

Theme 4

**Innovation approaches
and their scaling up/out in
Africa**

Upscaling Best-Bet Technologies in Arid and Semi-Arid Lands in Kenya

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Abstract

Kenya's land surface is primarily arid and semi-arid lands which account for 84 % of the total land area which is severely affected by land degradation. The Desert Margins Programme (DMP) in Kenya has made some contribution in reducing land degradation in marginal areas and conserving biodiversity through demonstrations, testing of the most promising natural resource management (NRM) options, developing sustainable alternative livelihoods and policy guidelines, and replicating successful models. In extension of sustainable natural resource management, two types of scaling-up strategies were used: (i) strategies for the promotion of readily available technologies and (ii) approaches for participatory learning and innovation on knowledge-based issues including NRM. Thus DMP has initiated up scaling of four 'best-bet' technologies. Under the rangeland /livestock management options, scaling up activities include improvement of rangeland productivity, rangeland resources management through community based range resources monitoring/assessment and fodder conservation for home based herds. Restoration of degraded lands includes rehabilitation of degraded rangelands using the red paint approach in conservation of *Acacia tortilis*, control of *Prosopis*, planting of *Acacia senegal* trees in micro-catchments and rehabilitation of degraded areas through community enclosures. Improved land, nutrient and water management involves upscaling water harvesting and integrated nutrient management (INM) technologies. Activities under tree-crop/livestock interactions include upscaling of *Melia volkensii*, fruit trees (mangoes) and enhancing biodiversity conservation through support of beekeeping as a viable alternative livelihood. Participatory Learning and Action Research (PLAR) was used for technology development and dissemination and capacity building and training is a major component of upscaling of these best-bet technologies.

Keywords: *Arid and semi-arid lands, biodiversity, Kenya, land degradation, upscaling technologies*

Some facts about fertilizer use in Africa: the Kenyan case

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Abstract

It is argued that for a green revolution to take place in Africa, fertilizer use must be increased from the current average of 8 kg ha⁻¹ to around 50 kg ha⁻¹ by 2015. This was a major issue tackled by the African Heads of States summit in Abuja Nigeria in June 2006. This paper assesses the fertilizer situation in Kenya versus the agreed milestones. Some of the agreed milestones were that (i) the African governments take appropriate measures to reduce costs of fertilizers by mid 2007 through policy; (ii) that African Union Member states take concrete measures to increase access to fertilizers by scaling up input dealers and community networks by mid 2007; (iii) that African Union Member States specially address the needs of the farmers and (iv) that African Union Member States work with development partners to tackle issues relating to subsidies that favour the fertilizer sector including infrastructure and other issues. In order to provide insight into some of these, we conducted a survey in Kiambu, Thika and Nairobi districts to establish the extent of fertilizer use in the area with a view to determining if the African Dream of the '*green revolution*' is realizable as planned. The study area was selected due to its strategic contribution to the agricultural economy of Kenya through coffee and tea. The results indicate that adequate fertilizer use is mainly practiced by large scale coffee and tea farmers. Cost of fertilizers and access still remain as issues to address for the small scale farmers.

Keywords: *Africa, fertilizer use, Kenya, policy*

Community Soil Fertility Management in the Region of Gourma Burkina Faso -West Africa

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Abstract

Meeting the millennium development goals in Africa, can only be achieved by intensification and increasing crop yield per unit area. Despite the research efforts made in the field of soil fertility management and the proposition of technology packages, crop yields are still under population needs in Africa. How African soil can nourish conveniently its population? To answers this question, field investigations using rapid and participatory method of research was carried out in 15 villages of the region of Gourma. These investigations were aimed to determined farmers knowledge on soil resources: soil classification, and soil degradation using local indicators, local soil fertility management, and smallholder farmers' capacity to adopt new technologies in soil fertility management. The results of the investigations show that the main parameter for soil classification was texture. Fellow, organic manure and crop rotation were the main soil fertility management; soil degradation was judged according to the agricultural output, and the apparition of certain species of weeds. Concerning the villages where modern technologies of soil fertility management were introduced, the lack of tolls and information were mainly the limitation factors of the adoption of these technologies at smallholder farmers' level. Our investigation have shown that stone belt construction in the field was essential for the limitation of soil erosion process and behind that advantage, it was the starting point of what farmers consider as investigation which can keep them from the practice of shifting agriculture.

Key words: *Local soil classification, region of Gourma, small holders' farmers, soil fertility management, stone belt.*

Effect of Zai soil and water conservation technique on water balance and the fate of nitrate from organic amendments applied; a case of degraded crusted soils in Niger.

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Abstract:

The Zai is a technology that creates conditions for runoff water harvesting in small pits. This water accumulates in the soil and constitutes a reservoir for plants. The organic amendment applied in the Zai pits releases nutrients for these plants. During the dry season of 1999 at ICRISAT research station and the rainy seasons of 1999 and 2000 on-farm in Niger, experiments were conducted on degraded crusted soils to study the water status and nitrogen release in the soil throughout the season. In these experiments, the effect of application rates and organic amendment sources on millet biomass production in Zai systems were tested on-station. While the effect of planting technique (Zai versus flat) millet grain yield and biomass production was tested on on-farm. A rapid progress of the wetting front during the cropping period could be observed. It was below 125 cm in the Zai treated plots 26 days after the rain started vs 60 cm for the non-treated plots. Applying cattle manure lead to shallower water profile due to increased water consumption. Plant available water was often exhausted in non-Zai treated plots presuming shortage of water. Total nitrate content increased throughout the profile compared to the initial status, suggesting potential loss to the soil-plant system with drainage, which was less pronounced when cattle manure was applied. This study shows that the system improves soil water status allowing plants to escape from dry spells, however at the same time it can lead to loss of nutrients, particularly nitrogen.

Keywords: *Drainage, Dry spells, Organic amendment, Water harvesting, Wetting front, Zai.*

Success Stories: A Case of Adoption of Improved Varieties of Maize and Cassava in Kilosa and Muheza Districts, Eastern Tanzania

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Abstract

The project of Eastern Zone Client Oriented Research and Extension was designed to improve the capability of researchers to better respond to the needs of the farmers and empower the Districts to obtain and implement relevant research results for the benefit of the rural populations. In the process, farmers in Mkobwe village of Kilosa District reported that they were getting very low maize yields due to problem which was later identified as Maize Gray Leaf Spot. Similarly, farmers of Tongwe Village in Muheza District had a disease problem on cassava which was later identified as Cassava Brown Streak Disease. Researchers were commissioned to solve these two problems which were severely limiting crop yields. At Mkobwe village a maize variety called TMV-2 was tested and found suitable, while for Togwe village, a cassava variety *Kiroba* was the best. The maize Var. TMV-2 and cassava Var. *Kiroba* were then provided to the Villagers of Mkobwe and Tongwe, respectively. The monitoring and Evaluation of Project activities for the last three years indicated that all the farmers in Mkobwe Village and more than 50% of the farmers in the nearby villages are growing TMV-2. As regards to *Kiroba* variety, the variety is planted by all the farmers in Tongwe village, and now the variety has spread to over 30 Villages in Muheza District. Apart from Muheza district, it is also planted in many villages in the nearby Districts. The source of cassava cuttings in all the villages planted with variety *Kiroba* is Togwe village.

Keywords: *Kilosa, Kiroba, Muheza, TMV-2*

Dissemination of Integrated Soil Fertility Replenishment Technologies Using Participatory Approaches in the Central Highlands of Kenya

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Abstract

In the central Kenya, declining crop yields has been a major problem experienced by the smallholder farmers due to soil impoverishment caused by continuous cropping without addition of adequate soil nutrients replenishment. The successful dissemination and adoption of new knowledge-intensive practices such as integrated soil fertility management (ISFM) technologies requires much more than the transfer of knowledge and germplasm provision; it involves building partnerships with farmers, ensuring appropriateness of the practice, assisting local communities to mobilize resources, and ensuring participation of farmers' groups and encouraging adoption. This study was carried out in Meru south district of central Kenya, with an aim to disseminate ISFM technologies using participatory approaches, as well as encourage their adoption by farmers. The participatory approaches used included mother - baby, field days at demonstration sites, village training workshops, farmer groups etc. Forty farmer groups formed were involved in several activities and acted as an entry point for dissemination activities. The groups bulked grain legumes, started income generating activities and propagated close to 200,000 seedlings of leguminous shrubs in their own tree nurseries. Farmers tested a wide range of newly introduced ISFM technologies on their farms and evaluated their performance. Technologies involving manure and inorganic fertilizer were mostly tested and farmers recorded higher yields from these technologies than from their conventional practices. Farmer participation enhanced efficiency and effectiveness in the transfer of technologies as it enabled the use of local knowledge. Participatory monitoring and evaluation was an eye opener for all stakeholders on how farmers would like to direct their activities.

Keywords: *Dissemination, farmer groups, integrated soil fertility management participatory approaches*

Exploiting soil fertility and socio-economic heterogeneity to enhance fertilizer use efficiencies in smallholder farming systems: a case of Murewa District, Zimbabwe

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Abstract

Smallholder farms in Africa consist of multiple fields that are managed differently, which leads to steep gradients of soil fertility within farms. Current blanket fertilizer recommendations are mainly based on potential yields as determined by rainfall, which often results in low fertilizer use efficiencies. FARMSIM (Farm-scale Resource Management SIMulator), a simple farm-scale model was applied in this paper to explore strategies for increasing nutrient use efficiencies under variable soil fertility conditions in Murewa District, Zimbabwe. Model output showed that attainable yields and agronomic N use efficiencies decreased sharply with decreasing soil fertility as follows: 5.6 t ha⁻¹ (46 kg grain kg⁻¹ N), 3.3 t ha⁻¹ to (27 kg grain kg⁻¹ N) and 2.4 t ha⁻¹ (20 kg grain kg⁻¹ N) on high, medium and low fertility zones respectively on the clay soil, and 4.1 t ha⁻¹ (46 kg grain kg⁻¹ N), 3.0 t ha⁻¹ to (27 kg grain kg⁻¹ N) and 0.9 t ha⁻¹ (20 kg grain kg⁻¹ N) on the sandy soil. Nutrient resources were used most efficiently when manure was applied to the medium fertility zone and mineral fertilizers high fertility zone. At least 5 t manure ha⁻¹ yr⁻¹ was required over multiple seasons to restore productivity on the low fertility zone on the sandy soil, which covers more than 50% of the study village. The analysis carried out in this study showed that variability in soil fertility strongly affects resource use efficiencies and there is need fine-tune fertilizer recommendation to specific soil fertility domains.

Keywords: *Farmer wealth status; fertilizer use efficiency; soil fertility gradients*

Adoption Potential of Legumes, Cattle manure, Tithonia and Inorganic fertilizer in the Central Highlands of Kenya

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Abstract

Soil nutrient depletion is a common feature of food-crops oriented small scale farms of central Kenya. A study to assess adoption potential of two leguminous trees, herbaceous legumes, cattle manure, *Tithonia diversifolia* applied solely or combined with inorganic fertilizer for replenishing soil fertility in Meru South district, Kenya, was carried between 2002 and 2004. Maize yields from researcher designed, farmer managed on farm trials were higher and less variable among the farms than the farmer designed and managed on farm trials. Use of cattle manure and tithonia were the most profitable among the inputs tested. The most commonly preferred technologies were those combining organic and inorganic resources especially manure + fertilizer and tithonia + fertilizer. Lack of adequate biomass for applying into the soil was one of the major problems farmers faced during the early stages of testing the technologies and tried to address it by planting trees on their farms, which they could later harvest the prunings from. Farmers mainly benefited from increased crop yields and fodder from the leguminous trees. In conclusion, cattle manure and tithonia were found to be the organic materials with the highest adoption potential for soil fertility improvement in this area. Calliandra and leucaena have potential for use as fodder. The herbaceous legumes seem to have the least adoption potential due to poor performance on the farms that caused low preference by the farmers. There is need to carry out more studies to validate the farmers innovations and to explore further the long-term sustainability of using tithonia.

Keywords: *Adoption potential, farmers' preference, maize yields, profitability*

Empowering Farmers in Monitoring and Evaluation for Improved Livelihood: Case Study of Soil and Water Management in Central Kenya

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Abstract

There has been a paradigm shift in terms of research planning, implementation, monitoring and evaluation, and upscaling. The previous procedure of little involvement of wider key stakeholders participation in this process ended up entrenching inherent biases that led to also entrenching rural poverty. Therefore, there has been a need to invert the paradigm from top-down to bottom up approaches to enhance stakeholder participation particularly farmers so that they become more proactive in the research and development process. Previous monitoring and evaluation rarely involved farmers. Also, the indicators that are used at the grassroots rarely incorporate communities' interests and/or knowledge. Therefore this study was designed to understand the farmers' perception of monitoring and evaluation, and build their capacities in development of monitoring and evaluation indicators that would empower them to assess success or failure of projects that they jointly implement with other stakeholders. This process was subsequently meant to influence research through feedback mechanisms, increase adoption and development of appropriate technologies that would create impact at the grassroots level for improved livelihood and poverty reduction. A farmers' group involved in soil and water management was selected as a case study. The results indicate that wider stakeholders' participation empowers them to create relevant feedbacks that inform research to develop appropriate technologies and accelerate impacts to improve livelihoods. The results also show that farmers have knowledge and capacity to develop framework for monitoring and evaluating projects making them more relevant to the communities' reality.

Keywords: *Monitoring, evaluation, empowerment, participation, livelihoods, and poverty*

Enhancement of Agricultural Production through Nutrition and Health Intervention Demonstrations: Case Study of Suba

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Abstract

Agricultural productivity is widely recognized as a critical determinant to both human well being and economic growth in Sub Saharan Africa (SSA), also accounting for over 70% of HIV cases globally. Several studies have shown that HIVS and nutrition operate in tandem. Moreover, it has been shown that the two greatly affect agricultural production due to reduced energy to work, inability to purchase agricultural inputs, low workforce and eventual death of the infected person especially the head of household among others. The link between agricultural productivity, malnutrition and HIV therefore cannot be overlooked. People who are inadequately nourished are more susceptible to diseases and poor health in general. In an attempt to achieve optimal nutrition and health status especially among vulnerable groups, various intervention programmes have used food supplementation using mainly plant based food products such as corn blend. These programmes have proved to be effective in restoring the nutrition and health status of the people concerned. However, much more value would be achieved if such programmes are complemented with basic health services such as deworming, micronutrient supplementation/fertilization, nutrition education as well as water, sanitation and hygiene as an additional component. This paper will explore the usefulness of adding value to agricultural production as an incentive for farmers to grow quality crops which could be used to address HIV/ AIDS, hunger and malnutrition with major focus on preservation, processing, nutrition intervention and research. The benefits of research and nutrition education in order to improve nutria-health and economic well being are highlighted.

Keywords: *Corn-soy blend, HIV, nutria-health, processing soybeans*

Stimulating Sustainable Innovation Processes: Role of Actor linkages and Learning

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Abstract

IPMS (of Ethiopian farmers) is a Research for Development project designed to make accessible knowledge available with various scientific and development outfits and enable them being applied to result in positive social and economic change, essentially stimulating innovation processes. The project aims to enhance the market orientation of smallholder farming, in support of the government strategy. Through its pilots in various geographical areas and centred around various crop and livestock commodities, the project is testing various approaches that can stimulate commercialisation and develop responsive service delivery systems through focused capacity building activities and addressing various institutional, financial, market and information related constraints in a complex innovation systems framework. IPMS has been learning much about optimal strategies, in terms of application of relevant knowledge and approaches. However, a major challenge lies in ensuring that service delivery agencies (including research and extension) learn from these experiences and adopt responsive ways of working by engaging in dialogues with users to shape their agendas and ensure a continuous flow of knowledge generated for application to solve priority problems. To ensure continuity and sustainability of the new institutional arrangements and ensuring a continuous dialogue, the boundary spanning function needs to be institutionalized. The natural choice for housing this function, in the Ethiopian context, seems like the Extension service, but there no adequate skills or experience in the system. This paper while analyzing the project experiences also tries to highlight some important lessons for stimulating sustainable innovation processes and developing strategies to scale them out.

Keywords: *Boundary spanning, innovation processes, service delivery, knowledge, scaling out*

Reducing the Risk of Crop Failure for Smallholder Farmers in Africa through the Adoption of Conservation Agriculture

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Abstract

Current degradation of the natural resource base calls for an innovative approach to sustainable agriculture in Africa. Conservation agriculture (CA) is a sustainable cropping system based on minimal soil disturbance, soil cover with crop residues and crop rotations. CA leads to soil organic matter accumulation and improved water harvesting, and therefore more stable yields and a reduction of the risk of crop failure. After several years, soil quality improvement results in greater crop productivity. However, small-holder, resource-poor farmers in Africa generally manage mixed crop/livestock systems, and depend on crop residues for animal feed in the dry winter. Therefore strategies need to be developed to convert the farm from conventional to conservation agriculture. Step-wise incorporation of CA into the farming system and concentration of plant nutrient resources will allow increased productivity of both food and the crop residues. Once productivity is increased part of the crop residues can be used as animal feed while still leaving sufficient residues for soil cover and soil quality regeneration. Greater production stability and reduced labour requirements of CA will allow farmers to use part of the farm for higher value crops, thus generating additional income. Reduced labour requirements of CA will allow farmers alternative activities, including possibly value addition to their products. However, CA systems are knowledge-intensive and, although the principles have very wide application, the actual techniques and technologies to apply these principles are site and farmer-circumstance specific, necessitating the development of multi-stakeholder “innovation networks” focussed on adapting CA systems to local conditions.

Keywords: *Conservation agriculture; crop residues; diversification; risk; soil quality.*

Farming innovation for food security among the HIV/AIDS affected rural households in Western Kenya.

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Abstract

Teso District in western Kenya is the home of close to 100,000 people and currently one of the most densely populated regions. Population densities range from 500 to 1200 people per km² and the population growth rate is over 3.4% per annum. It is also characterized by low crop productivity, shortened or non-existent fallow period, low fertilizer inputs, lack of use of pesticide and improved seeds. The high population pressure coupled with mono-cropping of maize (staple food crop) has caused a steady decline in soil fertility and soil organic matter content, which together have favored build up of *Striga* weed. Crop diversification is an instrument for successful agricultural innovation towards achieving high agricultural yields. Declining soil fertility and increasing food insecurity has necessitated evaluations of higher yielding methods of crop production as plausible alternatives to the traditional cropping systems. The performance of soybean when intercropped with grain amaranth was investigated on-farm in two sites in Teso district. The experiment was laid out in a randomized complete block design with two treatments replicated three times. Pure stands of each crop were used as controls. Grain yield of soybean and amaranth crops were significantly higher in the intercrops than in pure stands ($P < 0.05$). Similarly, there was a significant difference between yields from sites one and two. The Land Equivalent Ratio (LER) of the intercrops was greater than one (1.6) thus intercropping was preferred over the conventional mono-cropping system. Therefore, intercropping is one of the many technologies /innovations that can easily be adopted towards achieving the objectives of African Green Revolution.

Keywords: *Crop diversification, grain amaranth, intercropping, land equivalent ratio, monocropping, soil fertility, soybean*

Adoption and up scaling of water harvesting technologies among small scale farmers in Northern Kenya

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Abstract

In Sub Saharan Africa, especially in low potential areas agricultural production among small-scale farmers is constrained by declining soil fertility and unreliable rainfall. The “transfer-of-technology” model dominates most research and development approaches and it is important to understand drivers of technology innovation among small-scale farmers to guide future development of models that are effective in ensuring that farmers benefit more from research. This study was initiated in phases aimed to identify, test and develop appropriate water saving technologies using Participatory Learning and Action Research (PLAR) approach. Combinations of four water saving technologies were selected and tested with vegetable farmers, technologies included drip kit, compost basket, mobile sack and improved sunken bed. The improved sunken bed was more adopted compared to other options. In the first crop-growing season, 100 farmers adopted technology from 9 trial farmers. The farmers adopted the technology due to modification to ensure technology meets diverse socio-economic backgrounds of various households. Through adoption of improved sunken bed farmers increased income and nutritional status at the household level with total net benefits of USD 1500 per year for 10m² land area. Among other factors promotion of farmer innovation, partnership between researchers and extension agencies improved technology adoption pathway. To meet food deficits due to increased population in marginal areas, it is important to consider farmer innovations as part of technology development.

Key words: *Dry land farming, farmer innovation, vegetable*

Millennium Villages in Malawi: an Integrated Approach to Achieving a 'Green Revolution'

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Abstract

The Millennium Villages Project (MVP) started implementing its activities in Malawi in 2005 as a response to the country's chronic food insecurity. The overall objective of the project is to implement the Millennium Development Goals in rural communities, one of which is to eliminate hunger and malnutrition by increasing production, access and utilization of nutritious foods. In order to address this goal, the project provided an agricultural input package containing 100 kg of chemical fertilizer and 10 kg of hybrid maize seed enough to cover 0.45 hectare of land to 11,000 households in 2005/06 and 2006/07 cropping seasons. In these seasons, the households obtained maize yields three to five times those under traditional practices. The majority of the households reported maize surpluses and they contributed about 700 MT of maize towards a school feeding program that is supporting four schools in the community. Another 333 MT of maize was sold to ADMARC, a government grain marketing board at a good price that economically benefited the farmers. The impressive productivity improvements in maize have literally opened up space for alternative crops such as legumes that are more profitable, more nutritious and better for the soil. The MVP experience sets as an example of a 'green revolution' achieved within two years and efforts are now being made on the scalability of the approach to the rest of the country.

Keywords: *Cropping season; food security; household; marketing*

Micronutrient fertilizers for the Ethiopian soils in the new Ethiopian Millennium for fighting household food insecurity and malnutrition: a case from semi arid Tigray Plateau

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Abstract

Despite the fact that Ethiopia will ring in the year 2000, new Ethiopian millennium, in September 2007, fertilizer was first introduced to Ethiopia in 1967 following four years of trial carried out by the government with the assistance from FAO's Freedom from Hunger Campaign. Ethiopia totally depends on imports to meet its annual fertilizer requirement, though fertilizer consumption by the peasant sector rose from 14,000 MT in 1974/75 to 521,000 MT in 2005/06. DAP and Urea are the only fertilizers that have been imported and applied across the country since the beginning regardless the nature and properties of soils. Ethiopia has wide variations in climate, soil types and fertility; recommendations regarding the use of particular nutrients must be site-specific. Cognisant, a survey was made to assess the micronutrient distribution in the semi arid soils of Tigray Plateau. Thirty six soil samples were collected from five agriculturally important areas and DTPA extractable Fe, Mn, Zn and Cu were analysed in the National Soil Research Laboratory, Addis Ababa, Ethiopia. Plant available Zn makes up 0.10-1.04 ppm, available Cu ranges 0.06 to 0.96 ppm; available Mn accounts for 1.7 to 9.98 ppm and available Fe was found to range from 3.04 to 14.3 ppm. This study has revealed that soils of the Tigray Plateau are notoriously deficient in available plant micronutrients. When micronutrients become a limiting factor the currently applied urea and DAP may be wasted. Thus, this paper calls for prompt action for the correcting micronutrient deficiencies.

Keywords: *Ethiopia, fertilizer, micronutrients, new-millennium*

Micro-nutrients: another aspect to include in an African green revolution? Their role in quality and quantity of Sorghum production in Burkina and Benin

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Abstract

Next to generating more food Africa is challenged to improve the mineral nutrition of its population. The lack of minerals and vitamins delivered by staple based diets, may well be enlarged if technologies to improve productivity are not screened for their effect on micronutrient density and bio-availability. We report on an effort to design improvements in micronutrient delivery by a food chain with the use of a framework to direct research on improvements to Zn delivery by the sorghum food chain in Benin and Burkina Faso and to integrate findings. Inclusion of Zn fertilizers in improved soil and water management methods was shown to increase productivity and Zn density of sorghum. In fact without application of Zn current trends in P fertiliser use would lead to decreased delivery of Zn to the human body due to the enhanced phytate/Zn molar ratio. The negative effects of the phytate in sorghum seeds can be alleviated by through prolonged germination and fermentation during flour production. It is not yet possible, though, to alleviate the effects of polyphenolics through re-complexation with minerals during the cooking process. Given the observed effects in sorghum and the role of other staple foods next to sorghum in sorghum based diets there seems a good reason to combine fertilisation, breeding and food processing as tools to improve mineral delivery to the human body. The proposed framework was effective in the analyses of food chain improvements and will need further elaboration to generate implementation of these changes in actual chains.

Keywords: *Micronutrients, Nutrition Zinc*

Soil conservation in Nigeria: Assessment of past and present initiatives

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Abstract

Soil degradation is one of the most critical environmental problems in sub-Saharan Africa. There is an urgent need to develop effective soil resource management that reverses the degradation trend in order to sustain soil productivity and enhance food security. Earlier initiatives on soil conservation have resulted in a range of on-farm and off-farm technologies. But an evaluation of existing conservation strategies is still required for coming up with comprehensive practices for the West African savanna. In 2006, a soil scientist and a rural sociologist started an assessment study to identify past and present soil conservation initiatives and their effectiveness including sociological, technological, and economical aspects. An extensive literature review was conducted including scientific and digital resources to get information about past and present research and performance of soil conservation in different agro-ecological zones of Nigeria. In 2007, villages with different types of conservation technologies were visited and interviews with farmers were made in order to study the adoption of these technologies. The study provides information on the awareness of farmers of soil degradation, driving factors influencing the adoption of technologies, attitude and willingness of farmers towards erosion control, adoption barriers, adaptation to the initiatives, and perceptions of impact. Based on the results, the most promising soil conservation technologies for the savanna include agronomic measures like mulching and cover cropping as well as conservation tillage which contributes to an enhanced soil resources management in Nigeria.

Keywords: *Adoption, farmer evaluation, Nigeria, soil conservation technology*

Soil Organic Inputs and Water Conservation Practices are the Keys of the Sustainable Farming Systems in the Sub-Saharan Zone of Burkina Faso

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Abstract

The sub-Saharan region of West Africa has in the recent past experienced increased demographic growth and climatic changes that impede the sustainability of environmental resources. Harmful changes in the environment could be compensated by the adaptation of resilient farming practices. In Ziga located in Yatenga region, a research program was carried out between 1980 and 1987. In 2005, another survey was conducted in the same village to assess the evolution of farming practices. According to the study, two practices, the “zai” and “djengo”, were largely used in the cultivation of cereals crops. The characteristics of “zai” and “djengo” practices were assessed and their effects on grain crop yields measured. The “Zai” characteristics depend on the availability of manure. In addition, another practice has been noticed in Ziga that was not described in previous works. The “zai”, and “djengo” practices are associated with other soil and water conservation techniques and localized organic matter supply. In the case of “djengo”, the micro-basin is dug after the first rain. The “djengo” was less expensive in time. These two practices revealed a strategy of farming systems intensification by localization of organic and mineral fertilization, as well as better management of rain water. Thus, these practices increased significantly grain crop production. The results also showed that a large tree regeneration occurred in Ziga where “zai” or “djengo” practices were used. This study highlights that it is necessary to control soil, water and manage organic matter resources in farming systems to ensure agrosystem viability as a key to green revolution in the sub-Saharan region.

Keywords: *Djengo, farming practices, soil, sustainability, Yatenga, zai*

Effect of farmer management strategies on spatial variability of soil fertility and crop nutrient uptake in contrasting agro-ecological zones in Zimbabwe

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Abstract

Soil fertility variability within and across farms poses a major challenge for increasing crop productivity in smallholder areas of sub Saharan Africa. This study assessed the effect of farmers' resource endowment and nutrient management strategies on soil fertility variability and plant nutrient uptake in Gokwe South (~650 mm yr⁻¹) and Murewa (~850 mm yr⁻¹) Districts, Zimbabwe. In Murewa, wealthy farmers applied large amounts of manure (>10 t ha⁻¹ yr⁻¹) on fields closest to homesteads (homefields) and none to fields further away (outfields), and in Gokwe the manure was not targeted to particular fields. In both districts, maize grain yields were highest in homefields of wealthy farmers (2.7–5.0 t ha⁻¹), and lowest in fields of poor farmers (0.3–1.9 t ha⁻¹). Maize responded ($p < 0.05$) to N and P addition in homefields in Murewa and in all fields in Gokwe, but responded poorly in outfields in Murewa due to Ca and Zn deficiency. In developing fertiliser recommendations, farmer resource endowment and nutrient management strategies are key factors.

Keywords: *Maize grain yield, plant nutrient uptake, resource-endowment, resource management strategies, soil fertility variability*

Managing Soil and Water through Community Tree Establishment and Management: A Case of Agabu and Kandota Villages in Ntcheu District, Malawi

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Abstract

Agriculture is the backbone of Malawi's economy with over 90% of the country's population living in rural areas depending on agriculture for their livelihood. Consequently, deforestation is very pronounced because of the active agricultural industry which necessitates extensive clearing of woodlands. Trees are required in agriculture for both wood and non wood products, protection of water catchments, and preventing soil erosion thereby increasing agricultural productivity. In order to find out the technical and organizational aspects in community tree establishment and management, a research study was carried out in Agabu and Kandota villages in Ntcheu District. The study revealed that more than 55% of the people in both villages are involved in community forestry activities which includes seed collection, seed processing, seed storage, nursery establishment, nursery management and out planting of trees in communal village forest areas, gardens, and around homes. More than 70% of the community members value indigenous trees over the exotics because of their multipurpose functions as a source of fuel, timber and poles, edible fruits and leaves, animal feed, medicine, and as a source of manure which improves soil fertility and retains soil moisture. The study also identified that in both villages there are community forest clubs which are responsible in ensuring that members of the communities participate actively in the communal forest activities. The study recommends that government agencies, communities and other stakeholder must be involved in planning, implementation, monitoring and evaluation, of projects and programmes to ensure sustainability in the management of natural resources.

Keywords: *Agriculture, community, trees, soil, water*

Investigation on the Germination of *Zanthoxylum Gilletii* (De Wild) Waterm (African Satinwood) Seeds

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Abstract

Zanthoxylum gilletii is an indigenous tropical tree species that is valued for its structural timber, agroforestry and medicinal properties. Seeds of many *Zanthoxylum* species have been reported to have poor germination. The study investigated the germination of fresh *Z. gilletii* seeds harvested at two maturity stages; seeds from green and ripe follicles were harvested from Kakamega and Koiwa during November and December 2006 respectively. Follicles were dried at controlled temperature (20°C) and relative humidity (20%) at the National Gene Bank of Kenya. Germination experiments were laid in completely randomized design. Fresh seeds from green fruits (unwashed) from Kakamega and Koiwa at 12.5% MC sown on sand in the glass house (118/35°C±4 at 12/12 hours light/dark) gave a germination of 3 % and 8%; while washed seeds of the same seed lot germinated up to 10% and 27% respectively by the 12th week. Seeds sown on 1% agar in incubators at constant temperatures (20, 25, 30 and 35°C±1) and alternating temperatures (20/30°C and 15/35°C±1 at 8/16 hours light/darkness) germinated only up to 3%. Poor seed germination was attributed to the presence of inhibitors and other unclear dormancy problems. Washing seeds with 10% sodium hydroxide improved germination indicates that removal of oily film on the testa improves germination. Seeds from green fruits gave higher germination than those from ripe fruits indicating that *Z. gilletii* seeds may exhibit secondary dormancy after dispersal. Seeds from Koiwa are bigger in size and with a higher germination than those from Kakamega and therefore of higher quality.

Keywords: *Germination, inhibitors, maturity stages, Zanthoxylum gilletii seeds.*

Identification of plant genetic resources with high potential contribution to the soil fertility enhancement in the Sahel

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Abstract

The sandy soil in the Sahel is characterized as low inherent fertility, such as nutrient deficiency (total N and available P), low organic matter, and high risk of erosion. Under the concept of Integrated Soil Fertility Management (ISFM), possible contribution of crops and natural inhabitant plants was evaluated to the improvement of soil fertility in the Sahel. Cowpea (*Vigna unguiculata* [L.] Walp.) would have the highest potential to boost the soil fertility due to its biomass production, nitrogen fixation and phosphorus utilization ability. An evaluation on a total of 140 cowpea germplasm from West Africa and identified three promising varieties with high yield both in grains and fodder, so-called dual-purpose cowpeas, what the Sahel farmers prefer to cultivate. Longer-duration fodder-type cowpeas had much lower $\delta^{15}\text{N}$ values in their leaves and grains, showing higher dependency on biological N fixation (BNF). A broad variation in $\delta^{15}\text{N}$ values was observed among the plant species commonly found in cropland and fallow land of the Sahelian zone. Annual leguminous herbs, *Cassia mimosoides* (Caesalpinaceae) and *Alysicarpus ovalifolius* (Papilionaceae), had low $\delta^{15}\text{N}$ values, showing their higher dependency on BNF. They will be efficiently utilized as an extensive mean of the soil fertility management, for example, through more encouraged incorporation into the fallow vegetation. *Ctenium elegans*, *Eragrostis tremula* and *Schizachyrium exile*, greatly dominating annual grass species in the fallow land, though their $\delta^{15}\text{N}$ values were high, would contribute to the soil fertility by supplying a significant amount of organic matter.

Keywords: *Biological nitrogen fixation, cowpea, fallow vegetation, ISFM, soil organic matter*

Developing Standard Protocols for Soil Quality Monitoring and Assessment

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Abstract

We have been developing a set of inexpensive, agronomically meaningful, low-infrastructure-requiring indicators of Soil Health (Soil Quality) that are now available to the public in New York State, United States, similarly to the widely available soil nutrient tests. These indicators are successful at measuring differences between management practices and constraints in agronomically essential soil processes in agricultural soils. They thus help farmers specifically target management to alleviate quantified constraints. During the summer of 2007 we will be testing these indicators, and several others that are relevant to African soils, on an established chronosequence (0-100 yr old farms with several management practices on each), in the Kakamega and Nandi Forest region in Western Kenya, for their ability to function as indicators of soil quality degradation and aggradation in a tropical soil. Such indicators have the potential to be used as standardized soil quality tests by agricultural non-governmental and government organizations to better understand agricultural problems and develop management solutions. Their low cost and infrastructure requirements make them excellent tools for numerous low-budget extension and NGO-based experiments established in collaboration with local farmers, as well as for quantitatively assessing status and trends of soil degradation at regional and national scales.

Keywords: *Soil health, soil quality, soil quality assessment, soil quality indicators, soil quality monitoring*

Risk Preference and Optimal Crop Combinations for Small Holder Farmers in Umbumbulu District, South Africa: An Application of Stochastic Linear Programming

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Abstract

Using data collected from 200 rural farm households in Umbumbulu district of KwaZulu-Natal in South Africa, the stochastic linear programming model is used to model the farm family crop production enterprise incorporating risk with a view of developing the optimal enterprise combination that would enable households maximize their utility. The model incorporates smallholder farmers' risk preferences, revenue fluctuations and resource restrictions. The results show that (1) changes in risk preference do affect optimal crop combinations, and (2) the typical cropping pattern is rational under the present level of farmer's risk preference estimated in the study site. Effective extension programmes that will educate the farmers on efficient allocation of resources are pivots upon which the various smallholders' development programmes initiated by the government and/or other stakeholders should be built.

Keywords: *Optimal, risk, risk preference, smallholder*

Rhizobial inoculation of matures *Acacia senegal* trees increases Arabic gum production and affects the soil microbial functioning

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Abstract

The relations between plants and soil biota involve positive and negative feedbacks between soil organisms, their chemical environment, and plants. Then, the characterization of microbial community functioning is important to understand these linkages. An experiment was conducted in a field system for two years to investigate the impact of rhizobial inoculation at the beginning of the rainy season of 13-years old trees on their arabic gum production. We investigated whether the soil microbial biomass and nitrogen mineralization affect gum production. Soil samples from the 0–25 cm, 25–50 cm and 50–75 cm layers of the rhizosphere of inoculated (IN) and not inoculated (NIN) trees were incubated under laboratory conditions and in situ. Interestingly, results obtained during the two years (2005 and 2006) showed that rhizobial inoculation significantly increased the arabic gum yield. These results could be correlated to other soil properties related to soil fertility, such as carbon and organic nitrogen content, and total microbial biomass. Rhizobial activities were highest at the 0–25 cm soil layers; where roots are present. Hence, rhizobial inoculation significantly increased the microbial biomass. However, any correlation could be found between the inoculation treatment and the N mineralization. Our results confirmed the positive effect of inoculation of mature trees on arabic gum production highlighted in previous data. Regarding the economic role of arabic gum, this study suggest innovative microbial approaches for sustainable arabic gum production and to improve livelihoods of the local populations.

Keywords: *Acacia senegal*, *arabic gum*, *biotechnology*, *microorganism*, *soil fertility*

Translocation of soil bacterial phytotoxin thaxtomin A leads to systemic activation of the plant antimicrobial compound

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Abstract

Plants attract a variety of intruders, from viruses, bacteria and fungi to insects. To protect themselves, plants have an armoury of weapons expressed constitutively or in response to a pathogen's presence, including the release of antimicrobial compounds. The phytoalexins are inducible chemical defences produced de novo by plants in response to diverse forms of stress, including microbial attack and elicitors. We show here a systemic activation of plant antimicrobial compounds by thaxtomin A, a bacterial phytotoxin produced by *Streptomyces scabies* the causal agent of potato common scab. The activation is associated with the transport of the toxin throughout the plant. We also show a modification of the phytotoxin as a resistance mechanism. This is, to our knowledge, the first report showing that a phytotoxin is systemically transported throughout the plant and activates the accumulation of the antimicrobial compound. These findings may have important implications for the understanding of plant-pathogen co-evolution and the development of phytoprotection measures.

Keywords: *Phytoalexin, phytotoxin, potato scab, Streptomyces scabies, thaxtomin A.*

Wastewater Farming; Benefits, Public and Environmental Health Risks: A case of Urban and Peri-urban areas of Nairobi, Kenya

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Abstract

Urbanization has been one of the major factors affecting climate change and environmental sustainability thus threatening human existence. Fifty per cent of world population lives in towns and cities and by 2020 a further 1.5 billion will be living in urban areas and 95% of this projected growth will occur in developing countries. Eight hundred million people are engaged in urban agriculture worldwide. In Sub-Saharan Africa, 35-40 million urban residents will by 2020 depend on urban agriculture to feed themselves. In Nairobi, urban agriculture is practised by 30% of households. Farmers are known to depend on low quality wastewater which may pose public and environmental health burdens. Sewer, river and wastewater used for irrigation, soil and crop samples in wastewater farms were analyzed for Cadmium, Chromium and Lead. Soil and wastewater samples from the same farms were analyzed for Nitrogen, Phosphorus and Potassium. Soils, crops, wastewater and fecal samples from households involved in wastewater farming were analyzed for parasitic human helminthes eggs and fecal coliforms. Lead in wastewater exceeded the recommended 0.005mg/l level by British Columbia guidelines. Nitrates in wastewater varied between 16.45 mg/l and 126.46 mg/l. Wastewater had a mean coliform count of $4.80 \times 10^8 \pm 2.19 \times 10^{11}$ and one sample had larvae of *Balantidium coli*, 12% of vegetables were contaminated with *Shistosoma* eggs and 59% with fecal coliforms. Soil samples contained parasitic larvae at 43 ± 42 larvae/kg and 13 ± 13 kg of non parasitic larvae. There is need for development of strategies for safe use of untreated/treated wastewater for irrigation.

Keywords: *Health risks, heavy metals, wastewater farming*

Utilization of Wastewater for Producing Fuel, Forage and Fodder in Niger: Impact of the Irrigation with Wastewater on Nodulation of African and Exotic Tree Legume Species

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Abstract

In the framework of a European INCO DEV project called “utilization of wastewater for fuel and fodder production and environmental and social benefits in semi-arid, peri-urbans zones of sub-Saharan Africa” the impact of the utilization of wastewater for the irrigation of several species of tree legumes was undertaken. The study was conducted during four months in the seedbed station. The tree legume species tested were: *Acacia mangium*, *Acacia crassicarpa*, *Acacia auriculiformis*, *A. angustissima*, *C. calothyrsus*, *Gliricidia sepium*, *Leucaena leucocephala*, *A. nilotica*, *A. raddiana*, *A. seyal*, a mixture of exotic fast-growing Australian *Acacias*, exotic tree legume species from tropical Latin America and sahelian African *Acacias*. The results showed that when the plants were daily irrigated with wastewater, the tree nodulation was reduced or null, whatever the strain of rhizobium inoculated. By comparison, plants of the same species irrigated with tap water were perfectly nodulated (around 8 roots nodules per plant). It suggests an important correlation between the quality of the irrigated water and the tree nodulation. It also reveals some interesting cases of tree species able to get nodules even when there are irrigated with wastewater (*Leucaena l.*, *A. crassicarpa* et *Gliricidia s.*). A possible explanation could be that the wastewater contains important amounts of organic compounds and nitrogen as well which inhibit the process of nodulation by rhizobial strains.

Keywords: *Acacia*, *wastewater*, *rhizobial*, *nodule*

Quantifying Heavy Metal Contaminants in River and Sewer Water: Mapping Pollutant Sources and their Environmental Impacts along the Nairobi River Basin

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Abstract

Urbanization and population growth particularly in developing countries, places immense pressure on water and land resources and also results into release of untreated wastewater into the environment. Wastewater from unplanned settlements and indiscriminate industrial waste discharges contaminates rivers. In Nairobi, farmers source wastewater for farming through bursting sewer lines. Five points along the river and four sewer man holes sampling points respectively were identified along a transect starting from upstream near the source of the Ngong river and down stream after industrial area. River and sewer water and wastewater used for farming upstream (Kibera) and downstream (Maili Saba) were analyzed for Lead, Cadmium and Chromium and physical-chemical characterization done. Samples were taken during the dry (June-July) and wet (October-November) seasons.) A Water Quality Analysis Simulation (WASP) model was used to assess the effects of both point and non-point source pollution on the Ngong river water quality. Self purification took place as the river passed through sewered residential areas. Lead levels of 0.12mg/l in river water differed significantly ($p < 0.05$) from that of 0.26mg/l in sewer while there was no significant difference in Cd levels. The mean levels of Pb in wastewater at Kibera (0.25 mg/l) and Maili saba (0.09mg/l) differed significantly although there were within the acceptable levels proposed by FAO (1985) but higher than the British Columbia guidelines. Quality of Nairobi river was lowered by effluent from informal settlements, industry and bust sewer lines. These pollutants pose threat to the environment and health regulations need to be observed.

Keywords: *Heavy metals, river water, sewer water*

A survey of the agronomic efficiency of human stool and urine on the production of maize and eggplant in Burkina Faso

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Abstract

The rural poor populations are exposed to sanitary risks coming from improper management of the environment. Indeed the majority of the illnesses coming from water is bound to the management of human's excreta in this zone that sometimes account about 80% of households without latrine. The hypothesis is that, the stool and the human urine collected from the adapted and less expensive latrines are usable in agriculture to increase the productions and to improve the income of the small farmers. This work is made on the peri-urban site in Burkina Faso. Urine and stool, collected separately from the specific latrines, then stocked in the cans (urines) during four weeks and in the closed pit (stools) during six months, have been tested respectively on the eggplant (*Solanum melongena*) and on the maize (*Zea mays*). Three doses determined according to the chemical composition of excreta have been put in comparison with the mineral fertilizer on clay-sandy soil for the eggplant and, on ferric oxisoil for the maize in the farmer field, during two years. The optimal doses for urine and for stool are respectively 1.2 liters by plant for eggplant and 980 kg ha⁻¹ for maize. They increased yields respectively for eggplant and maize of +84% and +90% compared to the control, and also improve the income of farmers. The extension material facilitating the agricultural use of this human manure was elaborated. In conclusion the use of excreta collected would permit to purify the environment while improving agricultural production and income.

Keywords: *Eggplant, income, maize, stools, urines*

Appropriation of decision support systems for better agricultural scenario analysis: Relevance, challenges and opportunities

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Abstract

Research for development organizations and other stake-holders usually perform activities that require the analysis of complex scenarios. Such activities usually require a mixture of models and analytical tools to generate appropriate information for decision making. These models and tools are usually decision support systems (DSS): interactive computer programs that utilize analytic method for developing models to help decision makers formulate alternatives, analyze their impacts, and interpret and select appropriate options for implementation. Decision support systems have been a relevant technology for measuring the impact of agricultural research; but even though researches that develop or use them ask for an increase of awareness of their potential benefits, evidence from the literature suggests that the uptake of decision support systems technology has been limited. Despite considerable empirical research, results on the dimensions and determinants of decision support system use and adoption are often inconsistent. In this paper we explore the culture around two agricultural decision support systems: the Integrated Modelling Platform for Mixed Animal-Crop Systems (IMPACT) and the Decision Support Systems for Agro-Technology Transfer (DSSAT); showing how flexible is the interpretation of them between different relevant social groups. We analyse the problem of poor appropriation of agricultural decision support systems under the framework of Social Construction of Technology to argue that it is because of this interpretative flexibility, that social groups see different capabilities, potential, challenges and problems on them, therefore, their poor appropriation. The paper concludes with directions on how to reach stabilisation and better uptake of agricultural decision support systems.

Keywords: *Agriculture, Appropriation, Decision Support Systems, Social Construction of Technology, Relevant Social Groups*

Social and Economic Factors for the Adoption of Agroforestry Practices in Lake Victoria Catchment, Magu, Tanzania

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Abstract

Environmental degradation is an issue of concern in the Lake Victoria Catchment in Mwanza, Tanzania. Deforestation and improper soil management have led to soil erosion, Lake siltation, accumulation of C in the atmosphere and climate change. Agroforestry practices, soil conservation measures, manure application and retaining low-quality crop residues as soil organic inputs could reduce environmental degradation while increasing farm productivity and income. However, these options are not widely used by smallholder farmers in the Lake Victoria catchment area. Promotion and sustainable uses of these options require understanding of the prevailing socio-economic situation of the target farmers. This research investigated the social and economic factors that influence the adoption of agroforestry practices by smallholder farmers in Magu district, Mwanza region. Focused group discussions, household surveys and transect walks were used to collect data. A total of 120 households were interviewed and several fields visited during the transect walks. Data was analysed using cross-tabulation, cluster analysis and chi-square methods. Results indicate that involvement in off farm activities such as fishing, livestock keeping, mini-business and insecure land tenure negatively influence the adoption of agroforestry practices. Contacts with extension agents, level of training, perception of the problem and farm sizes are positively influencing the adoption. Recommendations to facilitate adoption include: integration of socio-economic factors into agro forestry plans, creation of more awareness among farmers and other stakeholders on environmental degradation problems and strengthening the extension services.

Keywords: *Adoption; Agroforestry; Environmental Degradation; Socio-economic factors*

Have we been here before? Africa's Green Revolutions and the innovation imperative

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Abstract

This paper takes a provocative look at the latest calls for an “African Green Revolution” using social history and ethnographies of agricultural practices in East and West Africa. Africa has in fact already been subjected to many agricultural “revolutions”, benefiting greatly from some, while letting others pass entirely by. Concrete examples show the utility of working more directly with existing knowledge and practices rather than emphasising the need for “innovation”. The paper also shows how biophysical science and interventions can be better applied through better understanding of the socio-political history and context of “target” communities, which can largely explain the “failures” (or at least the long delay in seeing the “successes”) of Africa’s planned agricultural revolutions.

Keywords: *African Green Revolution, context, interventions, target communities*

Exploring diversity and adoption of agroforestry technologies in mixed crop-livestock smallholder farming in Kenya

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Abstract

Smallholder farming in Kenya highlands is characterized by low farm productivity due to several multiple constraints which has led to constrained livelihood of the smallholder farmer. This has challenged researchers to address this problem which has resulted in accumulation of much knowledge (agroforestry included) to improve farm productivity in smallholder farms in sub-Saharan Africa. However this has not led to improved production due to lack of adoption or trial of these technologies by farmers. Of immediate concern technically is lack of farm scale research in the development of these technologies. Previous research activities were focused on plot scale and commodity based yet decisions by farmers are made at farm scale. Given the complexity and heterogeneity of farms in smallholder farming in these regions, plot level results could not be applicable to such situations, hence the need to explore the role of these agroforestry technologies within mixed crop/livestock smallholder farms in Kenya at farm scale to enhance adoption of these technologies. The objective of the research will be to explore the diversity of agroforestry technologies within mixed crop/livestock smallholder farming system in Kenya. The study is being conducted in Kenya in two regions; Western and Central highlands within sites of the AfricaNUANCES project. Currently questionnaires are being administered to get an inventory and quantification of the existing agroforestry practices in relation to farmers' objectives. Other research activities will include resource flows and stocks within case study farms, identification of niches for possible 'best fit' agroforestry practices and exploration of possible agroforestry practices using FARMSIM simulation model.

Keywords: *Agroforestry, Livelihoods, diversity, smallholder, crop, livestock, AfricaNUANCES, FARMSIM*

Farmer managed natural regeneration in Niger: A key to environmental stability, agricultural intensification and diversification

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Abstract

A study to assess the extent of farmer managed natural regeneration (FMNR) and its impacts on agriculture, people well beings as well as to determine what motivated farmers to practice natural regeneration at a larger scale was conducted in the south-Eastern part of Niger (Zinder). The farmers deliberately and actively protect and manage sprouts and germinating plants in their fields in order to recreate tree vegetation. Most of the tree species are of economic value. This practice differs from tree plantation (for village woodlots, windbreaks, etc) or management of natural stands in the forest outside farmer's fields. FMNR in Zinder could reach 1 million ha, with high dominance of Gao (*Faidherbia albida* and Baobab (*Adansonia digitata*). Natural forests have almost disappeared. Interviewed farmers said that ecological crisis which occurred during 1970s and 1980s motivated them to protect and manage systematically and massively, young trees than they do in the past. Other policies aspects went in favour of this farmer's innovation. The high pressure on natural resources has also incited farmers to agricultural intensification. The systematic protection of young *F. albida* has contributed to the creation of agroforestry parklands which help to maintain or improve soil fertility. This helps agricultural intensification and diversification in many villages. Despite this favourable evolution, some villages still have young parklands with little effect on soil fertility. These villages' territories are in intensification transitional phase. The production systems are being complex with a better integration of crop-live stocks and trees.

Keywords: *Adansonia digitata*; *Faidherbia albida*; *Natural regeneration*; *Production systems*; *Niger*

Counting eggs? Smallholder experiments as success indicators

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Abstract

The aim of this paper is to analyse how successful smallholders test-apply new soil fertility concepts, and to understand the diverse adaptive strategies they rely on. Through in-depth interviews and participant observation in western Kenya, we analyse *success* stories in the form of use-as-you-learn applications i.e. 'experiments', following a participatory research initiative. The nature and prevalence of smallholder use-as-you-learn 'experiments' referred to here as *try outs*, is a useful indicator of future application of research concepts and technologies; *whether* they can be gainful and sustainable. Smallholder experimentation can translate into long term application when integrated into research agendas or in the case of researchers who can dedicate themselves to participatory research full-time long enough. This paper concludes that co-research initiatives are crucial for successful soil fertility research, and also shows that the hunt for signs of success of research among smallholders is a crucial beginning point for any scaling out initiative.

Keywords: *Convenience, smallholders, soil fertility management, try-outs*

Micro-dosing as a Pathway to Africa's Green Revolution ICRISATs Perspective on Fertilizer Interventions for Semi-Arid Areas of southern Africa

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Abstract

ICRISAT Zimbabwe has been working for the last ten years to encourage small-scale farmers to increase inorganic fertilizer use, and progressively increase their investments in agriculture, as the first steps towards Africa's own Green Revolution. The program of work is founded on a technology breakthrough proven to be successful in a subset of communities Southern Africa - micro-dosing using small targeted quantities of inorganic nitrogen fertilizer. It starts from the proposition that resource constraints prevent most risk averse farmers from pursuing rates of fertilizer application recommended by most national extension agencies. Rather than asking how can a smallholder subsistence farmer maximize her yields or profits, micro-dosing asks how can a farmer maximize the returns to a small initial investment - that might grow over time, turning deficits into surpluses. Our results from three years of wide scale testing across southern Zimbabwe have consistently shown that fertilizer micro-dosing can, irrespective of the resource status of the household, increase grain yields by 30 to 50% in both low and high potential areas where farmers cannot afford to purchase the current recommended rates of fertilizer. This innovative technology involves the precision application of small quantities of Nitrogen based fertilizer, close to the crop plant. This enhances fertilizer use efficiency and improves productivity, enabling intensification of agriculture and productivity gains from initially low levels, closing the yield gap between what farmers are currently achieving, and what is achieved on the research station. Gains are even larger when fertilizer is combined with animal manures, better weed control, and simple water management methods.

Keywords: *Animal manure, Fertilizer, semi-arid tropics, smallholder, Zimbabwe*

Building partnerships for promoting integrated soil fertility management innovations in Mozambique

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Abstract

Agriculture contributes about 25% of Mozambique's gross domestic product and 65% of the total value of exports. The smallholder sector accounts for up to 80% of total agricultural production, but is facing a rapid decline in soil fertility. Despite notable advances in soil fertility research in many parts of sub-Saharan Africa, few technologies are currently available for farmers and extension agencies working to improve crop production and rural livelihoods in Mozambique. The Soil Fertility Consortium for Southern Africa (SOFECSA) is developing mechanisms for accelerating delivery of integrated soil fertility management (ISFM) technologies to resource-constrained farmers. Linkages among research and extension institutions, agricultural input suppliers, and farmers were facilitated in the promotion of ISFM technologies in Manica and Barue districts. The work involved identification of appropriate ISFM technologies, establishment of 21 learning centers on prioritized farms and schools to demonstrate potential benefits of the technologies and determination of suitable methods for information and knowledge dissemination. Various rotation and intercropping combinations of maize (*Zea mays*), pigeonpeas (*Cajanus cajan*), groundnut (*Arachis hypogaea*) and cowpea (*Vigna Unguiculata*) were evaluated under various levels of fertilization. Maize grain yields ranged from 2 to 5 t ha⁻¹ with different ISFM options compared to ~1 t ha⁻¹ on control fields. Two major lessons were drawn from the initiative: i) the partnership building process created greater awareness about the importance of ISFM; and ii) involvement of key stakeholders in planning, implementation and evaluation promoted their sustained participation throughout the season, and attracted the involvement of farmer with different socio-economic circumstances.

Keywords: *Facilitating stakeholder partnerships, Fertilizer, ISFM learning centers, maize, SOFECSA*

The role of multipurpose trees and shrubs resources in the strategies of rural communities coping with the HIV/AIDS epidemic in Africa

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Abstract

The HIV pandemic has had dramatic effects on rural livelihoods in Africa. In rural communities only a few people have access to treatment due to high prices of medicine, poor health infrastructure and long distances to the nearest health centers. This has led to a greater dependence on the natural resources by the rural communities to alleviate the problems. In the rural areas, the natural resource products are easily accessible to most people and their use has increased over the years. There has been higher demand for wood, to prepare food for increasingly frequent funerals and for making coffins. Similarly, HIV has complicated existing livelihood crises resulting from droughts, high prices of fertilizer and poor marketing services. The impact of HIV and AIDS on household labor has also intensified the dependence on tree products like, fruits, roots, tubers and vegetables. This paper examines the role of on farm tree resources in the responses to HIV and AIDS, particularly in terms of herbal medicines, energy and food. The paper shows that HIV and AIDS epidemic has tremendously increased the dependence on wood resources and that the pandemic has environmental and natural resource management implications. Some policy and program interventions that might help lessen the impact of the pandemic on natural resources and the role multipurpose trees and shrubs can play in the multi-sectoral response to HIV and AIDS has been highlighted.

Keywords: *Multipurpose trees and shrubs, HIV/AIDS, communities, health, food, livelihoods*

Role of Soil and Water Conservation in Enhancing Agricultural Productivity and Livelihoods in Semi-Arid Areas of Malawi

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Abstract

Soil and water management are essential ingredients for increased crop productivity and subsequent attainment of the Green Revolution in Sub-Saharan Africa. This is particularly significant in countries whose populations are heavily dependent on rain-fed agriculture. However, farmers in semi-arid areas often suffer from inadequate extension systems that do not function well due to the marginal nature of arid areas. Consequently, farmers' adoption of soil and water conservation innovations continues to remain a challenge. Using a combination of both qualitative and quantitative assessments on a sample of 200 farming families in Central Malawi, our research study showed that smallholder farmers who are a key to achieving a green revolution, face a variety of socio-economic and institutional bottlenecks that are both inherent in their farming systems and those caused by the broader macroeconomic environment. High on the list was the inadequate access to fertilizer and seed inputs by many farmers as well as declining land holding sizes which have impacted negatively on agricultural productivity. Similarly, increasing poverty and the prevailing HIV/AIDS pandemic coupled with inappropriate markets have significantly reduced communal investments in most of the resource demanding soil and water conservation innovations. The study recommended that a broad based green revolution in Southern Africa is achievable only if smallholder farmers adopt on a wider scale the use of improved seed, fertilizer and traditional low cost best bet soil conservation strategies to increase yields as well as sustain the natural resources base.

Keywords: *Adoption, conservation, green revolution, soil, water*

From Inertia to Action: The Role of Economic and Gender Factors in Soil Fertility and Technology Uptake

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Abstract

It is still unclear which of the social factors drive or condition the uptake of technological innovations derived from agricultural research by the poor smallholder farmers. The objective of the study was to unravel from the many social factors; the most dominant and determinant ones in the uptake of integrated soil fertility management (ISFM) options in Emuhaya, Western Kenya. It specifically delved into the relationship between financial endowment and land resources as well as role distinction between men and women in the study area on the uptake of ISFM options. The information was obtained from small-scale farmers through questionnaires, participant observations, focus group discussions and in-depth interviews with farmers, and extension officers in the area. The study generally established that there is a significant linkage between finance, land size and gender role differentiations with regard to the uptake of the innovative technology by the small scale farmers. Specifically, the study showed that the low income levels of farmers combined with small plots of land were a great impediment for uptake of the ISFM technology. The study revealed that the placement of most farm work on women, who head 70.2% of the households, but are coincidentally less financially empowered and with minimal land resources and decision making power, is an additional bottleneck towards successful adoption of ISFM technologies. The study recommends that soil fertility research interventions should take cognizance of distribution of financial as well as land resources among the target communities.

Keywords: *Finance, land size, tenure systems, gender roles, ISFM technology*

Using spatial analysis for targeting research and scaling-up opportunities

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Abstract

Geographical Information Systems (GIS) maps showing the prevalence and/or location of a certain feature, e.g. poverty rates, soil type, or rainfall distribution are common and these have evolved to predict/target where a similar environment or production system might occur, e.g. Homologue, Floramap. This paper reports the use of GIS to characterize the sub-Saharan African Challenge Program's southern Africa Pilot Learning site (PLS), and to identify project research sites that represent the variability across the PLS (250,000 km² across north-eastern Zimbabwe, central Mozambique and central Malawi). Initial variables were agro-ecosystem potential, population density, livestock density, time to input/output markets and poverty index. Time to markets was calculated using a model that takes into account road location and quality, as well as land cover classes and constraints to movement, like slope. By further classifying the variables into low, medium and high, a domain development matrix was developed that reflected the projects objectives. Selection of sites for the 2007-8 season and for implementation of the research programme were based on these derived development domains. This paper will present the results of a participatory diagnosis process that integrated the socio-economic variables into delineation of the development domains. A scaling-up approach which uses this methodology to target research and extension approaches across the PLS and into the wider geographical region will be presented. Linking this approach to other tools, like the use of Near Infra-Red Spectroscopy for analysis of soil and plant productivity, or CaNaSTA (Crop Niche Selection in Tropical Agriculture) will be discussed.

Keywords: *Decision support tools, GIS, resource endowment, socio-economic analysis,*

Linking African Networks to Agricultural Resources

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Abstract

In Africa, as in the rest of the world, there are increasing ways for subject-based networks and other agricultural communities of practice to find and share information and to learn from each other. With the increasing electronic access to information as well as numerous initiatives to provide otherwise expensive information at low or no cost to countries in Africa, Asia and Latin America, it is now possible for individuals, organizations, networks and other formal and informal groups to access information that previously would be far beyond their reach. However, many researchers and practitioners simply do not know where to look for and how to access free and low-cost material related to their own work. This study aims to improve African agricultural research and extension by linking networks and communities of practice associated with soil health to regularly-updated information on locating, accessing and sharing relevant practical and academic knowledge resources

The “secret” behind the good performance of *Tithonia Diversifolia* on P availability as compared to other green manures

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Abstract

Use of organic materials to improve soil nutrient and increase crop production is well documented. Organic resource quality influences the effect of these organic materials. Although characterization of these organic materials has been done a comprehensive characterization in terms of type and concentration of organic anions is still lacking. An incubation experiment was conducted to characterize *Tithonia diversifolia*, *Lantana camara*, *Gliricidia sepium* and farmyard manure and relate the parameters to P-availability. The experiment was in a completely randomized design, four treatments replicated four times. *Tithonia* produced the highest concentration of basic cations and oxalic acid while *Gliricidia* had the lowest. Farmyard manure and lantana were intermediate. At 5 t ha⁻¹ these organic materials significantly ($p < 0.05$) increased P availability through reduction of P-maximum on Chromic Acrisol. The order of this reduction was *Tithonia* > FYM > lantana = *gliricidia*. The influence of organic materials on P sorption was highly dependent on their pH, P, Ca and oxalic acid concentration. There was a significant ($P < 0.05$) negative correlation between P-Maximum and oxalic acid concentration of green manures ($r = -0.97$), this was attributed to the high Al complexation capacity of oxalic acid ($\text{Log}k_{\text{Al}} = 6.1$). Selection of organic materials therefore, besides being based on other conventional quality parameters should consider the concentration of oxalic acid. It was concluded that the better performance of *Tithonia* on P availability through reduction of P sorption is due to its higher oxalic acid. The agronomic implication of these results is that proper handling of *Tithonia* is required to avoid loss of oxalic acid during its application.

Keywords: *Farmyard manure, green manure, oxalic acid, and phosphorus sorption*

Defining soil organic carbon thresholds for mineral fertilizer response on granite-derived soils of Southern Africa

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Abstract

'No fertilizer - no crop' is a common challenge expressed by smallholder farmers who derive their livelihoods primarily from crop production on predominantly sandy (< 100 g clay kg⁻¹) of Southern Africa. This study investigated major causes of within field/farm soil fertility gradients, and quantified their potential influence on mineral fertilizer use efficiency. The study was conducted over three seasons on 120 field sites under different rainfall regions. Evidently, soil fertility gradients were driven by organic matter management practices and differentiated by farmer resource endowments. The soils had limited capacity to stabilize C, with SOC values ranging from 3 to 8.3 g C kg⁻¹, but the small differences among field or field sections had a significant influence on mineral fertilizer response by maize. There were three distinct SOC categories over which crop response to fertilizer application was significantly different. Little or no crop response was recorded in fields with <4.6 g C kg⁻¹ SOC regardless of management practice, and maize yields were invariably <0.9 t ha⁻¹. The highest variability in fertilizer responses was in fields with SOC levels between 4.6 and 6.5 g C kg⁻¹. Organic inputs at rates exceeding 10 t ha⁻¹ did not increase SOC beyond 8.5 g C kg⁻¹, suggesting that organic matter management in these systems should not be at maintaining critical SOC levels necessary for increased nutrient use efficiency. The findings provide opportunities for research, national extension agencies and non-governmental organizations to empower smallholder farmers to target available ISFM technologies and increase crop yields.

Key words: *Carbon threshold, fertilizer use efficiency, organic management, smallholder farmer, targeting*

Potential Nitrogen Contribution of Climbing Bean to Subsequent Maize Crop in Rotation in South Kivu Province of Democratic Republic of Congo

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Abstract

Nitrogen has become the most limiting nutrient in the Eastern Highlands of DR Congo because of high population density imposing continuous cropping without fallowing or external inputs. Among low input technologies to increase production, climbing bean is being promoted because of its high production potential. It is perceived as potential crop to contribute to sustainable cropping system through its high biomass production and N-fixing capacity. On station and farmer participatory trials were conducted to assess the beneficial effects of the climbing bean on the subsequent maize crop in rotation compared to bush bean and continuous maize cropping systems with and without applied fertilizer nitrogen. Maize grain yield was higher in climbing bean - maize rotation compared to bush bean - maize and continuous maize cropping system. Average maize grain yield increase over three cropping seasons in response to the preceding climbing bean effect were 489 kg ha⁻¹ and 812 kg ha⁻¹ compared to bush bean and maize as preceding crops respectively, which is 17.5% and 33.8% increase. However better yield advantage of climbing bean over continuous maize was obtained in the long rain cropping season, 43.2% compared to 24.2% in short rain season. Nitrogen contribution from the climbing bean to the system estimated as N fertilizer replacement values varied from 15 kg N ha⁻¹ to 42 kg N ha⁻¹ in the first season of rotation. The potential of climbing bean to improve soil fertility was confirmed by farmers' evaluation in on- farm trials.

Key words: *Climbing bean, maize, rotation, nitrogen, soil fertility*

Assessment of Potato Bacterial Wilt in the North Rift Valley of Kenya

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Abstract

A survey on potato bacterial wilt (*Ralstonia solanacearum*) was carried out in the major potato growing areas in the highlands of the North Rift Valley region of Kenya during the short rainy season, 2006 with the aim of assessing the incidence and prevalence of bacterial wilt. A questionnaire was administered to 256 potato growers and field observations made on the actual bacterial wilt incidence in two major potato growing divisions in each district. The survey established that potato was grown mainly under either monocropping or mixed cropping systems depending on the area and/or local community. Both characteristic of plants and tuber symptoms were the main criteria used to assess bacterial wilt disease in potato fields. Bacterial wilt was prevalent (0 – 100%) in the four districts covered but at varied and relatively low disease incidences (0 – 33%). However, in some parts of Marakwet district above 2800 m above sea level, the disease was either not present or was reported to be new. Bacterial wilt incidence had negative but low relationship with altitude. The area under potato and yields had declined in the major bacterial wilt prevalent areas with an overall average of 0.8 acres and 16.39 t ha⁻¹ realized. Most farmers could distinctly identify the disease but did not clearly understand the nature of the causal agent or its mode of spread apart from seed. There is need to train farmers on management of bacterial wilt.

Keywords: *Bacteria wilt, Diseases, Potato, Rift Valley*

Effects of Conservation Tillage, Fertilizer Inputs and Cropping Systems on Soil Properties and Crop Yield in Western Kenya

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Abstract

An on-farm experiment was conducted in Western Kenya (Busia) in the long rain season of 2005 to investigate the effects of conservation tillage on soil properties and the crop yields. The experiment based on a split-split-split plot design with three replicates and six core treatments arranged in a factorial combination of Nitrogen application and cropping systems was adopted. Maize variety IR (striga resistant) was used as a test crop, soybean (SB20) variety as an intercrop and for maize-legume rotation. Soil pH, Olsen P, soil N and organic carbon were analyzed in soil whereas total P total N and yield were analyzed in the plant tissue. Conservation and convention tillage systems combined with cropping systems (intercropping, rotation and continuous) at 0 and 60kg N/ha application were tested. Residue incorporation was done to all plots. The soil was sampled before and also after harvesting to compare the effects of the treatments. Weeding for conservation tillage plots was by hand pulling. Combinations of conservation tillage, continuous and with application of 60 kg N/ha for maize gave the highest yield of 2.8 tonnes/ha. The combination of conservation tillage, rotation and at 60 kg N/ha gave 2.5 tonnes/ha maize grain. Combination of conservation tillage rotational cropping system and at 60kg N/ha application gave the highest soybean yield (1.23 tonnes/ha). Soil carbon showed that there was significant difference between the conservation tillage and conventional tillage as well as the increase of the soil carbon from initial level of 1.44% to the highest percentage soil carbon of 1.9%.

Keywords: *Conservation tillage, Conventional tillage, cropping system, soil properties, residual incorporation,*

The potential role of legumes in facilitating green revolution in Africa: integrating biophysical and socio-economic dimensions of technology innovation

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Abstract

Provision of sustainable solutions to the soil fertility problems undermining food security in many smallholder farming systems in SSA has remained largely elusive due to a number of factors, such as the high degree of social and ecological variability, and poor access by smallholder farmers to markets for seed, fertilizer and other essential inputs. Legumes have an important potential role in SSA as sources of food, fodder and income. However, the capacity of legumes to produce grain and biomass and to contribute to soil N fertility through atmospheric N₂ fixation is influenced not only by the genetic potential of the species but also by variations in environmental conditions. A study was conducted in western Kenya to assess the capacity of a wide range of legumes to improve smallholder productivity, using the socio-ecological niche concept as a framework for integrating the biophysical and socio-economic dimensions into the technology innovation process. Generally, the species fixed 7-90% of their N requirements. N₂-fixation by the green manure species ranged from 29 kg N ha⁻¹ to 232 kg N ha⁻¹, while that of the grain legumes ranged from 3 kg N ha⁻¹ to 172 kg N ha⁻¹, and grain legumes with yields greater than 1 Mg ha⁻¹ resulted in negative net N inputs into the soil. The grain yield of maize following legumes was increased by 33-47%. While economic benefits of growing legumes in rotation with maize varied with species, rainfall, soil fertility and prevailing produce prices, returns to land and labour were greatest with grain legume-maize cropping systems. However, the impact of the legumes on household food security varied, depending on the level of farmer resource endowment. Legumes have the potential to make significant contribution to African green revolution by stimulating productivity in smallholder farms in Africa, so long as appropriate tools and methodological approaches are used to address the social and ecological variability.

Keywords: *Legumes, niche concept, smallholder farmers, soil fertility*

Fertilizer Policy and Marketing Arrangements for a Green Revolution in Africa

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Abstract

The Green Revolution in Asia was fueled by both technology and policy. The adoption of the seed and fertilizer technologies that increased crop yields and food production was facilitated by a supportive policy environment. In contrast, fertilizer use has remained low in Sub-Saharan Africa. The benefits of fertilizer use are known to many farmers, including women farmers, but fertilizer use remains constrained because of non-conducive policy environments and inadequate marketing and distribution arrangements. Fertilizer markets in most African countries are underdeveloped and fragmented so farmers have difficulty in accessing quality fertilizer products on time and at affordable prices. Country-level evidence suggests that despite structural adjustment programs and market reforms, input supply systems, or agricultural input markets (AIMs), do not function well due to constraints in what are known as the Five Pillars of Market Development: policy, human capital, finance, market information, and regulation of quality. In many countries, policy environment is non-conducive and unstable, human capital is insufficient, access to finance is limited, market information is inadequate, and quality control regulations are not enforced. African countries can not experience a Green Revolution unless farmers have an easy access to quality products on time and at cost-effective prices through well-functioning AIMs. To develop efficient and effective markets, policymakers and development partners should strengthen the Five Pillars of Market Development. Market development is “necessary but not sufficient” to improve food security in rural areas. Most of the rural population lives below the poverty line (one dollar/day) and lacks the purchasing power to participate in the marketplace. The markets do not function well, but even if they did, poor people would still be excluded from the market process. To include them, market development efforts should be supplemented by market-friendly safety nets. Both market development and market friendly safety nets should be pursued simultaneously; otherwise our search for optimal and viable solutions may yield limited results.

Keywords: *Fertilizer Policy, Markets, Pillars of Market Development, Structural adjustment programs*

Lessons for Africa's Green Revolution: The Sasakawa Global 2000 Project Experience

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Abstract

Early attempts to realize a green revolution in Africa were informed by Asia's green revolution of 1960's. The Sasakawa Global 2000 project initiative in Africa which began in 1986, has lasted for twenty years and clarified many important lessons about assumptions, objectives, approaches and events that are essential to realizing a green revolution in Africa. Most importantly lessons learned clearly point to the need for alternative project design, approaches and reforms that are prerequisites for location specific success that might lead to a green revolution in Africa. Replicating such concomitant successes on a continental scale requires resources that are beyond the scale of any single institution and can only be attained through partnerships over a prolonged period. However such institutional commitments to co-operation and collaboration require more purposeful and transparent partnerships that aim for a greater common good rather than institutional triumph. Organizations embarking on a second thrust to achieve a green revolution in Africa will do well to be informed by the institutional framework that commands the services that technologies need to flourish. Africa's green revolution may well be lead/driven by institutional reforms rather than technological innovations.

Feeding the thousands: from research to entrepreneurship

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Abstract

A lot of research has been carried out to address the problems of poor productivity in smallholder agriculture by both national and international agricultural research institutions. Successes have largely been localized and lacking in impact at the large scale. This has spawned several efforts looking at scaling up strategies focusing on linking smallholder farmers to markets, reorienting agricultural research, extension and education, and enabling innovative approaches for knowledge access by producers. This paper presents an approach for strengthening capacity for agricultural entrepreneurship and innovation in Africa and the possible role that this can play in scaling up production. The emphasis is a multi actor approach involving public, private sector, civil society partnerships coupled to a re-orientation of research to foster and promote the entrepreneur in the smallholder producer. More often research has focused on technology at the expense of the outcomes and how they can be maximized to mankind's benefit. The link between research and entrepreneurship is explored at different scales taking examples from the author's experiences in southern Africa to show how they mutually act to reinforce the achievement of greater impact.

Keywords: *Impact, innovation, research-entrepreneurship link*

Formulating crop management options for Africa's drought-prone regions: Taking account of rainfall risk using modeling.

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Abstract

Few smallholder farmers in Africa's extensive semi-arid regions use fertilizer and virtually none use recommended high levels of application. Essentially, Africa's farmers have ignored the formal fertilizer recommendations of national research and extension systems. Because of this, productivity gains from fertilizer use remain grossly under-exploited. The existing fertilizer recommendations are one clear example of an information constraint that has proven intractable, despite more than 15 years of farmer participatory research in Africa. Due largely to training, researchers are generally pre-occupied with identifying and reporting only the best option - the near maximum yield result. While such optima may be correct from an agro-climatic perspective, in drought-prone regions, the risk associated with seasonal rainfall variations can determine whether or not farmers are likely to adopt a new technology and in what form. Yet almost no research and extension recommendations given to farmers in Africa include any estimates of the variability in technology response that can be expected due to climatic risk. ICRISAT and partners have been pursuing a range of improved crop management options for the semi-arid tropics through crop systems simulation and farmer participatory research. This paper presents some examples of how the application of crop modeling can provide a cost effective pathway to formulation of crop management options under variable rainfall conditions and for farmers with a range of resource constraints. It includes examples of fertilizer recommendations, crop cultivar selection and residue management in semi-arid regions.

Combining ability for Grain Yield of Imidazolinone Resistant-maize inbred lines under Striga (*Striga hermonthica*) infestation

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Abstract

Striga hermonthica infests cereal crops particularly maize leading to severe yield reduction. In Tanzania, maize is grown on about 2 million hectares but the yield obtained is very low, it is estimated at 1.3 tons ha⁻¹, this is due to various factors including striga weeds. The control measures that have been used have not been effective. One of the promising strategies in controlling striga is the use of imidazolinone resistant (IR) maize seed coated with imazapyr herbicide. A research was conducted to investigate the inheritance of this trait in maize inbred lines. 93 testcrosses were evaluated under striga infestation conditions in the Lake zone of Tanzania and Kisumu-Kenya in the 2006 season using alpha (0,1) lattice design. Maize grain yield was used as a proxy for resistance to herbicide; resistant materials were selected as suitable candidates in striga infested areas with the use of the herbicide. The results also showed differences in both General Combining Ability (GCA) and Specific Combining Ability (SCA) effects for grain yield. GCA effects ranged from -0.57 to 0.78. SCA effects were different within each tester. The SCA effects with tester A, ranged from -0.67 to 0.58, tester B from -0.70 to 0.32 and tester C from -0.62 to 0.80. The contribution of GCA and SCA to entry sums of squares for grain yield was relatively higher for GCA than for SCA at 38 and 32 percent, respectively. This suggested that the additive gene effects were the more important source of variation on herbicide resistance.

Keywords: *General Combining Ability, Imazapyr herbicide, Imidazolinone resistant maize, Specific Combining Ability, Striga hermonthica.*

Towards sustainable land use in Vertisols in Kenya: challenges and opportunities

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Abstract

Vertisols are heavy clay soils with 30 to over 70% clay dominated by smectite mineralogy. They are the most widely distributed soils in the world located mainly in tropical and sub-tropical regions. In Africa, they occupy about 3.5% or 99 million hectares of the landmass located mainly in eastern Africa. In Kenya, they occupy about 5% or 2.8 million hectares of the landmass and occur mainly in arid and semi-arid areas (ASALs). They are potentially very productive soils because of their high cation exchange capacity and water retention, moderate soil fertility and low salinity/alkalinity problem. However, their poor infiltration and internal drainage result in severe management problems. Traditionally, Vertisols in Kenya were and still are used for extensive livestock grazing, however, due to increased population pressure and emigration of people from humid high potential areas to the ASALs, they are being converted to arable cropping. Vertisols cropping in Kenya is, however, a new utility system being embraced enthusiastically in spite of the serious management constraints observed. The major constraints include waterlogging and tillage difficulties, which pose serious challenges to their utilization for cropping in the country. In this paper, problems and challenges associated with the ecosystem, population pressure, and traditional and current land use including livestock grazing, and arable cropping in the Vertisols, is considered in relation to sustainable land use and management. In conclusion, views on the way forward towards sustainable land use and management of the Vertisols including proposals on stocking rates and cropping systems for maintaining the soil fertility and productivity while minimizing soil erosion and land degradation are given.

Keywords: *Vertisols, land use/utilization, cropping, sustainable, management.*

Changes in $\delta^{15}\text{N}$ and N nutrition in nodulated cowpea (*Vigna unguiculata* L. Walp.) and maize (*Zea mays* L.) grown in mixed culture with exogenous P supply.

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Abstract

A 2-factorial experiment, involving 3 levels of phosphorus (0, 40, and 80 kg P.ha⁻¹) and 4 cropping systems (mono, inter-row, intra-row, and intra-hole maize/cowpea culture), was conducted in the field for 2 consecutive years in 2003 and 2004 to assess the effects of P supply and cropping system on plant growth and symbiotic performance. Adding P to cowpea plants significantly increased the growth of all organs (shoots, pods, roots and nodules) and whole plants in Year 2, more than in Year 1. Mixed culture however depressed plant growth. Isotopic analysis of both cowpea and maize plants revealed significantly decreased $\delta^{15}\text{N}$ values in shoots, roots, pods and whole plants in Year 2, but less so in Year 1, with P supply. This resulted in significantly increased N derived from fixation in organs and at whole-plant level in the legume. Relative to monoculture, mixed culture decreased the $\delta^{15}\text{N}$ in all cowpea organs in Year 2, and in shoots and pods in Year 1. As a result, significantly more N was derived from fixation in intercropped cowpea plants compared to monoculture, with intra-hole cowpea showing the highest dependency on symbiotic fixation for its N nutrition. However, the growth suppression in cowpea caused by the mixed culture resulted in significantly lower actual amounts of N-fixed in intercropped cowpea relative to monoculture.

Keywords: *Nitrogen-15, N-fixation, cowpea*

Cereal-Forage Legume Double Cropping in Bimodal Rainfall Highland Tropics: the Kenyan Case

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Abstract

A two year study was conducted at two sites, Njoro and Mang'u both in Nakuru District in 1998-2000 to test the validity of double cropping selected forage legumes with wheat and test their contribution to enhanced crop yields in a cereal based cropping system. It was hypothesized that double cropping was possible in order to utilize the short rain season, where the land is left under weedy fallow. The main factor consisting of fallow management species at seven levels: *Medicago sativa* L. (Lucerne), *Vicia sativa* L. (common vetch.), *Melilotus alba* Desr. (white sweet clover), *Crotalaria ochroleuca* G. Don (crotalaria), *Trifolium subterraneum* L. (subclover), *Triticum aestivum* L. (wheat) and a natural weedy fallow was considered during the short rain season. An inorganic nitrogen supply to wheat at 0, 20 and 40 kg N/ha was introduced during the long rain season to make three sub-plots representing zero, full and double N rates, respectively. This factorial combination gave 21 treatments. An RCBD with split plot arrangement replicated three times was used during the long rain season. Only *V. sativa* and *C. ochroleuca* nodulated with *V. sativa* having the highest biomass of 6815kg/ha-1, tissue N content of 2.8% and C:N ratio of 13:1. Yield suppression was observed in the natural weedy plot probably due to wide C:N ratio and possibly allelopathic effects of the previous year's weeds. Wheat grown after *C. ochroleuca* produced the highest biomass and grain yields. This demonstrated that double cropping was possible using some species where the complementary legume crop could increase nutritive value of maize stover which is the main livestock feed during the dry season. This can improve the animal condition for higher total farm productivity and improve the farmers' income.

Keywords: *Forage legumes double cropping wheat*

Status and Trends of Technological Changes among Small Scale Farmers in Tanzania

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Abstract

The purpose of this paper is to highlight on the technological changes in agriculture among small scale farmers in Tanzania and how these changes have contributed towards poverty reduction and promotion of sustainable agriculture. The paper reviews the challenges in the sector with available evidence suggesting that most of the rural areas are faced with low production and productivity in agriculture, land degradation in the form of soil erosion, nutrient depletion are severe, while food crop yields of less than a metric ton per hectare are common and deforestation, overgrazing are widespread. The paper has gathered together issues on the status and trends of small scale farmers in Tanzania and their use of technologies, land and gender, labor, income and resources allocation. Results indicate that Investment in agricultural technology is crucial in order for to meet the growing demand for food at low cost. Current evidence provides support for the view that such investment is, indeed, profitable and does contribute to improved productivity. However, there is still a lack of empirical evidence derived from rigorously measuring the impact of technological change on household welfare, based on consumption and other factors. The few studies show that technological change improves income and food consumption while increase the burden of women's work hours in the field.

Keywords: *Agricultural productivity, Technological Change, Poverty reduction,*

Linking Small Holder Farmers to Markets: Implications for Investments in Natural Resource Management

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Abstract

Technology adoption and adaptation by farmers is influenced by a myriad of factors amongst them social and economic factors. Previous efforts to increase technology adoption have been based on a technology push whereby technologies developed either using conventional or participatory approaches are pushed to farmers for adoption. More recently debate on technology adoption by farmers has centered on the role of “technology pull” as a means to increasing the use of improved technologies especially by smallholder farmers. One of the “pull” factors is access to markets. It is hypothesized that better access to market opportunities provides incentives for adoption of agricultural technologies (improved varieties, seed, and inputs) and re-investment in Integrated Soil Fertility and Management innovations. In 2006, cross-sectional household surveys were carried out in selected sites in Malawi, Uganda and Tanzania, to investigate how farmers were investing their resources as a result of improved access to markets and what their investment priorities were. While there is evidence that the more market-oriented farmers are able to invest their additional income in ISFM technologies, the study found out that there are significant variations across countries, crops, gender and wealth categories. Empirical evidence in Malawi and Tanzania shows that farmers receiving higher incomes due to improved marketing opportunities are purchasing inorganic fertilizers. However, in Uganda, reinvesting in agricultural inputs and soil fertility replenishment was a lower priority compared to other livelihood needs such as paying school fees, health care, nutrition, food security, business investments, housing, and savings. In Malawi purchasing agricultural inputs (mainly fertilizer and seeds) ranked highly followed by investments into small business and in small livestock. Analysis showed that 62.7% of farmers (67.8% women and 57.3% men) preferred to invest in purchasing fertilizer as a first priority, while 23.8% (30% women and 18.2% men) who preferred to purchase seeds as a second priority. These differences in investment priorities are also determined by wealth category, the amount of income obtained and gender.

Keywords: *Gender, Markets, Technology adoption*