districts in the Northern region of Ghana. A Multinomial Logit model was used to determine the factors that influence the households' choice of alternative animal health service providers. The results show that the government para-vets are the most preferred type of animal health service providers, while CAHWs are the least preferred. The reasons for this observation include high transaction costs of treatment even in case of CAHWs, and their low performance, which may result from limited training. In areas where government para-vets are few or not available, farmers have resorted to self-treatment or to selling sick animals for consumption, which has undesirable health implications. These practices also inflict significant financial losses to farmers. This paper finds that, therefore, the CAHWs system is not a sustainable solution to providing efficient animal health services to the rural poor in marginal areas. The paper proposes "market-smart" alternative solutions, which require a stronger engagement of the state to support poor livestock farmers in marginal areas, while at the same time harnessing synergies between the private and public sector.

Keywords: Animal health services, community animal health workers, government para-vets, livestock farmers, northern Ghana

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Production Objectives, Trait and Breed Preferences of Cattle Keepers in Southern Mali

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In southern Mali, cattle play an important role to the livelihoods of many rural households. There, the endemic taurine N'Dama breed, the Sudanese Fulani Zebu breed as well as their crosses are raised. The present study characterises the specific functions these breed groups fulfil, as well as cattle keepers' trait and breed preferences.
A survey with 160 households keeping cattle in southern Mali was carried out between November and December 2012. The respondents were asked to rank reasons for keeping cattle based on a list of 9 predetermined production objectives; then to state the 3 most important traits they considered when selecting their breeding animal, to give the major weakness of each breed and to name their preferred breed with stated reason. Rank-means were calculated for the production objectives. Differences between production objectives were analysed based on a conditional logit model (SAS software PHREG procedure). To assess overall rank of traits, an index was calculated and frequencies were used to investigate breed preferences and weaknesses.
Draught power and savings were the most important functions of cattle. Large body size was reported as the most preferred trait followed by high fertility and traction ability. The major weaknesses were no tolerance to disease and feed shortage for Zebu and crossbred cattle, and difficulty to herd, small size and low selling price for N'Dama. Regarding overall breed preferences 35.0 %, 34.4 % and 30.6 % of cattle keepers preferred N'Dama, Zebu and crossbred, respectively. The main reported reasons for the stated breed preferences were disease resistance, low raising cost and tolerance to feed shortage for N'Dama cattle, high market price, high milk yield and large size for Zebu cattle and high market price, resistance to disease and large size for crossbred cattle.
The distribution of breed preferences indicates that all breeds have characteristic attributes which are appreciated by cattle keepers. In the context of climate change and pro-poor development the comparative advantages of the endemic N'Dama breed are especially relevant for the prospects of its conservation and promotion.

Keywords: Breed preferences, Mali, N'Dama, production objectives, trait preferences, Zebu

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A Global Assessment of Population Structure and Genetic Diversity in Chicken Populations from Africa, Asia, Europe, and Commercial Breeds

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The analysis of global diversity and population structure of chickens plays a vital role in priority settings and strategy development for genetic diversity conservation schemes, especially in the era of using genetic variations for future intensive selection programmes and breeding stock development. The genetic diversity and population structure of 114 chicken populations from Africa, Asia, and Europe were studied using 29 microsatellite markers. Three populations of wild chickens (RJF), nine commercial purebreeds and one inbred line encompassing four sublines were used for comparison. Allele frequencies, mean number of alleles, heterozygosity, Wright's fixation indices, marker-estimated kinship and molecular coancestry coefficients were estimated to investigate the extent of genetic variability between and within chicken populations from different geographical regions. Population structure was determined by using Bayesian model-based clustering and phylogenetic neighbour net was derived from marker estimated kinship distances. High heterozygosity was observed in African (0.614) and Asian (0.603) chickens relative to European (0.454) and Commercial (0.453) breeds. European chicken breeds showed higher range of variability in heterozygosity, while the majority of Asian and African chicken populations had heterozygosity levels above the mean of all populations. They also showed lower differentiation (FST estimates) than European or commercial breeds. A spatial difference of Marker-estimated kinship was obtained from similarity matrices calculated from the allele frequencies of the microsatellites over chicken populations under geographical distribution. The cluster analysis revealed high admixture in African and Asian chicken populations whereas European breeds partitioned into distinct groups with minimum sharing of genetic material. Attention should be drawn to conservation of some European chicken breeds.

Keywords: Coancestry, genetic diversity, microsatellite markers, population structure

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Factors Influencing the Choice of Genetic Stocks for Commercial Layers' Production in the Humid Tropics

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The performance of commercial layers can be viewed simply as the sum of its genotype and the effect of the environment with which it is associated. However, in the humid tropics, the pattern by which different layer strains respond to a shift in the environment, management and husbandry practices often changes drastically. Evidence of detrimental effects of environment and the interaction between layer strains and environment on rate of egg production, egg weight, feed intake, feed efficiency, livability, body weight and many other traits of economic importance for the layer industry need to be reviewed.

Hot and humid conditions decrease the difference between ambient temperature and the average temperature of the body surface, reducing the rate at which metabolic heat can be dissipated in commercial layers. Hot conditions can be avoided with good nutritional strategies, management practices and with modern layers houses equipped with efficient cooling and ventilation systems. However, the global commercial layer industry continues to expand to hot-climate developing countries where climatic control of layer houses is limited due to high installation and operational costs and an unreliable supply of electricity. Hence, breeding heat-tolerant layers may offer a sustainable approach to mitigate the negative effects of heat on commercial layer production. Breeding for adaptation to a specific stressful environment is the strategy of choice when GxE interaction affects economically important traits. In tropical countries where commercial layer producers cannot afford costly cooling and ventilation, it would be better to select under the prevailing or varying conditions where the laying birds are to be used.

The results showed that different preferences observed among thirty five commercial layer farms in these studies using seven key egg-stock traits may be attributed to the differences in the performance gains,disease resistance and the extent of heat tolerance.

In conclusion, while there is little data available that actually compare production systems; taking into account all environmental, breeding and production costs, it is established that the choice of commercial layer production stocks depends on their production gains, capability to adapt to their environments and even contribute to environmental sustainability in order to achieve performance objectives.

Keywords: Commercial layers, genetic stocks, humid tropics

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Effect of Body Condition Score and Short-Term Nutritional Flushing on the Reproductive Performances of Spanish Female Goats and their Crosses with Male Boer Goats

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Goat production has become an attractive alternative livestock enterprise for limited resource farmers in many tropical and subtropical countries. The objective of this experiment was to evaluate the effect of body condition score (BCS) and the subsequent short-term supplementation with high levels of energy and protein sources on the reproductive performance 90 Spanish and 90 Spanish × Boer (60 ½ Boer = F1-cross and 30 ¾ Boer = F2-cross). Each genotype was equally distributed to treatments of 2 body condition groups (BCG, low and high) and 3 flushing treatments consisting of no supplementation (control), supplementation with protein mixture (PM) alone and PM + ground corn (PE) (2×3 factorial arrangements). The flushing period lasted for 11 days after which does were exposed to sexually active Boer bucks for 42 days long. The results indicated that flushing with PM and PE diets numerically increased the body weight and body condition score values of all genotypes categorised in high BCG. In low BCG, however, flushing with PM and PE diets significantly ($p < 0.05$) increased the body weight of F1-cross and Spanish does, respectively. Moreover, in low BCG, flushing with PE diet increased($p < 0.05$) the BSC values by 26.7 %, 18.1 % and 29 % in Spanish, F1- and F2-crosses, respectively. Similarly, flushing with PM diet increased($p < 0.05$) the BSC values in Spanish and F1 genotypes by 19.6 % and 10.7 %, respectively. In high BCG, does of the Spanish and F1-cross flushed with PE diet had higher($p < 0.05$) pregnancy and multiple birth rates than F2 genotype. In low BCG, the pregnancy and kidding rates of Spanish does flushed with PM diet was higher($p < 0.05$) than those of F2-cross. Similarly, the F2-cross supplemented with PM and PE diets had significantly ($p < 0.05$) higher pregnancy and multiple birth rates than both Spanish and F1 genotypes. The litter size was significantly ($p < 0.05$) higher for F1 and F2 genotypes supplemented with PE diet. In conclusion, flushing with protein and energy sources for short period of time was found to be beneficial for improving the body weight and body condition score and subsequently, the reproductive efficiency of does characterised by poor body condition.

Keywords: Body condition score, body weight, Bore goats, nutritional flushing, reproductive traits, Spanish goats, Spanish × Boer crossbreeds

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Regression Models to Predict Body Weight from Body Condition and Testicular Dimensions in Yankasa Rams

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Body size and testicular measurements have been found to be important parameters utilised in breeding soundness evaluation. Therefore, the present study aimed at determining the relationship between body weight (BW), body condition score (BCS), testicular length (TL), testicular diameter (TD) and scrotal circumference (SC) in Yankasa sheep. Data were obtained from 120 rams. The randomly selected animals, which were approximately 30 months old, were extensively managed in Nasarawa State, North Central Nigeria. Age was determined from available records on rams provided by the livestock keepers; where information was missing, the age of each ram was estimated using dentition. Descriptive statistics were computed for BW, TL, TD, SC, and BCS. The Pearson's correlation coefficients were used to assess the association between the BW, TL, TD, and SC, respectively. The Spearman correlation coefficients were estimated to quantify the relationship between BCS and BW, TL, TD and SC. In order to predict BW from TL, TD, SC and BCS, the linear, quadratic and cubic predictive models were fitted. Coefficient of determination (R^2), adjusted R^2, the estimate of Mallows' Cp, RMSE (Root mean squares error) and the parsimony principle (p=number of parameters) were used to compare the efficiency of the different models. Strong Pearson's correlation coefficients (r = 0.83–0.94; $p < 0.01$) were found between BW, TL, TD, and SC. Spearman correlations between BCS and other variables were also highly significant (r = 0.78–0.85; $p < 0.01$). SC was the sole variable of utmost importance in estimating BW, which was best predicted using the cubic model. However, the optimal model for BW prediction comprised TD, SC, and BCS with p, R^2, adjusted R^2, RMSE and Cp values of 4, 0.948, 0.946, 1.673 and 4.85, respectively. The present findings could be exploited in husbandry and selection of breeding stock for sustainable sheep production among smallholder farmers in a developing economy.

Keywords: Body condition, body size, rams, regression models, testicular measurements

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Interventions for Establishing Breeding Strategies to Improve Dairy Production of Zebu Cattle Breeds in Kenya

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The cattle population in East Africa is dominated by Zebu cattle breeds. Despite their perceived low productivity, Zebu cattle are an integral part for the majority of the rural households. Their roles are multifaceted and range from the provision of milk and meat, revenue generation, insurance against risks and other socio-cultural roles notwithstanding the complex and challenging production systems under which they are raised. However, there has been little focus on improving their productivity. The end result has skewed focus on introduced taurine breeds at the expense of Zebu cattle genetic resources for economic important traits such as milk production. This study provides preliminary results of a broad project that aims to improve Zebu cattle for dairy production through targeted selection and systematic cross breeding programs in the East and Central African region. The focus was on Kenya, where a baseline survey was conducted in four counties of Kitui, West Pokot, Busia and Homa Bay to evaluate the possible interventions to support establishment of breeding strategies to improve milk production among Zebu cattle breeds. There was a high preference for up-grading programs across the sampled sites with most cattle keepers showing high willingness to use modern reproductive technologies such as artificial insemination to improve the genetic potential of their herds. However, such conventional breeding services are out of reach for the majority of the cattle keepers and in all cases village bull schemes with unproved genetic merit are predominant. There are no comprehensive breeding intervention strategies to support improvement of dairy production potential of the Zebu cattle breeds despite the fact that farmers have considerable amount of knowledge on options to improve performance.

Keywords: Breeding strategies, Kenya, milk production, Zebu cattle

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Effects of DGAT1, Leptin and Kappa Casein Gene Variants on Milk Production in Sudanese Cattle

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The present study aimed to study the allelic and distribution pattern of candidate genes and to investigate the genetic variation of the selected polymorphisms located within diacylglycerol acyltransferase 1 (DGAT1), leptin (LEP), and kappa casein (CSN3) genes on milk production traits in Sudanese dairy breeds. The samples of milk and blood were collected from 40 Butana and 20 Kenana dairy cows. The polymorphism of DGAT1 promoter variable number tandem repeat (VNTR) was genotyped using LI-COR -DNA analyser, while the LEP and CSN3 were genotyped using the polymerase chain restriction fragment length polymorphism. The effect of polymorphisms was analysed using SAS software.

For the DGAT1 promoter VNTR, three different alleles (3, 4, and 5) were segregated in Butana cattle, while two alleles (3 and 4) were found in Kenana cattle. Allele 3 was the most frequent with a frequency of 70.46 % and 81.25 % in Butana and Kenana breeds, respectively. The DGAT1 promoter VNTR genotypes significantly affected the fat content. The VNTR allele 3 significantly increased both fat (0.84 ± 0.22 %) and protein (0.19 ± 0.08 %) contents. A similar trend was observed in Kenana cattle, where the 33 homozygous genotypes at the VNTR locus showed higher fat and protein contents than the 34 heterozygous genotypes.

For the Mbo1-RFLP on the LEP locus, the frequencies of allele A were 97.50 % and 97.06 % in Butana and Kenana cows respectively. Both breeds showed a complete absence of homozygous BB carriers. The AB heterozygous means were higher for milk, protein and fat yields when compared with those of AA homozygous cows in Butana and Kenana dairy cattle.

In the CSN3 variant, the allele A was the major with a frequency of 86.25 % and 89.29 % for Butana and Kenana cows respectively. Results from the statistical association analysis between CSN3 genotypes and milk production parameters were not significant.

The results of the present study demonstrate that polymorphisms in the candidate genes, which show a significant association with milk production traits, may provide a high potential for marker-assisted selection (MAS) programs in dairy cattle and could be used for selection at the genomic level.

Keywords: CSN3 gene, dairy cattle, DGAT1, LEP, milk production traits, polymorphism

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The Importance of Preliminary Diagnostics before Embarking on Large-Scale Treatments of Livestock in Emergency Interventions

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Since March/April 2012 refugees from Blue Nile State in the Republic of Sudan have arrived in neighbouring Maban County, Upper Nile State, South Sudan together with large numbers of livestock. High mortalities of the newly introduced livestock populations were recorded soon after their arrival. During early November 2012 as many as 400 cattle were reported to have died per week. VSF-Germany was then requested to conduct emergency measures in the area.

Initially, blood samples from 62 animals were examined of which 25 % were positive with *Trypanosoma vivax*. Novidium® (Ethidium chloride, 1 mg kg^{-1} bw.), a trypanocidal drug used for treatment of infections with *T. vivax* (and *T. congolense*) was given to 9500 cattle. The cattle were also vaccinated against Haemorrhagic Septicaemia, Contagious Bovine Pleuropneumonia, and Anthrax. As animals in poor condition were still observed, a fact-finding mission was performed during March 2013. Thirtyfive clinically suspect cattle were investigated. Their average haematocrit (PCV%) was 21.4 %, and in nine cases trypanosomes were detected by wet blood film examination. Subsequently, *T. evansi* - which is refractory to Novidium® treatment - was confirmed in one animal.

Five mono-conical (Vavoua) and five NGU traps were deployed for 24h along the river Yabus in what appeared to be suitable habitats but failed to catch any tsetse fly. However, the presence of numerous *Stomoxys* and *Tabanus* spp. points to the possibility of mechanical transmission of trypanosomes. Another potential mechanical vector (Lyperosia) was frequently observed on cattle.

Our findings show the need for thorough diagnostic investigations even in emergency situations where all parties involved often act under time constraints. Measures might be in vain or – even worse – might contribute to the development of therapy-resistant pathogens unless the causes of disease and animal losses are fully understood.

Keywords: Livestock diseases, Sudan

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Are Capsule Polysaccharides of Mycoplasma Pathogens affecting Ruminants in Africa Novel Vaccine Targets?

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Contagious bovine pleuropneumonia (CBPP) caused by *Mycoplasma mycoides* subsp. *mycoides* (Mmm) is one of the most important livestock diseases in sub-Saharan Africa. CBPP impacts health and poverty of livestock-dependent people through decreased animal productivity, reduced food supply, and the cost of control measures. Additionally, CBPP is a barrier to trade in many African countries and this reduces the value of livestock and the income of many value chain stakeholders.

Presently control of CBPP relies mainly on a live vaccine of limited efficacy and duration of immunity. Vaccines with better efficacy are necessary for control and eradication programmes within all African regions.

To date, our understanding of pathogenicity of the *Mycoplasma mycoides* is rather limited, since neither toxins nor colonisation factors have been identified. Up to now a long-lasting protective immune response could not be induced experimentally. *Mycoplasma mycoides* has a polysaccharide capsule that is likely to protect the pathogen from the host's immune responses. Full genome sequencing and *in silico* analysis of *Mycoplasma mycoides* isolates revealed a set of conserved genes involved in polysaccharide biosynthesis. A series of complementation assays and transposon mutagenesis experiments confirmed their function and highlighted the importance of these genes for survival of the pathogen, respectively.

Vaccines based on capsular polysaccharides are today available against *Streptococcus pneumoniae*, *Neisseria meningitidis*, *Haemophilus influenzae* type B and typhoid fever, and we are investigating the possibility of using the polysaccharides from the Mycoplasma capsule as a vaccine target. To this end, we are characterising the capsule using NMR technology.

We are investigating the role of *Mycoplasma polysaccharides* by mutagenesis of proteins involved in polysaccharide biosynthesis. Therefore we are using synthetic genomics via codon pair alteration, in order to decrease expression/abundance of the encoded enzymes. These mutants allow us to finally gauge the role of the capsule polysaccharides in host pathogen interactions using adhesion or *in vivo* experiments. The capsule of the resulting mutants will then be characterised, and the phenotypes will be tested *in vitro* and subsequently *in vivo*.

Keywords: Capsule, carbohydrates, CBPP, Contagious Bovine Pleuropneumonia, mycoplasma, polysaccharide, vaccine

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Camel Brucellosis: A Disease Barrier to Sudan's Camel International Trade due to Slight Differences in Testing Results

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Brucellosis is a chronic infection caused by intracellular bacteria belonging to the genus *Brucella*. Freedom from this disease is a pre- requisite for exportation of live animals, especially the camels, because of the zoonotic nature of this disease. During the last few years, brucellosis emerged as one of the most important disease barriers to Sudan's international camel trade. Whole camel shipments were returned to Sudan from Saudi Arabia due to few animals being found sero-positive for brucellosis - despite all animals were tested negative before being shipped. Precautions such as double testing of all camels in the primary and final veterinary quarantines and application of the last test shortly before shipment did not completely solve the problem; some camel shipments are still rejected from time to time for the same reason. To address this problem, camel sera were tested twice with different batches of Rose Bengal antigen, the same sera were tested in two different laboratories and different times, standard and modified Rose Bengal test (RBT and mRBT, respectively) protocols were used. Different batches of RBT antigen and different labs as well as RBT and mRBT gave consistent results, with some differences in the degree of agglutination and agglutination time. It was concluded that this problem of rejection of export camels due to brucellosis can be partially attributed to these slight differences between the results of different labs and/or different batches and protocols that are routinely used for brucellosis testing.

Keywords: Brucellosis, camel, modified Rose Bengal test, Sudan

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Multivariate Model for the Assessment of Risk of Abortion and Stillbirth in Nigerian Goat Herds

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The aim of the study was to investigate the application of multivariate logistic regression to assess the potential factors associated with the prevalence of abortion and stillbirth in indigenous goat breeds in Nasarawa State, North Central Nigeria. 5,268 kidding records of does from a total of 105 traditional goat herders from the year 2010–2011 were utilised in the study. The goats which were of West African Dwarf (WAD), Red Sokoto (RS), Sahel (SH) and WAD × RS crossbred (WR) genetic groups originated from different flocks and were reared under the traditional extensive system. The risk factors investigated were dam breed group, season, parity and number of foetuses. The logit of the probability of an abortion or stillbirth was modelled using logistic regression assuming an asymptotic binomial distribution. Backward stepwise elimination based on Wald method was applied. The Hosmer and Lemeshow Chi-square goodness-of-fit test was performed to check if the multivariate logistic model fit the data well. Of the 5,268 kidding records, 520 (9.87 %) and 570 (10.82 %) were cases of abortion and stillbirth, respectively. The logistic regression analysis revealed that season, parity and number of foetuses were the parameters of utmost importance ($p < 0.05$) influencing the prevalence of abortion and stillbirth in the four genetic groups investigated. The logistic regression models were able to predict correctly 89.2 and 90.1 % cases of abortion and stillbirth, respectively. The present information may be exploited in management practices to attenuate the incidence of abortion and stillbirth parturition, thereby increasing the productivity of the animals especially within the resource-poor farming system under tropical and subtropical conditions.

Keywords: Abortion, goats, logistic regression, Nigeria, stillbirth

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Ruminant nutrition

Posters

Effect of Fenugreek Seeds Supplementation on Nutritional Performance and Milk Production of Sudanese Nubian Goats

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This study was conducted to assess the effect of supplementing a basal diet with different levels of fenugreek seeds 0 % (F0 %), 5 % (F5 %), 10 % (F10 %) and 15 % (F15 %) on feed intake, digestibility, milk yield and composition, and economic appraisal. Twelve lactating Nubian goats were divided into four equal groups, consisting of 3 replicates of one animal on each group, using a completely randomised design. The diet fed immediately postpartum for two consecutive months. Feed intake (g/day) and milk yield (liter/day) were recorded daily while feces samples of individual animals were collected during the last week of the trial. The results revealed that dry matter and crude protein intake were significantly ($p \leq 0.05$) increased when fenugreek seeds were fed to goats as compared to the control. Also supplementing diets with fenugreek seeds significantly ($p \leq 0.05$) increased nutrients digestibility of dry matter, crude protein and organic matter. Milk yield increased significantly ($p < 0.05$) with the increased levels of fenugreek seed supplement, with concomitant decrease in milk fat content, while the other milk components (protein, lactose and solid not fat) showed an inconsistent pattern.

In addition, the results indicated that the cost of diet increased in supplemented groups compared to the control group. It was 0.47, 0.92, 1.28 and 1.63 SDG for (F0 %), (F5 %), (F10 %) and (F15 %), respectively. However, the profitability was increased dramatically with increasing the levels of fenugreek seeds, being 199.05 % (F5 %), 212.38 % (F10 %) and 253.33 % (F15 %) compared to the control group.

It was concluded that supplementing Nubian goats with fenugreek seeds has positive effects on dry matter and crude protein intake, dry matter digestibility, crude protein digestibility, organic matter digestibility, milk yield and profitability.

Keywords: Digestibility, fenugreek seeds, intake, milk composition, milk yield, profitability

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Performance of Zero-Grazed Sahelian × Djallonke Ewes with *Lablab purpureus* Supplementation under Tropical Climatic Conditions

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In tropical ruminant production, dry seasons are characterised by steady loss of weight of flock due to loss of nutritive value of feed resources. In the light of this challenge which is particularly prominent in peri-urban production systems where the natural grazing land is rapidly declining there is the urgent need to develop farmer friendly feeding strategies to mitigate it. A two fold experiment was conducted at the ruminant section of the Biotechnology and Nuclear Agriculture Research Institute during the dry season from January to February 2013. The growth performance of five Sahelian × Djallonke crossbred ewes over a ten week period in the dry season was evaluated in the context of adaptive agriculture. The age range of selected ewes were between 13 and 16 months. Ewes' basal diet of *Panicum maximum* was supplemented with a drought tolerant tropical leguminous fodder *Lablab purpureus* under zero grazing conditions for the first five week period and followed by a week break then another five weeks during which their diet was not supplemented. Proximate composition of the *Panicum maximum* and the *Lablab purpureus* were evaluated. The ewes on average gained 37.86 g day^{-1} during the supplementation period compare to a net loss of 15.17 g day^{-1} when the supplementation was withdrawn. One way analysis of variance showed that the difference was not significantly ($p > 0.05$) different. Given the short duration of the intervention it still demonstrated the potential of the use of simple modifications of existing production systems to mitigate production losses due to drought conditions in the tropical ruminant production.

Keywords: Djallonke, *Lablab purpureus*, non supplemented, *Panicum maximum*, peri urban, supplemented

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Ruminal Fermentation and Nutrient Digestion in West African Dwarf (WAD) Sheep Fed *Dialium guineense* Supplemental Diets

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Ruminant livestock production in sub-Saharan Africa is based on forage as the major feed resource, which of course is highly seasonal with low nutritive quality during dry seasons. Multipurpose trees (MPTs) which are part of the natural vegetation and accessible to farmers have always been a useful protein supplement. Studies by a number of researchers have indicated that some MPTs are less suitable as protein supplement because their soluble phenolic and condensed tannin compound limit protein digestion. It was against this background that an experiment was designed to study the fermentation profiles of dried *Dialium guineense* leaves as supplement to grass hay fed to West African Dwarf (WAD) sheep. Eight 24 months old WAD sheep (28.8 kg $\pm$4.2 BW), fed a basal hay diet at 2.5 % BW dry matter were used to evaluate the fermentation profiles and nutrient digestion of *Dialium guineense* leaves. Four of the sheep were fistulated ruminally and used for rumen pH, ammonia and volatile fatty acid (VFA) in the rumen fluid. Dried leaves of *D. guineense* were offered at two levels (25 % and 50 % of DMI, diets 2 and 3, respectively) as supplement to a basal hay diet. Rumen liquor was sampled one hour before and one, three and five hours after the morning feeding. Rumen pH of diet 3 was higher ($p < 0.05$) compared to the controls. Diet 3 also had a lower ($p < 0.05$) (14.6 mg dl^{-1}) rumen ammonia concentration compared to the controls (30.6 mg dl^{-1}). The total VFA of diet 3 was lower ($p < 0.05$) (67.9 mmol l^{-1}) when compared to the controls (94.1 mmol l^{-1}). Diet 3 showed a negative N- retention (3.5 %) compared to the control diet (16.8 %). These results demonstrate that dried *D. guineense* leaves have a potential as forage during dry season feeding. Even though it showed a lower total VFA and rumen ammonia concentration, the value from this study was within the range of 5 to 23 mg dl^{-1} recommended for optimum microbial protein synthesis.

Keywords: Chemical composition, *Dialium guineense*, fermentation profiles, WAD sheep

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Growth Response of West African Dwarf Goats Fed Differently Treated Corncob Silage Diets

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A study was conducted to evaluate the growth responses of thirty (30) West African Dwarf (WAD) goats (males) fed differently treated corncob silage diets. Five hundred kilograms of sun-dried corncobs were divided into 5 equal portions, the 1st portion was untreated, 2nd portion was treated with water (1 l water per kg corncobs), 3rd portion was treated with lye solution (1 l lye solution per kg corncobs), 4th portion was treated with poultry litter (1 kg poultry litter per kg corncobs) and the 5th portion was treated with 5 % urea solution (1 l urea solution per kg corncobs). All portions were ensiled for 28 days. Five diets were formulated such that air-dried of the ensiled untreated corncobs (A), water treated corncobs (B), lye treated corncobs (C), poultry litter treated corncobs (D) and urea treated corncobs (E) were incorporated at 45 % level into the diets respectively. The animals were randomly assigned to the 5 diets (six goats/diet) in a completely randomised design for a period of 63 days. The analysed crude protein (CP) contents of the diets ranged: 12.54 (diet A) - 30.96 % (diet D), while analysed crude fibre ranged: 18.61 (diet D) - 38.45 % (diet B). The DM intake ranged: 210.25 (diet B) - 376.83 g day^{-1} (diet E) and CP intake ranged: 32.09 (diet B) - 94.62 g day^{-1} (diet E), while the highest DM digestion coefficient value (80.26 %) was observed in animals fed diet E and the least value (58.41 %) in animals fed diet B. The highest weight gain (38.79 g day^{-1}) was observed in animals fed diet E and lowest (11.57 g day^{-1}) was observed in animals fed diet A. The animals fed diet D had the best feed/gain ratio (8.48) compared to 26.23 observed in animals fed diet C. From foregoing, urea treated corncobs enhanced better weight gain than other test diets while goats fed poultry litter treated corncobs had better feed/gain ratio than the other test diets. Thus, the use of urea and poultry litter treated corncobs in goat diets could lead to enhanced goat production in sub-Sahara Africa.

Keywords: Corncob, digestibility, goats, poultry litter, response, urea

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Protein Picture, Clinical Profile and Rumen Characteristics of Sheep Fed Diets containing Condensed Tannins

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A study was carried out to investigate the effects of feeding low quality non-conventional feeds (NCF) containing phenols and condensed tannins on health and performance characteristics in Omani sheep. Twelve Omani sheep were fed one of two base roughages, urea treated palm frond (UTPF) or Rhodes grass hay (RGH) plus a commercial concentrate for 63 days. Haematological, serum biochemical and urine analyses were used to assess sheep health. Serum protein fractions were measured using electrophoresis.

Urea treated palm frond contained higher levels of polyphenols and condensed tannins and fiber than the Rhodes grass hay or the commercial concentrate feed. Animals fed UTPF had lower feed intake ($p < 0.05$) and lower body weight gain ($p < 0.001$) than those fed RGH. Rumen liquor of UTPF-fed animals had higher pH, ammonia-nitrogen and butyric fatty acid but lower acetic fatty acid ($p < 0.05$). Animals fed UTPF had higher neutrophil ($p < 0.05$) but lower lymphocyte ($p < 0.05$) and monocyte ($p < 0.001$) counts by the end of the trial than those fed RGH. There were no effects of diet on serum albumin or globulin fractions levels or albumin : globulin ratio. There were no major effects on urine analysis but there was a trend by control animals to have higher protein and specific gravity than treated ones. This experiment indicated that feeding low quality non-conventional feeds containing polyphenols or tannins would reduce body gain and may produce some effects on clinical parameters. Although tannins are known to influence protein digestion and absorption in ruminants, they did not significantly affect serum protein picture in sheep.

Keywords: Haematology, phenols, protein, sheep, tannins

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Evaluation of *Prosopis juliflora* Pods as Potential Feed for Livestock in the Arid Tropics

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Prosopis juliflora (Meskit) is a tree originating in America and has been introduced over the past centuries to many parts of the world mainly to combat desertification. Its pods and leaves have been used in the dry tropics for feeding ruminants. However, feed intake of the leaves and the pods is low. The current study aimed at evaluating the potential of raw and processed prosopis pods as a livestock feed. The pods were processed by the following methods: soaking, roasting, boiling and autoclaving for 10, 20, 30, 40 and 50 minutes. Proximate chemical analyses was carried out on the pods. *In vitro* gas production was determined using goat rumen liquor and following published routine techniques. The raw dried pods contained 90.2 % dry matter (DM) and 12.8, 18.3, 36.9, 24.1, 12.8, 32.3, 4.5, 1.0, 5.1, 4.2, 0.04 and 0.06 %/DM crude protein, crude fibre, neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose, cellulose, lignin, ether extract, ash, Ca and P, respectively. It also contained 18.7 kcal g^{-1} gross energy. The treated pods produced more gas than Rhodesgrass hay (RGH), the most dominantly used roughage in Oman. There was a trend that processing of pods improved gas production with soaked pods producing the highest cumulative gas value. Autoclaved samples also produced gas volumes comparable to soaked pods but higher than those of non-treated pods or RGH, with autoclaving for 20 and 30 minutes producing best results. This study indicated that *Prosopis juliflora* pods are a potential drought feed especially if they are processed by soaking and roasting. An *in vivo* experiment with native sheep and goats to evaluate the potential of using the pods in feeds will be conducted soon.

Keywords: Chemical composition, gas production, livestock, pods, *Prosopis juliflora*

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Effect of Dietary Energy Level on Performance and Carcass Characteristics of Sudan Baggara Heifers

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Fourty-eight Baggara heifers were used to study the effects of dietary energy levels of 9.5, 10.5 and 11.5 MJ kg^{-1} (a, b and c, respectively) on performance and carcass characteristics. The diets were formulated from sorghum grains, wheat bran, groundnut cake, molasses and groundnut hulls with different proportions. The heifers were divided into three groups of equal number and weight. Each group was further subdivided into four sub groups. The study site was Kuku Livestock Research Station, Khartoum North, Sudan. The results indicated that daily dry matter intake ranged between 6.14 – 6.8 kg and was significantly affected by dietary energy level. Dry matter intake was significantly ($p < 0.01$) greater for heifers fed diet a. Daily weight gain ranged between 0.58 – 0.73 kg but did not differ significantly and was superior for the heifers fed diet c. While feed conversion ratio was significantly ($p < 0.01$) inferior for heifers fed diet a. The results indicated that the slaughter weight ranged between (225 – 250) kg ,while empty body weight ranged between (193 – 213) kg and they were significantly affected by the dietary energy level. Heifers group fed diet a had significantly $p < 0.05$ lighter slaughter weight and empty body weights. Dressing percentage values were improved by the dietary energy level and heifers fed diet a had consistently the lowest dressing percentage. Dressing percentage of hot carcasses ranged from 52 to 54 % when calculated on slaughter weight bases and from 61.3 to 62.4 % when calculated on empty body weight bases. The area of the Longissimus dorsi muscle ranged from 48.5 – 65.2 cm^2 and was affected by dietary energy level where, it was significantly ($p < 0.01$) smaller for heifers fed diet a. Back fat thickness ranged from 0.99 – 1.10 cm and was improved by dietary energy level. Heifers fed diet b and c had thicker back fat. Carcass composition indicated that total carcass muscle percentage ranged from 60.6 to 63.5 % and was found to be higher for heifers fed diet a. Total carcass fat ranged from 14.2 to 17.6 % and was lower for the heifers fed diet a. The results indicated that increasing dietary energy level improved the performance as well as the carcass characteristics and composition of Baggara heifers.

Keywords: Baggara heifers, carcass characteristics, dressing percentage

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Supplementing Goats with Charcoal: Effects on Feeding Behaviour and Faecal Nutrient Output

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Charcoal has positive effects on soil fertility; therefore it is directly applied to soils or mixed with compost or manure. When supplementing animals with charcoal it is intensively mixed into the faeces through the digestive processes. Due to its absorptive capacity, charcoal may bind rumen or hindgut microorganisms of supplemented animals and by this hamper digestion processes and reduce the nutrient availability from manure to plants, but also prevent leaching of nutrients to deeper soil layers. However, charcoal can be only a padding in animal diets, as it has no nutritive value and may lead to constipation. The objective of this study was to assess how much charcoal could be included into goats? diet without negative effects on feeding behaviour and health. A feeding trial was conducted with 4 Boer goats (22.8 kg $\pm$ 3.91) receiving the same diet (50 % hay, 50 % concentrate) over six 14-day-periods in which increasing amounts of activated charcoal (AC; 0, 1.5, 3, 5, 7, 9 % of total diet, dry-matter-basis) were included into the pelleted concentrate. Goats' feeding behaviour (consumption rate, refusals) and manure characteristics (colour, odour, consistency) were observed during the first 5 days of each period. During days 8-10 total faecal excretion was determined using collection bags and samples were taken for C and N analysis. Supplementing goats with up to 9 % AC did not influence their feeding behaviour - they ingested the concentrate at a constant rate and already 4 minutes after feeding less than 5 % of the AC pellets were left. The faecal consistency changed from normal to hard when more than 5 % AC were supplied, and the colour changed from normal to dark at the 3 % and to very dark at the 9 % AC level. The odour was reduced when more than 3 % AC were included in the diet. The faecal C excretion increased while the N excretion tended to decrease with increasing AC level. We conclude that supplementing goats with up to 9 % AC is a possibility to incorporate charcoal into faeces and increase faecal and soil C concentration without negative short-term effects on goats' feeding behaviour and health.

Keywords: Charcoal, feeding behaviour, goat, nutrient excretion

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Observations on Serum Copper Levels in three Omani Goat Breeds in Different Regions of Oman

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Goats comprise an important source of animal food and income in Oman. Copper deficiency is an endemic problem in Omani livestock. To investigate prevalence of copper deficiency, serum samples were collected randomly from 184 Omani native goats of three breeds including 93 Jabal Akhdar (JA), 41 Batina (BAT) and 50 Dhofari (DOF). The animals, belonged to three geographical regions in Oman (Al-Jabal Al-Akhdar, Al-Batina and Dhofar), comprised 34 males and 150 females. The goat ages ranged between 3 months to 8 years. Goats were divided into five age groups: (Age1): 2 m–1 y (n=26), (Age2): >1–2 y (n=31), (Age3): >2–3 y (n=41), (Age4): >3–4 y (n=49) and (Age 5): > 4 y (n=37). JA goats were raised on partial range grazing plus stall supplementation while the BAT and DOF goats were kept and fed indoors. All animals were supplemented with extra Rhodes grass hay plus a variety of concentrates as well as mineralised salt licks. Means of serum Cu (mg/l) of all breeds ranged from low to deficient. The mean serum Cu (mg/l $\pm$ SE) of JA, BAT and DOF were 0.48$\pm$0.01, 0.28$\pm$0.04 and 0.46$\pm$0.04, respectively. There were highly significant ($p < 0.001$) breed differences, reflected in lower levels of serum Cu in the Bat compared to both JA and DOF. The JA and DOF goats had comparable levels. There was no significant effect ($p > 0.05$) of age or sex or their interaction on Cu levels in Omani goats. This study indicated that subclinical Cu deficiency in Omani goats may be prevalent in certain regions. Further studies are needed to investigate levels of other minerals and trace elements in goat serum and levels in rangeland and pasture. The economic effects and methods of alleviation of mineral deficiency in Omani goats need to be investigated.

Keywords: Batina, copper deficiency, Dofar, goat breeds, goats, Jabal Akhdar, Oman, plasma copper

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Aquaculture, fisheries and fish

Posters

Integrated Aquaculture and Hydroponics System using Renewable Energy: I. Fish Performance and Nutrient Flows

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Aquaculture in the desert and arid regions must be based on the use of as little of freshwater as possible due to the limited rainfall and available freshwater sources. In land-based fish culture, water quality can be controlled by either a high rate of water exchange, which is costly or by water treatment and subsequent recirculation, which comes at a price. To reduce costs and increase profitability, maximise the utilisation of water and convert the excretion of fish culture into valuable products, the integration of aquaculture and plants offers an ideal solution. Therefore, during the present study, an integrated multi-trophic aquaculture (IMTA) and two separate hydroponic systems (HS, nutrient film technique and floating raft systems) for the land-based culture of Nile tilapia, African catfish, thin lipped grey mullet, freshwater prawn, freshwater clams and vegetables were established using a solar energy system. In the IMTA–HS system the cultured tilapia and catfish were fed only with a suitable commercial diet. All dissolved and particulate excreted by fish were carried out from fish ponds by the effluent water and drained into other hydroponic systems in which further fish were cultured to control a nutrient flow and uptake. The results showed that Nile tilapia and catfish consumed a total of 408.9 kg of feed, containing 125.6 and 5.7 nitrogen (N) and phosphorous (P) per kg, respectively. Nile tilapia and catfish grew by 199.2 kg of 26.1 and 3.8 kg N and P, representing 48.7, 26.1 and 66.0 % of feed utilisation and dietary N and P retention, respectively. The combination of Nile tilapia and catfish with thin lipped grey mullet and prawn as detrivores increased N and P utilisation efficiency to 30.1 and 84.8 %, respectively, and with addition of clams to the system, N and P efficiency increased to 32.6 and 97.3 %, respectively. Finally, dietary N and P efficiency increased by addition of the hydroponic system to 71.5 and 97.6 %, respectively. These results indicate that IMTA–HS as a bio-integrated food production system which converts maximum percentage of the fish feed into valuable products is applicable to desert, rural and urban areas in developing countries.

Keywords: Fish culture, hydroponics system, nitrogen, nutrient flow, phosphorous, renewable energy

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Integrated Aquaculture and Hydroponics System using Renewable Energy: II. Water Quality and Economic Analysis

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Development of aquaculture is limited by resources, such as water and land. An integrated multi-trophic aquaculture (IMTA) and hydroponic system (SH) for the land-based culture of Nile tilapia, African catfish, thin lipped grey mullet, freshwater prawn, freshwater clams and vegetables using solar energy was developed in Egypt to maintain water quality, and reduce the nutrient load in freshwater effluents. In this system, fish was cultured separately in an aquatic modular system, which allows the conversion of discharged nutrients into valuable products. The dissolved oxygen levels in different units of the system ranged between 95 to 100 % saturation. pH levels ranged between 8.09 – 8.47 during the experimental rearing period. Data obtained on nitrate-N, nitrite-N and ammonia-N in different experimental test units of IMTA-HS indicated that nitrate-N level was 26.7 $\mu g\,l^{-1}$ at freshwater source input, increased to 177.4 and 489.9 $\mu g\,l^{-1}$ in tilapia and catfish ponds output, respectively, as a result of the nitrogen-rich fish feed, and decreased to 425.9 and 440.5 $\mu g\,l^{-1}$ at the mullet, prawn and clams pond output. The values then increased again to 571.7 $\mu g\,l^{-1}$ at the outlet of the biological filter as a result of nitrification processes, and finally increased to 581.3 $\mu g\,l^{-1}$ at the hydroponic system output. The same pattern showed the nitrite-N (NO_2) level except for lower concentrations at the hydroponic system output. Ammonia-N was relatively high at freshwater source input (545.2 $\mu g\,l^{-1}$), then increased to 1160.7 and 961.8 $\mu g\,l^{-1}$, respectively in Nile tilapia and catfish ponds output and maintained a high level at the mullet and prawn pond (2122.5 $\mu g\,l^{-1}$), then decreased at clams pond output (771.6 $\mu g\,l^{-1}$). Ammonia-N decreased again to 458.6 $\mu g\,l^{-1}$ at the biological filter outlet and finally decreased at the hydroponic system output to 304.2 $\mu g\,l^{-1}$. These results indicate that the integrated aquaculture and hydroponic system has their specific limitations, which are related to nutrients uptake, conversion processes and a biotic factor. An economic analysis including the total operational variable and fixed costs showed that the net return of the IMTA-HS was higher then in a traditional aquaculture system.

Keywords: Economic analysis, hydroponics system, integrated multi-trophic aquaculture, renewable energy, water quality

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Factors Affecting the Participation in Sea Farming Project: An Empirical Finding from Panggang Island, Indonesia

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Aquaculture plays an important role in reducing poverty and ensuring food security, particularly within coastal areas. Kepulauan Seribu is a part of the capital city of Indonesia, Jakarta, but it experiences severe pollution and environmental degradation caused by mining, marine transport, irresponsible and destructive fishing activities in the area. In fact, Kepulauan Seribu not only has the lowest Human Development Index (HDI) but also the highest poverty rate, compared to other areas in Jakarta. In order to improve the local community's welfare while conserving the marine ecosystem, the local government and Center for Coastal and Marine Research Studies (CCMRS) initiated a project called "sea farming" in Panggang Island, Kepulauan Seribu. Sea farming is a mariculture-based project to create sustainable marine resources management.

The study aimed to examine the factors influencing participation in the sea farming project in Panggang Island. The probit regression showed that factors which significantly influence a households' decision in joining the sea farming project were education, occupation, household size, and membership in a non sea farming organisation. The results indicated that the project was more attractive for the less educated, whose primary occupation was not as a fisherman, had less household members, and were less involved in any organisation other than sea farming. This implies that the project managers should communicate the objectives and positive impacts of the project effectively to attract the fishermen as main beneficiaries.

Keywords: Aquaculture, mariculture, Panggang Island, sea farming

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Assessing the Adoption and Impact of Women Integration in Fishing Community Initiatives in South-Western Nigeria

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The Nigerian fishery sub-sector is still at its infant stage where available resources are compared with the level of utilisation, economic benefits of exploiting the resources and the socio-economic status of the operators especially women in the industry. The full participation and empowerment of women in the fisheries sector will gain widespread recognition and support if the profile of the age-long social, cultural and economic barriers hindering women from being active agents and beneficiaries of development are removed.

The gender issues surrounding the roles and participation of women in both capture and culture fisheries are not unique to fisheries alone, hence, a better understanding of the constraints and challenges that women face, and the actual and potential contribution of women in fisheries requires a holistic approach that encompasses the many roles played by women in fisheries in rural and peri-urban societies. Women make highly significant but undervalued contributions to fisheries: agriculture, processing, production and retailing and fisheries sector services. The knowledge of the contributions of women in the fisheries sector is only slowly evolving and still lags behind in the rural sectors and peri-urban societies of southwestern Nigeria.

Results indicated that these roles are usually associated with the central role of women in agriculture and in attempting to secure food for their families. Hence, gender relations should not be seen as competitive but rather as complimentary and mutually reinforcing. Studies showed that rectifying the situations involves the need for family, government and non-governmental organisation (NGO), etc to cover gender questions on fisheries and agriculture in their regular agricultural censuses (awareness). Despite the lack of comprehensive data on the impact of women in fisheries, the government and several stakeholders can help hundreds of thousands of women entrepreneurs and fish producers with technical assistance, loans and credits, and fostering self-help groups.

Hence, adopters of women integration into fisheries were the economically better-off segment of the population with larger land holdings, higher income and literacy, indicating that in addition to complimentary innovations, a gender-sensitive approach is vital if the resource-poor are to benefit from fisheries advancements.

Keywords: Adoption, fisheries, impact, initiatives, women integration

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Aquaculture Development in a Semi-Urban Coastal District of Ghana: The Marine Fishermen to Target

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Marine resources are depleting, making the economic dependence on marine fish for coastal populations no longer the best option. Aquaculture has been suggested as an alternative livelihood. This study assesses the profitability of aquaculture and the willingness of marine artisanal fishermen in the coastal region of Ghana to adopt aquaculture. The Effutu municipality in the central region of Ghana, which is peri-urban to the Greater Accra region that hosts the capital city of Ghana was purposely selected for the study. A multi stage cluster sampling procedure was used to randomly select 150 artisanal fishermen from two communities in the district. Data were collected using semi structured questionnaire. The profitability of pond-type aquaculture enterprise was estimated using budget analysis. The study employed the Binary Logit model to assess the influence of technical, socioeconomic and institutional factors on the decision to integrate the aquaculture enterprise into household enterprises of fishermen. The results of the study showed the aquaculture enterprise was profitable since each Cedi invested returned more than a Cedi to the investor. In the survey, about 62 percent of the marine fishermen were willing to adopt and integrate aquaculture into their enterprise mix. The Logit estimation results revealed that fishermen willing to change and adopt aquaculture are those who lacked savings accounts, had difficulty in accessing credit, did not belong to fishermen's association, and were new in marine fishing. Since there is potential for marine fishers to explore and use aquaculture to enhance their wealth, interested stakeholders should target young and inexperienced marine fishers for training and capacity building.

Keywords: Aquaculture, Binary Logit model, Ghana, marine artisanal fishermen, semi-urban

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Aspiring Forenvironmentally Concious Aquafeed: Comparative Life Cycle Assessment (LCA) of Aquafeed Manufacturing using Different Protein Sources

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Aquaculture is one of the fastest growing animal production activities in the world and it plays a vital role in many countries by providing economic, social and nutritional opportunities. However, the production of several culture species heavily depend on feed produced from resources of wild fisheries, namely fish meal and oil, that aquafeed manufacturing is a major contributor to several of the impact categories. In reality, the increased focus on growing few high value culture species at large quantities will accelerate the demand for fish meal and oil, a concern that is threatening the global capture of fish currently in decline due to overfishing and environmental changes. Therefore, continued growth of aquaculture production dictates that substitutes must be utilised without compromising fish health and product quality. In response, several investigators have successfully observed that partial or complete substitution of fishmeal by alternate protein sources, such as soybean meal and rapeseed meal, is possible.

In this study, a comprehensive environmental evaluation of the impacts of aquafeed is explored in order to provide decision support in policy discussions regarding aquafeed manufacturing. Thus, the impact of the product itself and the entire production system to produce it is investigated. In our study, we used consequential life cycle assessment (LCA) to model the environmental impact of trout feed manufacturing using different scenarios of fishmeal, soybean meal and rapeseed meal based protein sources for aquafeed formulations. In a cradle to factory-gate assessment of fishmeal-based standard trout feed, the impact categories acidification potential, global warming potential, eutrophication potential and land competition were 8.7 kg SO_2 equiv., 1797 kg of CO_2 equiv., 2.0 kg of PO_4 equiv. and 1065 m^2a, per tonne of aquafeed, respectively. Results indicate that fishmeal-based aquafeed has considerably higher impact on the environment as compared to plant protein based aquafeeds across all the impact categories. These impact results were sensitive to changes in different marginal energy uses. Moreover, the selection of attributional and consequential approaches of LCA result in considerably large differences that system expansion using consequential LCA is most appropriate in evaluating the impacts of aquafeed.

Keywords: Aquaculture, aquafeed, attributional LCA, consequential LCA, Life cycle assessment

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Growth Performance of African Mud Catfish, *Clarias gariepinus* (Siluriformes: Clariidae) Fed with Tropical Banana Blossom, *Musa sapietum* (Zingiberales: Musaceae)

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One of the contemporary problems faced in aquaculture is the provision of adequate nutritive and cheap feed to reduce the cost of fish production. In this study, the efficacy of *Musa sapientum* inflorescence (MSI) as an ingredient in the diet of the juveniles of African mud catfish, *Clarias gariepinus* was evaluated over a 90-day growth period. Three experimental diets were formulated at 0 % (control), 10 % and 15 % inclusion levels of MSI. The nutrient composition of MSI, growth performance and survival rate of the juvenile fish, feed intake and water quality parameters were determined using standard procedures. The results showed that MSI had a moisture content of 94.90 %, in the DM fat represented 2.08 % and crude protein 1.85 %. MSI was a good source of potassium (24755 ppm in DM), calcium (9804 ppm in DM), sodium (8824 ppm in DM) and magnesium (3529 ppm in DM) but low in phosphorous (106 ppm in DM). There were no statistical differences ($p > 0.05$) in the specific growth rate, feed conversion and protein efficiency ratio of the juvenile fish fed with the banana blossom in comparison to the control. Similarly, there were no significant differences ($p > 0.05$) in the condition factors of the fish fed with 10 % and 15 % inclusion levels of the flower meal (0.83±0.13 and 0.75±0.04 respectively) compared to the control (0.76±0.03). The 15 % flower meal inclusion resulted in the highest fish survival rate (70 %) compared to 63.3 % (10 % inclusion) and 60 % (control). There were no significant differences ($p > 0.05$) in the feed intake by the fish raised with 10 % and 15 % inclusions of MSI (34 % and 33 % respectively) in comparison to the control that yielded 33 %. The mean water pollution rate by nitrite accumulation (0.000 mg dl^{-1} and 0.275 mg dl^{-1} in 15 % and 10 % inclusions, respectively) was not statistically different from the control (0.042 mg dl^{-1}). Similarly, there were no significant differences in the mean water pollution rates by total dissolved solids (32 %, 35 % and 33 % in 15 %, 10 % and 0 % inclusions, respectively). The results obtained in this study indicated that *M. sapientum* flowers, which are locally available in the rural areas and inexpensive, have the potential to partially replace the expensive animal protein required in feed formulation and thus reduce feed cost in fish farming.

Keywords: Aquaculture, banana blossoms, *Clarias gariepinus*, fish feed, *Musa sapientum*

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Growth, Feed Utilisation and Condition Factor of *Clarias gariepinus* Fingerlings Fed *ad-libitum* in Different Hatcheries

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A farm adaptive research was carried out on the production of African catfish, *Clarias gariepinus* juveniles within three weeks. Fingerlings of average weight 0.84 g ±0.55 were raised under two different hatchery conditions (outdoor and indoor) and fed with three different commercial feeds, namely: Le-Gouessant, Coppens and Multi-Feed. The commercial feeds were fed *ad-libitum* to the fingerlings. The feeds were accepted and utilised for growth. In the outdoor hatchery there were significant differences among the mean values of weight gain while percentage weight gain showed no significant difference (p˃0.05). *C. gariepinus* fed Le-Gouessant diet had the best feed conversion ratio (FCR) compared to those fed with Coppens and Multi-Feed. For the indoor hatchery, there were no significant differences (p˃0.05) among the values of weight, specific growth rate and percentage weight gain of fingerlings. There were no significant differences (p˃0.05) among the mean values of FCR of fish fed with the respective feeds in the indoor hatchery. This study therefore indicated that Le-Gouessant feed would be best converted in outdoor hatcheries, while any of the feeds could be used in indoor hatcheries. The length–weight relationship and condition factor of fish fed in the respective hatcheries were also calculated: $\log W = 0.0125 + 2.8460 \log L$ and $\log W = 0.0708 + 2.6147 \log L$ for Le-Gouessant; $\log W = 0.0536 + 2.6023 \log L$ and $\log W = 0.0533 + 2.7933 \log L$ for Coppens; and $\log W = 0.0744 + 2.510 \log L$ and $\log W = 0.1031 + 2.5230 \log L$ for Multi-Feed. The fish exhibited negative allometric growth patterns when values of b were less than 3.

Keywords: Catfish, *Clarias gariepinus*, condition factor, feed utilisation, growth,

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Effect of Genetic Selection for Increased Body Weight at Harvest on Disease Resistance and Immune Responses of Nile Tilapia *Oreochromis niloticus*

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The potential effect of selection for growth and related traits of Nile tilapia *Oreochromis niloticus* on disease resistance and a variety of specific and nonspecific immune parameters was investigated between two different lines of *O. niloticus* (selected bred line SBL derived from the 8th generation selected for increased body weight at harvest and a random bred line RBL), via an experimental challenge through the intraperitoneal route with *Aeromonas hydrophila*. Prior to challenge, SBL showed observed enhancement of survival rate and significant increases ($p < 0.05$) of growth performance compared to RBL group after a rearing period of 180 days in circular earthen ponds. Mortalities due to challenge were higher in RBL group than those recorded in SBL group. SBL group revealed significant increases in the hematological indices compared to the RBL group, which were consistently higher in females than males before and after the challenge. Plasma total proteins, albumin, α, β and γ globulins were significantly higher in SBL group, which also showed a significant increased level in plasma glucose in comparison to RBL group, in which plasma cortisol recorded significantly higher levels than in SBL group. Results of the immune responses (leukocyte phagocytic activity, respiratory burst activity, lysozyme activity, and plasma immunoglobulins) showed significant increases in SBL group compared to RBL group. The results of the present study revealed a positive effect of selection for growth of *O. niloticus* on disease resistance and immune responses, which indicate the possibility of indirect selection for disease resistance in breeding programmes in which growth and size are the selected traits in *O. niloticus*.

Keywords: Disease resistance, genetic selection, *Oreochromis niloticus*

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Multi-Mycotoxin Contaminations in Fish Feeds from Different Agro-Ecological Zones in Nigeria

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Fishes are known to be very sensitive to mycotoxicoses, a leading cause of low productivity and death in the fish farming industry in Nigeria. Mycotoxicoses caused by moulds and multi-mycotoxin contamination of fish feeds have resulted in losses of income to farmers, processors, traders and short supply of fish, hence aggravating the problem of malnutrition and food insecurity in Nigeria. Random sampling of fish feeds were carried out across different agro-ecological zones (AEZs) of Nigeria. Quantification of the multi-mycotoxin contamination levels in the fish feed samples were assessed using high sensitive liquid chromatographic tandem mass spectrometry method (LC-MS/MS). Eighty-four different mycotoxins were detected from the fish feed samples. Results showed that fumonisin B1 had the highest toxin value of 6097 μg kg^{-1} from Guinea savannah AEZ. Enniatin B, equisetin, beauverucin, emodin, alternaric methylether, methyl sterigmatocystin and averufin toxins were detected in all samples from the AEZs. Data also revealed highest mycotoxin occurrence from fumonisins (FB) ranging between 0.800–6097 μg kg^{-1}. Guinea savannah had the highest contamination level of mycotoxins followed by the derived savannah while the least contaminated AEZ was the humid forest. Derived savannah zone had more mycotoxins but their levels were relatively low as compared to the Guinea savannah AEZ. All samples analysed were contaminated with various mycotoxins which were produced by *Aspergillus*, *Penicillium* and *Fusarium* moulds. They are considered to be the moulds producing mycotoxins of great concern in the food and feed industries. The high levels of mycotoxins call for concern as multi-mycotoxin contaminations are very hazardous to the development of aquaculture in Nigeria. Considering the lack of information on fish feeds multi-mycotoxin contamination from African countries, this work contributes to the global data on multi-mycotoxin contamination of fish feeds in various agro-ecological zones of Nigeria.

Keywords: Agro-ecological zones, contaminations, fish feeds, multi-mycotoxins

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