

Abstracts

Innovations as Key to the Green Revolution in Africa: Exploring the Scientific Facts

Editors: Andre Bationo, Jeremiah M. Okeyo, Boaz S. Waswa, Paul Mapfumo, Fredah Maina and Job Kihara



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Preface

Africa remains the only continent that has not been able to fully benefit from the effects of the Green Revolution. The first Green Revolution failed in Africa because it did not take account social and ecological variability, culture, institutional bottlenecks and a host of other issues. This Revolution failed to recognize that although agricultural technology is an important factor, it is only one aspect of a complex socio-economic-ecological system.

Various local, regional and international forums have been held to discuss how Africa's Green Revolution can be achieved. The African Heads of State and governments have developed the Comprehensive African Agricultural Development Program (CAADP) as a framework for agricultural growth, food security, and rural development. CAADP has set a goal of 6% annual growth rate in agricultural production to reach the UN's Millennium Development Goal of halving poverty and hunger by 2015. The African Heads of State Fertilizer Summit held in Abuja Nigeria in June 2006 led to the Abuja Declaration on Fertilizer for the African Green Revolution. The Summit identified three most critical issues that need to be addressed if millions of African farmers are to increase utilization of fertilizer. These are access, affordability and the use of incentives. The Summit recognized that given the strategic importance of fertilizers in achieving the African Green Revolution, there is need to increase the level of use of fertilizer from the current average of 8 kg ha⁻¹ to an average of at least 50 kg ha⁻¹ by 2015. Similar sentiments were echoed at the African Green Revolution Conference in Oslo where it was resolved to take concrete and concerted action towards the development of self-sustaining changes in African agricultural growth through the use of enhanced approaches to public-private partnerships.

Achievement of the desired growth in agricultural production calls for deliberate effort to increase access and affordability of inorganic fertilizers, seed, pesticides and profitable soil, water, and nutrient management technologies by the smallholder farmers in Africa. For many years now, agricultural research has generated numerous technologies that can launch the African Green Revolution but these have not been widely adopted and benefited the smallholder farmers in the continent. There is need for a shift in paradigm from the linear model of research-to-development to the systems perspective. This calls for agricultural innovation, which is the application of new and existing scientific and technological (S&T) knowledge to achieve the desired growth in agricultural production and overall economic development in Africa.

Crop diversification is an important instrument for economic growth. Through the use of biotechnology, high yielding crop varieties have been bred with potential to significantly increase production. NERICA, "New Rice for Africa", for example,

is a new rice variety that has been bred through the application of biotechnology and offers great potential for transforming agriculture in the continent. Other high yielding crop varieties such as maize, sorghum, millet, cowpea, soybean, cassava, cotton with additional benefits of being disease and insect resistant have also been bred and these have the potential for increasing food production and incomes if accessed by smallholder farmers in the continent. There is need for agricultural practitioners in Africa to explore the application of the benefits of biotechnology and crop diversification in achieving the desired Green Revolution.

The world is experiencing rapidly evolving production, consumption and marketing conditions driven by new technology, globalization, urbanization and associated phenomenon. There is need for smallholder farmers to be aware, prepared and equipped to face the resultant challenges. Farmers need to be linked to input-output markets and supported in order to access the required seed, fertilizer, pesticides and also access market information and better prices for their produce. Further, there is need for change in paradigms in development practice where participation, diversity and self reflection are incorporated in agricultural research and development. There is need therefore to build strong institutions among all actors in the natural resource management (NRM) sector as basis for influencing change.

Africa needs to adopt a holistic, dynamic and innovative approach to availability of all agricultural inputs, improved output markets, and policies that encourage input use by farmers and fair prices for their produce if significant growth in the agricultural sector is to be achieved. What is needed is innovative application of existing and new knowledge, the narrowing of the gaps between income generation and investment in the natural resource base through linkages to markets, policy be informed by sound natural science, investments be made in extending this knowledge to farmers, and proper institutional linkages in NRM built and strengthened.

It is on the above backdrop that the African Network for Soil Biology and Fertility (AfNet) in collaboration with the Soil Fertility Consortium for Southern Africa (SOFECSA) organized this International Symposium entitled '*Innovations as Key to the Green Revolution in Africa: Exploring the Scientific Facts*'.

The goal

The overall goal of this symposium is to bring together scientists, agricultural extension staff, NGOs and policy makers from all over Africa to explore the scientific facts and share knowledge and experiences on the role of innovation in soil fertility replenishment as a key to the Green Revolution in Africa.

Objectives of the symposium

- (i) To assess the potential and feasibility of use of external input and improved soil and crop management to achieve the African Green Revolution
- (ii) To identify and learn about innovative approaches needed to build rural input market infrastructure
- (iii) To review the main policy, institutional, financial, infrastructural, and market constraints that limit access to innovations by poor farmers;
- (iv) To evaluate strategies for scaling out innovations to millions of poor farmers in the continent

Symposium Themes

Theme 1: Constraints and opportunities towards the African Green Revolution

Theme 2: Potential and feasibility of use of external input and improved soil and crop management to achieve the African Green Revolution

Theme 3: Factors that limit access to and adoption of innovations by poor farmers

Theme 4: Innovation approaches and their scaling up/out in Africa

It is trusted that this volume of abstracts will enlighten the reader and will contribute significantly to elucidating the importance of innovation in achieving the desired growth in the agricultural sector in the continent.

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Acknowledgements

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Theme 1

Constraints and opportunities for the African Green Revolution

Regional experiences

Targeting technologies - from fields to farms and farming systems; from 'silver bullet' technologies to 'best fits'

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Abstract

African agriculture is highly diverse, with major farming systems matched to the major agroecologies. In each country or region there are localised agroecological gradients, and large differences between regions in terms of access to markets. Within each village a wide diversity of farming livelihoods can be found - differing in production objectives and resource endowments. Differences in soil fertility are partly derived from inherent differences in properties (the 'soilscape') but are strongly influenced by past management, particularly by the rates and quality of organic manures added to the soils. It is clear that 'one-size-fits-all' or silver bullet solutions that are generally applicable for enhancement of soil fertility simply do not exist. Further, although research has focused on 'best bet' technologies for different regions, a better conceptualization is 'best fit' technologies for specific situations.

Although the heterogeneity in African farming is at first sight bewildering, systematic analysis across farming systems in West, East and southern Africa reveals repeating patterns of management. These repeating patterns of allocation of nutrient resources and management methods lead to self-organization among smallholder farms. The past management of fields leads to extreme differences in fertilizer use efficiency, e.g. from 5 kg grain kg N⁻¹ to 50 kg grain kg N⁻¹ between fields of the same farm. By categorizing field types within agroecological zones in simple terms, easily recognizable by farmers, 'rules-of-thumb' can be derived for highly-efficient management of scarce nutrient resources in these heterogeneous environments. Success of legume-based technologies for soil fertility improvement, such as grain legume/cereal rotations or legumes for animal fodder also varies enormously depending on the soil fertility status of fields.

New approaches for enhancing productivity in Africa must take account of, and harness, the dynamic nature of farming systems and the heterogeneity between regions, farmers and their fields. Our proposed approach represents a substantial shift in concept from traditional 'blanket recommendations' to focus on the targeting of best-fit technologies to different farmers and crops within production systems using simple 'rules-of-thumb' derived from scientific principles and local farmers' knowledge.

Keywords: *Farming systems, Fertilizer recommendations, Grain legumes, Residual effects*

Achieving an African Green Revolution: A Perspective from an Agri-Input Supplier

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Abstract

Discussions about increasing agricultural production in Africa often either focus on farmers alone or rest on simple assumptions that producing fertilizers in Africa are a magic-bullet solution. Drawing on his experience, both as a fertilizer executive and farmer in Zimbabwe, the speaker will discuss some of the major economic and policy issues that must be addressed for a sustainable, market-driven agriculture to take root in Africa.

Confessions of a Mad Soil Scientist

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Soil science is an interdisciplinary pursuit involving the biology, chemistry, geology, physics and human impacts upon complex soil systems. Despite this interdisciplinary, soil scientists have too often operated in relative isolation of other disciplines, in part through the belief that most agricultural problems can be solved through the manipulation of soils. While operating in this manner, a huge volume of technical findings were compiled. "Solutions" to many African small-holder's production constraints were identified, but too few of these found widespread utility within routine farm operations. In addition, soil scientists (and others) tended to be overly influenced by travel opportunities, passing fads and shifting paradigms, and many soil scientists became absorbed within pet projects. Pressure is now being placed upon all agricultural disciplines, including soil scientists, to translate their relevant findings into useful technologies and products that offer assistance to Africa's small-scale farmers. These demands are necessary because science is ultimately held responsible by society to offer new solutions to pressing problems and the world's development community now stands poised to assist Africa's poor to conquer food insecurity and reverse rural stagnation. As a result, now is the time for soil scientists to rethink the value of their past, on-going and future research findings. Several approaches may assist this process. Express results not only in terms of soil parameters or crop yield, but also in economic costs and returns. Use this economic information to develop straightforward technologies and affordable soil management products. Do not work with isolated farmers, rather work through farm associations and in collaboration with extension or development agencies. Whenever possible, work within larger interdisciplinary teams composed not only of scientists but also members from civil society and private enterprise. Find means to lobby policymakers regarding the benefits from employing available expertise, technologies and products to social and economic problems. Be deliberate and avoid counterproductively by rushing this process or making excessive claims concerning one's findings. Soil scientists have much to offer the next African Green Revolution once we better incorporate market-led technology adoption and management of available capital, farm and human resources into our problem-solving approaches.

Five Skill Sets for the Development of Groups and Linking Poor Smallholder Farmers to Markets

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Abstract

This paper argues that the goal of improving the access of poor farmers to markets on a large scale requires innovative strategies for developing groups that have a portfolio of basic skills to prepare them for market engagement. This type of skill formation receives little attention in the current debate about how to overcome wealth-differentiated barriers to market entry in poor societies. The paper discusses the findings of a multi-country Study Tour organized by a development assistance agency and an international research organization to explore how their support to farmer groups could be improved and expanded to reach more of the rural poor and prepare them for agro-enterprise development. The primary finding was that there was a basic set of five skills that essentially all of the groups were seeking to obtain, irrespective of the skill sets being provided by their external supporting agencies. Although no skill set was new in and of itself, the novel discovery was the expressed demand by farmer groups to obtain and combine all of these five skill sets. Our findings suggest that the ability of farmer groups to form and successfully self-manage market linkages, and to control their own market-led livelihood strategies, is correlated with the acquisition of these five skill sets. We argue that interventions to promote market access by poor smallholder farmers should include explicit strategies to build the capacities of farmer groups in all of these skill sets.

Keywords: *Farmers, markets, poverty reduction, skills, social capital.*

Challenge of family farms' access to agricultural innovation in West Africa: institutional and political implications

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Abstract

West African countries are expecting major contributions from science and technology in the agricultural sector in order to meet the significant challenges of economic growth, food security, and overall poverty reduction. Although Research-Development in West Africa has experienced instability with regard to financing, much effort has been made over the last three decades. However, with the exception of cash crops, the majority of producers which are family farms have little access to and therefore cannot benefit from agricultural innovations. How come this is the situation despite the hopes for an agricultural innovation system in these countries? In addition to the frequent recriminations that research and agricultural extension institutions perform poorly – or complaints that producers are too passive and refuse to change, this regional analysis addresses the key issue of the role played by the institutional and political environment in the access and use of agricultural innovations. The methodological approach was based on the analysis of case studies, which also contributed to deepen strategic thinking with all of the actors involved in order to learn lessons and their implications. The analysis reveals that in addition to the performance of agricultural innovation and producers' level of knowledge, the political and institutional environment also has a determining role in the access and use of the research results. In most cases, it has a vital role in up-stream and down-stream production support services and notably opportunities providing a better connection of family farms to the market whether it is local, national, regional or international. But the real challenge is to know how to create a political and institutional environment favourable to such support services in a context of liberalisation and globalisation where most of the States withdrew from the agricultural production support sectors such as marketing inputs, extension services, etc. and where private initiatives often take a long time to materialise on the ground.

Keywords: *Family farms, agricultural innovation, access to and use of agricultural innovation, political and institutional environment*

A Regional Approach to Promoting the African Green Revolution

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Abstract

Agricultural development is key to broad-based economic growth, poverty reduction, food security and sustainable development for the majority of countries in Sub-Saharan Africa. About 70 percent of the poor of the region live in rural areas where their livelihoods depend primarily on agriculture. Moreover, the performance of the overall economy of most African countries is significantly determined by that of agriculture, as the sector employs directly 60 percent of the total labor force and provides for strong growth and employment linkages backward and forward linkages with other sectors. Yet, the advent of an African green revolution has been severely hampered by multi-faceted failures in the realms of policies, institutions, infrastructure and technologies. Chief among these are the extreme fragmentation of the food and agricultural systems of the region and, as a result, an increasing double disconnection of farmers from both input and product markets. This paper proposes a two-way integrative approach to promoting both public and private investment in addressing these critical impediments and the resulting under-capitalization of African agriculture. The underlying strategy consists of a set of policy and institutional innovations aimed at creating a conducive business environment for the development, within a framework of broader regional integration, of coordinated value chains of selected food and agricultural commodities, which are strategic in terms of their unexploited intra-regional production and trade potential and/or their importance in the interface (trade relations) between the region and the global economy.

Keywords: *Agribusiness, public and private investment, regional integration, strategic agricultural commodities, value chains.*

Building sustainable rural input markets for poor farmers in Africa: approaches and lessons for the Africa Green Revolution

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Abstract

Farmers in Africa face huge challenges in accessing agricultural inputs due to poorly developed agricultural input markets, segmentation of the private sector against the rural sector, high costs of inputs and high transaction costs. Measures are needed to develop rural input markets; improve access to innovative financing instruments all along the entire value chain; and develop supportive pro-poor policies that can accelerate the access, affordability and incentives for farmers to invest in new agricultural technologies. This key note address will identify the major challenges facing poor farmers in accessing farm inputs; discuss institutional options for improving access and affordability to farm inputs; discuss the successes of agrodealers in delivering inputs to poor farmers; and policies that can assure rapid and large scale uptake of new agricultural technologies for an equitable green revolution in Africa.

Improving targeting and priority setting of global and regional programs

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Abstract

The achievement of desired impacts by global and regional programs requires targeting and *ex ante* impact analysis. A small inter-disciplinary group representing several CG Centers is applying several tools and methods to improve the targeting and prioritization—and thereby the impacts—of the activities of the Generation Challenge Program (GCP) and HarvestPlus (H+). The GCP is working to improve drought resistance or tolerance of major crops around the world. Targeting has involved analysis of major regional farming systems; associated census data; climatic analysis and modeling; crop production of major crops by farming system, by area, and crop combinations; and analysis of drought risk and risk management strategies. H+ is working to improve human health by increasing the micronutrient content of major crops. Targeting has involved analysis of infant and children's health (e.g., in terms of stunting, underweight, infant mortality); crop production data; crop imports and exports; food aid; and effects of cultural practices on both consumption and bio-availability of improved foods. Field work was conducted to better understand constraints and opportunities regarding adoption and consumption by targeted groups of improved crops. Ways to identify and address the needs of by-passed areas have been considered. Analysis for both Challenge programs has relied on Geographic Information Systems (GIS) to help provide program leaders with readily useful and usable decision support tools.

Keywords: *Generation Challenge Program (GCP), Geographic Information Systems (GIS), HarvestPlus, Human health, Impact*

Enhancing regional capacity for a Green Revolution in Southern Africa: SOFECSA's strategic direction and experiences

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Abstract

Developing suitable mechanisms for delivering appropriate integrated agricultural technologies to large numbers of smallholder farmers over short to medium timeframes is a major challenge for reducing poverty and increasing food security in sub-Saharan Africa (SSA). Most of the poverty traps that characterise agricultural production systems in SSA are driven by poor and declining soil fertility, a degrading environment and limited access to viable markets by farmers. Reducing poverty and increasing food security in Southern Africa requires intensification and diversification of the region's cereal-based farming systems to include strategic high-value crops that contribute to improved soil fertility, sustained productivity, farm income growth, and environmental service functions. This inevitably demands for increased and sustainable use of mineral fertilizers as the soils inherently have a small nutrient capital and low organic carbon. The Soil Fertility Consortium for Southern Africa (SOFECSA) promotes technical and institutional innovations that enhance contributions of integrated soil fertility management (ISFM) research and development to sustainable food security and livelihood options. However, two years of field-based interventions in four countries have revealed lack of human and institutional capacities as serious threats to technology delivery at various levels of agricultural research and development in the region. Lack of a common vision on appropriate technologies as well as approaches for their effective delivery among stakeholders poses a major challenge to any regional prospects for an agricultural green revolution. Drawing from these experiences and intricate features of an agro-ecology by socio-economic response matrix that dictates the unique livelihood options adopted by different farmer categories, SOFECSA focuses on the following output areas: i) providing technical leadership and support services on ISFM matters; ii) developing and promoting innovation platforms for integrating farm production systems, markets, institutions and policies; iii) developing and promoting Integrated Knowledge and Information Management Systems (IKIMS); and iv) enhancing regional capacity building on ISFM for sustainable livelihoods and environmental systems.

Water for Agriculture in Africa: Optimizing the Management

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Abstract

The word 'famine' nowadays applies almost exclusively to the African continent. Up till the end of the 20th Century, the 'hunger belt' usually referred to the Horn of Africa countries, but the new millennium has seen several countries in southern Africa join in the group requiring food aid. In all cases of famine, lack/shortage of rainfall is cited as the main cause. Yet within the same continent there are countries which are food secure, but normally receive much less rainfall than the 'drought' rainfall amounts of the hunger belts. Just how much is agriculture in Africa retarded by water scarcity? Or is it simply poor management of agricultural water? Or better still, by how much could African agriculture recoup from targeted management of water that is or could be made available to agriculture? There are varied answers to this, most of them qualitative, and ample information exists on the technologies, practices, approaches, policies and even finances required to bridge the food gap. However, the fact that the problem has persisted means that either, not enough has been done, or what has been done has had little impact. The innovations needed in agricultural water management so as to propel the African Green Revolution, will require more than just exploring case-studies of various experimental trials. They have to include approaches and interventions capable of changing the perceptions and thus the actions of vast cross-sections of society, from farmers to decision makers, and even those in the non-farming sectors. It can be done (examples of such wide-scale change of attitude and thus propelled action have been achieved in the campaigns for family-planning, HIV/AIDs, basic education and environmental conservation). This paper therefore describes some broad-category water management initiatives relevant to smallholder agriculture in Africa. It also explores the wider options to enhance the prioritization of agricultural water management at decision making levels, promotion of action across the various sectors, and optimal management of water by practitioners.

Keywords: *Agricultural water management, practices, approaches, policy, knowledge management, Africa*

A Complete Maize Fertilization for Plant and Human Health in Africa: Current Statutes and Perspectives for Human Health

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Abstract

Yara develops a specific maize formula, especially adapted for the smallholder in Africa. This Africa wide approach is based on the crop needs, precisely a nutrient replacement of the export by the harvests. The approach matches the optimum nutrient ratio, irrespective of the level of intensification, from only one or two bags of fertilizer per hectare to higher level. A complete fertilization requires a full package with the entire nutrients Macro-, secondary, and micro-nutrients- in the same bag. Further this should be an “easy” single fertilizer to apply once or two splits according to the level of intensification. The traditional cereal species do not respond very well to intensification (no real African Green Revolution in Africa until now), yet maize receives more and more fertilizers. The traditional fertilizers were limited to a few standard grade of NPK like 15:15:15, 12:24:12 or 20:10:10 and only DAP where K was not required like in East Africa. Two years ago Yara-West Africa demonstrated the need for sulfur in maize fertilizer, in Mali and for all the countries in the region. The fertilizers manually applied aren't always incorporated and most African soils are very light, sandy, so without buffer. The traditional practices with top-dressed urea lead to high pH increase around the dissolving prill or granule so there is a lot of volatilization and a lot of N losses. Fertilizer application can be adapted for plant nutrition not only for crop yield, but also for better nutritious food and human health. Balanced fertilization will ensure that produce is rich in essential micronutrients such as zinc, selenium and iron that are essential for improved health.

Keywords: *Balanced nutrition, Human health, Soil fertility, Micronutrients,*

Operationalizing the Africa Green Revolution: progress so far and emerging challenges

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Abstract

Africa is the only region in the world that has not experienced a Green Revolution, the process which raised agricultural productivity in other parts of the world. Launching an African Green Revolution to increase agricultural productivity – particularly among Africa’s smallholder farmers – is key to ending hunger and extreme poverty. It is against this background that UN Secretary-General (Koffi Annan) called in July 2004 for a uniquely *African Green Revolution for the 21st Century* to increase productivity in environmentally sound ways. In Africa, the green revolution needs to tackle five interconnected constraints faced by smallholder farmers: (i) low and declining soil fertility, (ii) poor access to improved seeds and planting materials, (iii) dependence on rain-fed agriculture and poor management of water, (iv) insufficient agricultural extension services, and (v) lack of access to markets. Many countries in Africa have headed the call, and are developing comprehensive strategies and several have started implementation. This is being done within the framework of national development strategies that many countries are currently developing to achieve the Millennium Development Goals by 2015. The UN family is supporting the process in various ways. For example, UNDP is assisting with the development of tools for needs assessment and for costing appropriate interventions at farm, community and national levels. FAO is working directly with the ministries of agriculture in developing broad-based sector strategy and assist with its implementation. Using lessons emerging from this national level process and from the experiences of countries already experiencing the green revolution, this paper will highlight policy and institutional innovations needed to operationalize it, particularly subsidy programs for inputs (fertilizers and seeds) and access to remunerative markets that target smallholder resource-poor farmers. These are two key ingredients for the success and sustainability of the revolution.

Keywords: *Improved seeds, Markets, Millennium development goals (MDGs), Soil fertility*

African Green Revolution: Will It Become A Reality, Particularly In Sub-Saharan Africa?

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Abstract

Sub-Saharan African region (SSA) continues to experience problems of perennial hunger, poverty and poor health of its people. Agricultural production has remained low over decades and it is even declining to miserable low maize (staple) yields below 0.5 t/ha/season at the smallholder farm scale, against the potential of 4 – 5 t/ha/season when modest levels of inputs and good crop husbandry are practiced. Constraints contributing to low productivity are numerous, but the planting of poor quality seed, declining soil fertility, poor markets and value addition to products, frequent incidences of malaria and HIV/Aids pandemic, significantly contribute to poor productivity. Partnerships for development are weak. Technologies to improve and sustain agricultural production are numerous as result of extensive research and extension messages in SSA. But, technology adoption rates have been extremely slow to none. In this paper we highlight constraints which are bottlenecks for achievement of a green revolution in Africa. Success efforts are reported, but we moot a focus on efficient utilization of abundant and affordable African natural resources, such as phosphate rocks to replenish depleted phosphorus in soils. But we feel that to achieve African Green Revolution, partnerships with concerned global communities, national institutions, including Universities, NGOs, CBOs and farming communities need initiation and strengthening. Specifically, human capacity at all levels should be built through training. Without private sector strong participation on acquisition of inputs and marketing product, it will be difficult to achieve the dreams. Above all, we must accept a “change”.

Keywords: *African Green Revolution, bottlenecks, partnerships, food security, poverty alleviation, accept change.*

Role of rural banking, microfinance, Small and Medium Scale Enterprises in achievement of the African Green Revolution

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Abstract

Seventy to eighty percent of the African population lives in rural areas where the extent and severity of poverty is great. The main occupation of this population is agriculture and agriculture related activities. This part of the population does not have access to financial services (credit, saving, transfer, insurance, etc.) and the difficulties that subsistence farmers have in financing seasonal input purchases for food grain production is a major problem for governments, NGO, research institutions and development partners. Financial institutions (formal and informal) also have difficulties to serve smallholder producers due to the associated high transaction costs, low rentability of agro-product, high market risk, climatic risk and inappropriate legal framework. However, the demand for financial services remains very high. Recently a more diverse approach to financial intermediation in rural areas became apparent. These innovations acknowledge context and a range of institutional options are promoted as well as new approaches in the lending mechanism. All these institutional innovations and delivery channels to support the provision of financial services to smallholder producers still need effective commitment of all stakeholders (governments, financial institutions, NGO, research institutions and beneficiaries) to create impact. Joint actions need to be implemented and coordinated from policy level to practice for sustainable development. Government have a major role to play in creating a policy environment conducive to rural financial intermediation, a supportive legal and regulatory framework as well as to support and facilitate the creation of market, infrastructure and risk mitigating strategies. On institutional level, more innovation need to be implemented in resources mobilization, outreach financial product development and delivery mechanisms. Furthermore, on-going consultation by all stakeholders and information sharing on innovations and best practices should be encouraged.

Keywords: *Agro-enterprise, Microfinance, Rural banking*

Scaling-Up and -Out of Fertilizer Microdosing and “Warrantage” or Inventory Credit System to Improve Food Security and Farmers’ Income in West Africa

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Abstract

The fertilizer microdosing technology deals with the application of small quantities of fertilizer in the planting hole thereby increasing fertilizer use efficiency and yields while minimizing input cost. In drought years, micro-dosing also performs well, because larger root systems are more efficient at finding water, and it hastens crop maturity, avoiding late-season drought. Recent research also found that solving the soil fertility problem unleashes the yield potential of improved millet varieties, generating an additional grain of nearly the same quantity. Recognising that liquidity constraints often prevent farmers from intensifying their production system, the warrantage or inventory credit system helps to remove barriers to the adoption of soil fertility restoration. Using a participatory approach through a network of partners from the National Agricultural Research and Extension Systems (NARES), Non-Governmental Organizations (NGOs), farmers and Farmers groups and other International Agricultural Research Centers, the microdosing technology and the warrantage system has been demonstrated and promoted in Burkina Faso, Mali and Niger during the past few years with very encouraging results. Sorghum and millet yields increased by up to 120 % while farmers’ incomes went up by 130 % when microdosing was combined with the warrantage system. This paper highlights the outstanding past results and the on-going efforts to further scale-up the technology using Farmers Field Schools (FFS), capacity and institutional strengthening, private sector linkages and crop diversification amongst other approaches

Keywords: *Farmers Field Schools, fertilizer microdosing, millet, participatory approach, sorghum, warrantage or inventory credit system*

Ex-Ante Evaluation of the Impact of a Structural Change in Fertilizer Procurement Method in Sub-Saharan Africa

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Abstract

In June 2006, the African Heads of State made a declaration to support increase in use of fertilizers in the farming systems of sub-Saharan Africa from the present average, about 8 kg ha⁻¹ to about 50 kg ha⁻¹. One route to attain this goal is to engender regional joint fertilizer procurement to reduce farm gate price and increase fertilizer demand and use. A review of fertilizer use in Africa has shown that structural changes in fertilizer procurement can reduce farm gate price by 11-18%. Using an average of these figures (15%), this study compares the effect of structural changes in fertilizer market (reducing farm gate price by 15%) on total fertilizer demand, total farm income, and additional farm income with the base situation (using FAO data) under three own (fertilizer) price elasticity of demand scenarios (low: -0.38; medium: -1.43; and high: -2.24) for 11 sub-Saharan Africa countries. Data were analyzed using Microsoft Excel. Result shows that compared with base level, structural change in fertilizer procurement arrangement (reducing farm gate price by 15%) led to 6% additional farm income (US\$125 million) under low elasticity scenario; 22% (US\$472 million) under medium elasticity scenario; and 34% (US\$730 million) under high elasticity scenario. Switching from one scenario to another indicates the potential to further increase farm income from 20% to 32%. The paper concludes by supporting interventions that reduce farm gate price of fertilizers and other inputs. Such interventions increase farmer productivity, total production, and total farm income and lead to improved livelihoods.

Keywords: *Farm gate price; fertilizer use; joint procurement; price elasticity scenarios; sub-Saharan Africa.*

Assessment of Nutrient Deficiencies in Maize in the West Africa Savanna

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Abstract

Low soil fertility is one of the main constraints to crop production in the West Africa savanna. Yields of major cereals such as maize are low and the response to N, P, K fertilizer recommendations is often far below the optimum. Possible causes for the poor response are the inadequacy of current fertilizer recommendations for a wide range of agricultural environments and practices, and the no consideration of nutrients other than NPK that limit optimum crop production. In addition, a big fraction of applied fertilizers can be lost through runoff, leaching and inefficient use by existing crop varieties. A study was conducted to identify limiting nutrients in the West African Savanna in on-farm experiments in Togo and Nigeria or in some of on-going long-term experiments in Nigeria and Benin. Maize ear leaf samples were analysed for macro and micro-nutrients and the Diagnosis and Recommendation Integrated Systems (DRIS) applied to check the limiting nutrients of maize production. Both yield data and DRIS results indicated that P and S were the 2 major limiting nutrients in Togo when N was supplied, contributing to 30% and 20% yield reduction on average, respectively. In long-term experiments where N, P, and K have been annually applied, Ca and Mg were strongly negative whereas limitation of S depended on the management. Despite its supply, N was negative in some of the long-term experiments pointing to low efficiency of applied fertilizers.

Keywords: *DRIS, ear leaf, long-term experiments, nutrient limitations, on-farm trials*

Best-Fits for Heterogeneous Farming Systems in Africa: A New Research Agenda

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Abstract

The previous papers in this symposium have highlighted the heterogeneity of smallholder farming systems in Africa, and the strong effects that this can have on the efficiency of fertilizer use, organic manures and crop yields. Within resource-constrained environments in many areas in SSA, 'best-fit' interventions are those that compatible with farmer production goals and supply optimal returns to investments in inputs, labour, and land. Here we focus on the implications of these findings for a new research agenda for improvement of soil fertility and productivity. First, we describe the various potential components of 'best-fit' Integrated Soil Fertility Management (ISFM) options, as presented in other papers within this section. These components are related to the biophysical, economic, social and infrastructural dimensions which are the principal driving forces which give rise to different farms and farming systems. Second, the returns to investment in ISFM options are analysed within the context of soil fertility gradients and compared with commonly available, less knowledge-intensive 'blanket' recommendations. Emphasis is placed on the need to identify the thresholds in these various factors that determine responses to ISFM options. Third, suggestions are made concerning the types of experimental research and analytical tools that are required to analyse trade-offs in investment in different ISFM options. In the final section, some general considerations for the identification and dissemination of 'best-fit' ISFM interventions are discussed, and the consequences explored of integrating these concepts in the implementation phase of an uniquely African Green Revolution.

Keywords: *Best-fit interventions, ISFM options, thresholds, trade-offs*

Exploring crop yield benefits of integrated water and nutrient management technologies in the Desert Margins of Africa: Experiences from semi-arid Zimbabwe

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Abstract

The benefits of integrating locally adaptable water and nutrient management technologies were explored under semi-arid conditions in Zimbabwe. On-farm maize based experiments were set up on six farmers' fields in Ward 5, Shurugwi. Three tillage systems namely *post-emergence tied ridging* (PETR), *rip & pot-holing* (RPH) and *conventional mouldboard ploughing* (CMP) were integrated to three nutrient management regimes i.e. a *control* with no fertility amelioration, *pit-stored cattle manure* band applied at 10 t/ ha and the latter with an additional top dressing of *ammonium nitrate* (34.5% N) at 100 kg/ha. On each site the treatments were set up as a completely randomized split-plot block design replicated 3 times with tillage (water management) as the main treatment and fertility as the sub-treatment. CMP mimicked the farmers common land preparation practice while PETR and RPH systems represented the improved water harvesting tillage techniques. The experiments were repeated for 3 seasons and crop yields analyzed using a combined analysis of variance across sites. Results revealed significant nutrient management effects right from the first season giving 3-year means of 1111, 1959 and 2464 kg/ha for the control, manure and manure plus fertilizer treatments respectively. On the other hand water harvesting tillage effects were insignificant initially but had beneficial effects in subsequent seasons with 3-year grain yield means of 1656, 2023 and 2129 kg/ha for CMP, PETR and RPH, respectively. The results therefore showed increased benefits when *in-situ* water harvesting tillage techniques are integrated with appropriate nutrient ameliorants giving realizable food security benefits to the farmer.

Keywords: *Crop yield, in-situ water harvesting, nutrient management, tillage, water*

Integrated Management of Fertilizers, Weed and Rice Genotypes can Improve Rice Productivity and Profitability

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Abstract

The influence of weed control on nitrogen fertilizer use efficiencies (NUE) by rice genotypes was studied in the Senegal River valley of West Africa with a field experiment during four seasons. It was hypothesised that integrated management of technologies could improve rice productivity. The objective was to develop integrated high-return technologies that improve irrigated rice-based systems productivity and profitability. Data indicated that rice yields were affected by N fertilizer, genotypes and plant densities. In good weed control conditions, optimum doses of recommended N fertilizer varied from 80 to 180 kg N ha⁻¹. Fertilizer N use efficiencies by genotypes were affected by weed control. Profitable management options of genotypes and N fertilizer recommendations have been identified. With a good control of weed, four genotypes (WAS 33, WAS 62, WAS 122 IDESSA1 and WAS 122 IDESA2) better used N fertilizer and yielded from 7 to 9 tonnes ha⁻¹ of paddy with low application of N fertilizer (80 kg N ha⁻¹). But poor control of weed increased N lost, decreased yields and profitability. Two genotypes (Sahel 202 and WAS 55-B-B-2-1-2-5) have been found to be most competitive against weeds. However, no more than 60 kg N ha⁻¹ should ever be recommended when weeds are poorly controlled. It was concluded that productivity and profitability of irrigated rice-based systems could be improved with integrated management options of genotypes, fertilizers and weed.

Keywords: *Fertilizer, nitrogen, rice, technology, weed*

Zooming-In, Zooming-Out: Developing farmer-education videos to scale up local innovations and sustainable technologies

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Abstract

To ensure that farmer-education videos are international public goods that do not remain on the shelf, learning topics should have a regional relevance. Hence I present a novel method called *zooming-in, zooming-out*. It starts with a broad stakeholder consultation to define regional issues. Only then are communities approached to get a better feel about their ideas, knowledge, innovations and the words they use in relation to the chosen topic (*zooming-in*). Key learning needs are defined and videos are produced in close consultation with the end-users. Consequently, when showing the draft videos to further villages (*zooming-out*), more novelty is identified, and further adjustments made. Two case studies from Bangladesh and Benin illustrate the role of video in scaling-up sustainable rice technologies. Evidence shows that based on a few well-selected local innovations, and merged with appropriate scientific knowledge, video was able to explain underlying biological and physical principles. The more these principles resonated with what farmers already knew and did, the more video became useful as a stand-alone method. Facilitation increased experimentation and adaptation of sustainable technologies, but was not always a prerequisite. Both process and outcomes of participatory research increased the effectiveness of educational videos. Ideally videos should be made with graduates of farmer field schools or with farmers who engaged participatory research. The potential of video in scaling-up participatory research is discussed.

Keywords: *Extension, learning, participatory research, scaling-up, video*

Effect of Manure on Millet Production in a Long-Term Soil Fertility Management Experiment in Niger, West Africa

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Abstract

Sahelian climate is characterized by erratic rainfall but soil fertility is the most limiting factor to crop production in this zone. Without fertilizer, millet grain yield that constitute the staple food of the rural people in the zone are very low (300-400 kg ha⁻¹). Since rural farmers are very poor, their income cannot allow them to buy mineral fertilizer, organic amendment through Crop Residue (CR) or/and manure is indispensable to enhance household food security and increase their income within a sustainable agriculture system. Two sites over six years (2001-2005) are used for this study with three factorial experiment in both cases: Sadore and Banizoumbou. At Sadore, the first factor was three levels of fertilizers (0, 4.4 kg P + 15 kg N ha⁻¹, 13kg P + 45 kg N ha⁻¹), the second factor was crop residue applied at (300, 900 and 2700 kg ha⁻¹) and the third factor was manure applied at (300, 900 and 2700 kg ha⁻¹). At Banizoumbou, manure (0, 2 and 4 t ha⁻¹), nitrogen (0, 30 and 60 kg N ha⁻¹) and phosphorus (0, 6.5 and 13 kg P ha⁻¹) was established to assess the fertilizer equivalency of manure for N and P. The results show significant effect of organic manure on both millet grain and total dry matter yields although they were variable over the years due to climatic constraints. Manure effect is less than inorganic P and N (5% in the total variation) but their combination is highly significant. High values of fertilizer equivalency for N and P of manure were observed, over 100% in most of the cases.

Keywords: *Fertilizer equivalency of manure, millet production, organic amendment, soil fertility, Simulation*

Conservation tillage, local organic resources and nitrogen fertilizer combinations affect maize productivity in Arid and Semi-Arid Lands in Kenya

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Abstract

Small holder land productivity in drylands can be increased by optimizing resources available locally through nutrient enhancement and water conservation. In this study, I investigated the effect of tillage and crop residue on productivity in a sandy soil in eastern Kenya. The objectives were to determine (1) effects of soil, water and nutrient management practices on crop yield and, (2) optimum organic-inorganic nutrient combinations for Arid and Semi-Arid lands in Kenya. This experiment initiated in 2005 short rains is a split split plot design involving tied ridges, conventional tillage and no-tillage as main factors and manure and crop residue as sub-factors. Each plot was also superimposed with four N fertilizer application rates (0, 30, 60, 90 kg N ha⁻¹) and was replicated three times. Tied ridge treatments have highest yield followed by conventional tillage while no-till treatments performed poorly. The data also shows that combined application of 1t ha⁻¹ of manure plus 1 t ha⁻¹ of crop residue is better than sole application of manure at 2t ha⁻¹. There was response to N fertilizer application with the highest yield observed at 60kg N ha⁻¹. It can be concluded that farmers are better off using tied ridges while applying 1t ha⁻¹ each of manure and crop residue.

Keywords: *Crop residue, manure, nitrogen, tied ridges, tillage*

Integrated Agricultural Production System Management – The Dryland Eco-Farm, A Potential Solution to the Main Constraints of Africa’s Rain-Fed Agriculture

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Abstract

This paper presents the results from a trial on a new innovative production system that addresses major constraints to agricultural productivity in dryland Africa. This innovation combines the use of live hedges and alleys of *Acacia colei*, earth bunds connecting micro-catchments inside which are planted high value trees such as the domesticated *Ziziphus mauritiana*. Pearl millet, cowpeas and roselle (*Hibiscus sabdariffa*) are planted in rotation. This trial was meant to test its effect on (1) soil erosion control, soil fertility and water use efficiency, (2) feed supply during the dry season, (3) income generation and diversification and (4) labor productivity compared to the traditional millet-cowpea system. Results showed that, pearl millet yields were twice higher than the control when no mineral fertilizer was applied. With the application of NPK fertilizers, millet yields were similar under both conditions. Cowpea yields were 5 to 9 times higher than the control without NPK and 3 to 5 times with NPK. Roselle yields increased in the range of 2 to 10 times with NPK and 2 to 5 times without NPK. These results showed that the system has the potential to produce yield response similar to that of the recommended rate of 100 kg of the NPK (15-15-15) fertilizer per hectare. The returns to land and labor are estimated to US\$224 and US\$1.87 for the DEF respectively compared to US\$77 and US\$1.33 for the millet-cowpea. DEF has the potential to improve rural livelihood in the Dryland of Africa while sustaining the natural resources base.

Keywords: *Acacia colei, Dry land eco-farm, millet-cowpea, Roselle, soil fertility, Ziziphus mauritiana.*

Achieving Impacts at Scale with Integrated Soil Fertility Management Innovations in Sub-Saharan Africa: Successes, Lessons and Prospects

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Abstract

Agropessimism still pervades much of the current initiatives on agricultural development in Sub-Saharan Africa (SSA). Specifically, there is doubt that integrated soil fertility management (ISFM) can achieve impacts at scale, i.e., bringing benefits to more people over wider geographic areas. Based on a number of selected case studies, this paper shows that, there are successful cases across SSA where ISFM has registered considerable impacts at large scales. These include (i) micro-dosing adopted in Sahelian dryland areas; (ii) soil and water conservation; (iii) grain legume-cereal rotation and intercropping systems, and (iv) crop-livestock systems in the east African highlands areas.. Using a dynamic analytical framework, the paper attempts to identify key ingredients and critical lessons that contributed to their success. Analysis shows that the main driving forces for success include: (i) technology 'sparks' resulting from improved germplasm and simple technologies that provided additional benefits to yield such as livestock feed and crop residues; (ii) market linkages support ISFM because it performs best where farmers have access to farm inputs, credit facilities, storage facilities, and fair produce markets;(iii) research for development partnerships; (iv) alternative dissemination and extension approaches in different contexts including public sector extension, NGO-led participatory approaches and market-led information services. However, a critical missing element has been the absence of policy support, as well as considerable financial investment in ISFM. The paper delineates the impact zones for intensification where ISFM can make a considerable difference, and suggests a number of investment options to achieve large-scale impacts in a relatively short time.

Keywords: *Dissemination, investment options, ISFM innovation impacts, scaling up adoption.*

Lessons Learnt From Long Term Experiments in Africa

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Abstract

Sub-Saharan Africa is the only remaining region of the world where per capita food production has remained stagnant over the past 40 years. About 180 million Africans do not have access to sufficient food to lead healthy and productive lives. The low food production is as a result of the breakdown of traditional practices and the low priority given by governments to the rural sector. Over the years, the paradigms underlying soil fertility management research and development efforts have undergone substantial change because of experiences gained with specific approaches and changes in the overall social, economic, and political environment the various stakeholders are facing. Long term experiments (LTE) have played a key role in understanding the changes in soil fertility as a result of the changing land management practices. The history of LTE in Africa dates back to the colonial days. A number of these experiments are still existing and actively researched while others have been discontinued or diminished in intensity because of lack of resources. Most of these experiments were designed to determine the effects of inorganic fertilizers and organic inputs on crop yields and soil properties. However over time other components such as rotation and intercropping were also assessed. Although yields were measured in all the experiments, climatic and soil variables were documented in only a few trials. There was no evidence of other measurement factors outside the treatments e.g. pests, diseases incidences and economic parameters. This paper presents a review of some key lessons learnt from selected LTE in Africa.

Keywords: *Agricultural productivity, long term experiments, soil fertility, sub-Saharan Africa*

Establishing a GIS based classification in support for regional studies.

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Abstract

In tropical zone, researchers have mostly relied on intuitive classifications to identify similar environmental zones. These classifications are based on expert judgment and are difficult to reproduce. In addition, cartographic maps derived from these classifications are country-specific in most cases, making difficult choice of representative sites in the context of regional studies. Establishing a more objective method for selection of representative sites is a strategy that can ensure accuracy and reduce research costs in regional studies. Statistical stratification approach previously used for European Environmental classification was adapted and applied for Rwanda and Burundi region. Seventeen environmental variables were selected based on relevant criteria and experience from previous studies. A principal component analysis (PCA) was performed to explain 99% of variation followed by clustering procedure using maximum likelihood classification technique. The mean first principal component values were used to aggregate strata into environmental zones. The stratification procedure yielded 37 strata which were aggregated into 6 environmental zones. Zoning derived from stratified classification was compared to other existing classification such as land use system classification established by AFRENA (1988), showing close similarities. Strata were described using existing environmental information. Stratified classification approach applied for Rwanda and Burundi is a tool that can potentially assist in objective sampling for environment and resources assessment studies. In view of ongoing regional projects on strategic management of limited resources under the influence of various environmental and human factors in tropical areas, stratification method can have tremendous potential applications especially in monitoring and modeling assessments studies.

Keywords: *Clustering, Environmental Stratification, Principal component analysis, Representative sites, Rwanda and Burundi*

Long-term land management effects on crop yields and soil properties in the sub-humid highlands of Kenya

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Abstract

The effect of continuous cultivation using inorganic and organic fertilizers on crop yields and soil agro-properties was studied in a 30-year old long-term field experiment at Kabete, near Nairobi, in the highlands of Kenya. The area is sub-humid with an average bimodal rainfall of 980 mm and two cropping seasons per year. The soil is dark red, friable clay classified as a Humic Nitisol and is considered to be moderately fertile. The main treatments consisted of three rates of inorganic fertilizers nitrogen (N) and phosphorus (P), farmyard manure with or without stover restitution. Maize and beans were planted during the long and short rains seasons, respectively. Results indicate that the use of chemical fertilizers alone increased maize grain yields by more than 50 % during the first six years of experimentation but declined thereafter. Application of combined chemical fertilizers and farmyard manure proved superior to inorganic fertilizers alone and maintained maize yields at 3 - 5 t ha⁻¹. Farmyard manure also gave better yields than chemical fertilizers. However, application of chemical fertilizers alone led to decreased maize yields, increased soil acidification from 5.5 to 4.3 and raised bulk density from 1.04 to 10.8 g cm⁻³ soil. The total % N declined by 25% from 0.16% while soil organic carbon decreased from 2 to 1.2 % after 27 years. Fertilizer N utilization ranged from 25 - 33 % but was higher in plots supplied with chemical fertilizers than in those with combined organic and inorganic inputs.

Keywords: *long-term, chemical fertilizers, farmyard manure, crop residues, maize, soil properties*

Theme 2

**Potential and feasibility of use of external input
and improved soil and crop management to
achieve the African Green Revolution**

Promoting uses of indigenous phosphate rock for soil fertility recapitalization in the Sahel: State of the knowledge on the valorisation of the rock phosphate of Burkina Faso

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Abstract

The general deficiency of the tropical soils in phosphorus constitutes one of the main factors limiting the production in sub-Saharan Africa. The present work is to collect a knowledgments on the use of Burkina Rock phosphate in the recapitalization of soils fertility in order to increase agricultural production. The main research permitted to: (1) define the doses of rock phosphate to recommend by culture: 400 kg.ha⁻¹ in first year and 100 kg ha⁻¹ year⁻¹ the years after or 200 kg ha⁻¹ every year, for sorghum, maize, cotton, peanut and cowpea; 500 kg ha⁻¹ in first year and 200 kg ha⁻¹ year⁻¹ the following years for the pluvial rice; 600 kg ha⁻¹ in first year and 300 kg ha⁻¹ year⁻¹ the following years for the irrigated rice; (2) finalize a formula of partially solubilised rock phosphate whose is: 4,22N - 24,55P₂O₅ - 6,26S - 25,52CaO - 0,16MgO. This one is practically equivalent to TSP in term of production of cereals and better in term of nutrients content on soil and, is economically profitable; (3) improve phosphate rock solubility by add 80 Kg per tonne of organic residue at the beginning of composting organics residues. Mixed formula combining 75% rock phosphate to 25% TSP or 50% rock phosphate + 50% TSP associated to the rotation with cowpea increased sorghum production. Rock phosphate is efficient, in the struggle against the soils degradation and the recuperation of the degraded soils and in the stabilization of the productions for a lasting agriculture.

Keywords: *Burkina rock phosphate, mixed formula, rate, tropical soils*

Improving phosphorus availability in maize based systems in the West African moist savanna

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Abstract

Management options to improve phosphorus (P) availability in the West African savanna include the application of organic residues, sole or with inorganic fertilisers. The quality and quantity of organic resources affect their contribution to nutrient availability. The quality of residues influences decomposition and nutrient release in the short term but its importance in the long term is unclear. A greenhouse study with six different soils assessed the residual effect of contrasting organic residues (maize stover, *Senna siamea*, *Mucuna pruriens*, *Leucaena leucocephala*, *Gliricidia sepium*, *Pueraria phaseoloides*, and *Lablab purpureus*) and triple super phosphate (TSP) on maize growth during four cropping cycles of 7 weeks. For the first cropping, the average shoot dry matter yield (DMY) obtained with residues of C:P ratio ≤ 200 was similar to the TSP treatment (about 14 g pot⁻¹), and higher than the yield obtained with maize stover (C:P ratio = 396). From the second cropping, the shoot DMY of the maize stover treatment (15 g pot⁻¹) was higher than those of the other treatments. Both high and low quality residues had similar effects on the cumulative DMY. Cumulative shoot P accumulation in the maize stover treatment (53 mg pot⁻¹) was significantly higher than the control (30 mg pot⁻¹), and also similar to those from high quality residue treatments. Significant interaction ($P < 0.05$) between soil and organic resource for DMY occurred only during the first two croppings. This indicates that the effects of soil type and residue quality on nutrient availability dwindle in the long term.

Keywords: *Phosphorus accumulation, phosphorus availability, residual effect, residue quality and quantity, shoot dry matter.*

Reversal of productivity decline in agroecosystems with organic amendments of different stability

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Abstract

In tropical agroecosystems, productivity declines associated with SOM degradation can be reversed through organic inputs of diverse quality which also increase crop fertilizer use efficiency. To soils that had been under continuous cultivation for 5, 20, 35, 80 and 105 years, four OM sources; *Tithonia diversifolia*, Hemsley A. Gray, cattle manure, biochar and sawdust were incorporated at the rate of 6 tons C ha⁻¹, for 3 seasons over a 2-year period. Full fertilizer N, P and K rates (120, 100, 100 kg ha⁻¹ respectively) were superimposed to the organic treatment plots. For soil with a long-term (105-year) cultivation history, full fertilization yielded a maximum of 3.0 t ha⁻¹ of maize grain which more than doubled with the addition of Tithonia (6.7t ha⁻¹ and 8.0t ha⁻¹ in the first and second year respectively). For Tithonia and manure, there was an increase of 2.0 ± 0.6t ha⁻¹ and 2.0 ± 0.3t ha⁻¹ respectively above fertilized, no biomass treatment in soil with medium cultivation history (20 yrs). No immediate changes to maize yield were noted with application of highly recalcitrant OM (charcoal and saw dust) but in the second year, charcoal and sawdust addition yielded 2.9 t ha⁻¹ and 1.7 t ha⁻¹ respectively higher than control. Nutrient uptake by maize crop was significantly improved with the application of Tithonia and charcoal OM. Soil pH, CEC_{pot} and CEC_{eff} were improved with OM inputs. We demonstrate that improved SOM, especially in degraded soil, are an integral part of reversing soil productivity declines in tropical agroecosystems.

Keywords: *Chronosequence; degradation; fertilizer use efficiency; SOM*

Evaluation of shoot and root traits for identifying P-use efficient cowpea genotypes

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Abstract

Cowpea is a pro-poor crop with a high potential in marginal environments in the dry savanna zones of West Africa. However, cowpea biomass and grain yields are constrained by low levels of available phosphorus (P) in the soil. Plant scientists and soil fertility experts have proposed the adoption of plant genotypes that are efficient in mobilizing less-available soil-P pools and demonstrate optimal response to P fertilizer application. This demands that appropriate plant traits are identified and used in breeding programs to achieve the desired results. Field trials were conducted at Kano and Shika in the Nigerian savanna in 2004 and 2005 to examine the variation in traits for P uptake and incorporation efficiency under different P regimes (0, 20, 40, and 60 kg ha⁻¹). At Ibadan, greenhouse pot experiment was conducted in 2005 with P applied as 0, 25, and 50 mg P kg⁻¹ soil to examine variations in root traits for P uptake efficiency. Field experiments revealed large year and location effects. In both years, significant ($P \leq 0.05$) P rate, genotype, and P rate \times genotype interaction effects were recorded for vesicular mycorrhizal fungal colonization of roots, tissue P concentration, grain yield, and total P in grain. In the greenhouse experiment, the application of P significantly influenced total biomass P and the root parameters measured. The studies revealed that P availability and cowpea genotype influence the suitability of percentage root colonization by mycorrhiza, root parameters, biomass P concentration, and grain yield as P-use efficiency traits.

Keywords: *Cowpea; P use efficiency traits; Soil P availability; West Africa*

Low Input Approaches for Soil Fertility Management in Semi-Arid Eastern Uganda

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Abstract

Grain sorghum [*Sorghum bicolor* (L.) Moench] is an important food crop in semi-arid areas of sub-Saharan Africa. Crop yields are low and declining, partly due to low soil fertility. The aim of this research was to evaluate, with farmer participation, alternative low-input practices for soil fertility improvement in sorghum-based cropping systems. These were: use of herbaceous legumes in improved fallow; a grain legume in rotation with sorghum; use of farmyard manure; application of low levels of N and P fertilizers; and reduced tillage. Four studies, comprised of 142 on-farm trials, were conducted at three locations over three years in drought-prone parts of eastern Uganda. *Mucuna pruriens* (L.) DC. on average produced 7 t ha⁻¹ of above-ground dry matter containing 160 kg N ha⁻¹ across the three locations. Application of 2.5 t ha⁻¹ of manure and of 30 kg N plus 10 kg P ha⁻¹ increased grain yield by 1.05 and 1.30 t ha⁻¹, respectively and a combination of 2.5 t ha⁻¹ manure with 30 kg N ha⁻¹ by 1.50 t ha⁻¹ above the yield with no nutrients applied (1.1 t ha⁻¹). The increase in sorghum grain yield in response to 30 kg N ha⁻¹ alone, to a mucuna fallow, and to a rotation with cowpea (*Vigna unguiculata* (L.) Walp.) was 1.15, 1.55 and 0.82 t ha⁻¹, respectively. These soil fertility management practices and reduced tillage, were found to be cost effective in increasing sorghum yield, hence on-farm profitability and food security for sorghum production systems can be improved by use of alternative low-input practices.

Keywords: *Low input, Mucuna pruriens, reduced tillage, resource poor, rotation, smallholder agriculture*

Integrated soil fertility management for increased maize production in the degraded farmlands of the Guinea Savanna Zone of Ghana using devil-bean (*Crotalaria retusa*) and fertilizer nitrogen

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Abstract

The native N and P of soils of the Guinea Savannah Zone of northern Ghana are only about 20% and 10% of the crops' requirements, respectively and organic matter content is usually below 1%. Hence, cereal yields without soil amendments are usually below 500 kg ha⁻¹. Organic residue and mineral fertilizer combinations are necessary to increase nutrient use efficiency. Devil-bean is a very promising leguminous cover crop for this agro-ecology. The best time to intercrop devil-bean in maize, effect of P on the maize and the effect of incorporated devil-bean biomass on grain yield of N-fertilized maize were investigated. In 2003, devil-bean was drilled in maize at 1, 3 and 4 weeks after planting (WAP) the maize which received 0, 20 and 40 kg P ha⁻¹. Phosphorus enhanced maize growth and yield. The devil-bean biomass was incorporated into the soil in the 2004 growing season. Maize was planted, fertilized with 0, 20 and 40 kg N ha⁻¹ and intercropped again with devil-bean as before. 40 kg N ha⁻¹-fertilized maize grown on incorporated devil-bean intercropped at 1 WAP in 2003 had the highest grain yield of 1.59 t ha⁻¹. In 2005, the devil-bean intercropped in the 2004 40 kg N ha⁻¹-maize at 3 WAP produced the highest biomass containing 42 to 88, 4 to 11 and 25 to 52 kg ha⁻¹ of N, P, K, respectively. Maize grain yield significantly increased with incorporated biomass with the highest biomass producing the highest grain yield. The cumulative effect of the biomass applications was significant in this study.

Keywords: *Devil-bean biomass, fertilizer nitrogen, intercropping, maize production, soil fertility management*

Effect of Continuous Mineral and Organic Fertilizers Inputs and Plowing On Groundnut Yield and Soil Fertility in a Groundnut – Sorghum Rotation in Central Burkina Faso

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Abstract

Two field groundnut-sorghum experiments were conducted at Saria in the centre of Burkina in order to assess the effect of chemical and organic fertilizers on groundnut yield and its components and soil fertility on two ferruginous tropical soils of different texture. Groundnut haulm yield, pod yield, number of pods, percent pod two-seeded, percent pod rot, seed yield and 100 seeds weight as well as sorghum dry shoot and grain yields were measured during 8 years. Most of the different variables were affected by continuous cropping without fertilizer application on the two soils, in particular on the coarse one. The effect of a likely deficiency in some nutrients (P, K, and Ca) was observed. The mineral fertilizers allowed maintaining yield, but their supply was not able to replenish the nutrient uptake by plants. The effect of compost on the crop production was weak but enhanced during the years, 7 and 8. Tillage had also an effect on yield, but this effect was limited and varied with soil type. In the control, the initial status of organic matter reduced in five years and did not increase with the application of fertilizers and compost. In contrast the addition of fertilizers increased the content of total N and Bray-I P. Nitrogen, P, K and Ca balance was negative in almost all treatments without mineral fertilizers. The cultural techniques improved sorghum production, while groundnut responded better than sorghum on the soil eroded.

Keywords: *Groundnut-sorghum rotation; mineral and organic fertilizers; soil fertility; Yields.*

Targeting Resources within Heterogeneous and Diverse Farming Systems: Towards a 'Uniquely African Green Revolution'

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Abstract

Smallholder farms in sub-Saharan Africa are diverse and heterogeneous, often operating in complex socio-ecological environments. Heterogeneity within farming systems is caused by spatial soil variability, which results from the interaction between inherent soil/landscape variability and human agency through management history of different fields. Technologies and resources designed to improve crop productivity often generate weak responses in the poorest fields of smallholder farms. Thus options for soil fertility improvement must be targeted strategically within heterogeneous farming systems to ensure their effectiveness and propensity to enhance the efficiency of resource (e.g. land, labour, nutrients) use at farm scale. Key issues in design of approaches for strategic targeting of resources include: 1. Inherent soil variability across agroecological gradients; 2. Social diversity, farmers' production orientations and livelihood strategies; 3. Farmer-induced gradients of soil fertility, their causes, and consequences for efficient allocation of scarce resources; 4. Competing objectives and trade-offs that farmers face between immediate production goals and long term sustainability; 5. The complexity of farmers own indicators of success. We used an analytical framework (NUANCES) in which systems analysis is aided by survey, experiments and simulation modeling to analyse farming futures in the highlands of East Africa. Our work contributes to the development of 'best-fit' or tailor-made technologies, using combinations of mineral fertilizers and organic matter management from N₂-fixing legumes and animal manures. Thus we hope to contribute to design of an 'uniquely African green revolution' called for by Kofi Annan, that fits technology interventions to diverse and heterogeneous smallholder systems of sub-Saharan Africa.

Keywords: *Agricultural inputs, Farm typology, Resource use efficiency, Soil fertility, Sub-Saharan Africa*

Effect of Organic Inputs and Mineral Fertilizer on Maize Yield in a Ferrasol and a Nitisol Soil in Central Kenya

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Abstract

Declining land productivity is a major problem facing smallholder farmers in Kenya today. This decline primarily results from a reduction in soil fertility caused by continuous cultivation without adequate addition of external nutrient inputs. Improved fertility management combining organic and inorganic nutrient inputs can enable efficient use efficiency of the inputs applied and increase overall system's productivity. Field trials were established at three sites in distinct agro-ecological zones of Central Kenya (one site at Machang'a and two at Mucwa with different soil fertility status) aiming to determine the effects of various organic sources (Tithonia, Lantana, Mucuna, Calliandra and manure) and combinations with mineral N fertilizer on maize grain yield of the inputs applied during four consecutive seasons. In Machang'a site, sole manure recorded the highest maize grain yield across the four seasons. In Mucwa poor site, sole tithonia gave the highest maize grain yield during the four seasons. Generally the maize grain yields were lower in the treatments with fertilizer alone compared to the treatments with organics across the three sites in the four seasons due to the poorly distributed rainfall. In Machang'a during the SR 2004 and SR 2005 seasons, the treatments with integration of organic and mineral fertilizer inputs were significantly higher than the sole organics, however in Mucwa good and bad sites, generally the treatments with sole organics did better than the ones with integration of mineral N fertilizer and organics with the exception of the mucuna treatment which did significantly better in the integration compared to the sole application.

Keywords: *Lantana, maize yields, manure, mineral fertilizer, tithonia*

The Potential of Reducing Nitrogen Fertilizer Rates Using a Soyabean-Sugarcane Production System in the South Eastern Lowveld of Zimbabwe

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Abstract

Monoculture is common in sugarcane production throughout the world and leads to decline in yields and soil fertility and build up of pests and diseases. Legumes have been shown as potential crops that break the monoculture cycles in several crops. Farmers can reduce nitrogen fertilizer requirements to the subsequent sugarcane crop when soyabean [*Glycine max* (L.) Merr] is used as a fallow crop. Field studies were conducted from 2004 to 2005 on Nitrogen depleted sandy loam soils at the Zimbabwe Sugar Experiment Station in the South East Lowveld of Zimbabwe. The objectives of the study were to determine nitrogen fixed by soyabeans at various growth stages, determine nitrogen in the foliar of subsequent cane and estimate the artificial nitrogen fertilizer reduction. The treatments used were (i) vegetable soyabeans followed by cane topdressed with 80 and 120 kg nitrogen ha⁻¹, (ii) grain soyabean followed by cane topdressed with 80 and 120 kg nitrogen ha⁻¹, (iii) Monoculture cane topdressed with 120 kg nitrogen ha⁻¹. Both grain and vegetable soyabeans fixed more nitrogen at flowering stage, 128 and 118 kg nitrogen ha⁻¹, respectively. The results showed that farmers can save nitrogen fertilizer by using vegetable soyabeans. The nitrogen saved was estimated at 80 kg nitrogen ha⁻¹ as shown by the number of tillers, biomass and nitrogen in leaves of cane.

Keywords: *Grain soybeans, nitrogen fertilizer, tillers, vegetable*

Residual Effects of Applied Phosphorus Fertilizer on Maize Grain Yield and Phosphorus Recovery from a Long-Term Trial in Western Kenya

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Abstract

Phosphorus (P) application is essential for crop production in the weathered, P-fixing soils of Western Kenya. It is hypothesized that a single large application can lift available P levels above a critical threshold, but further seasonal applications are requisite for sustaining yields. A field study was conducted in Siaya district to evaluate maize yield, P uptake, soil P balance and economic returns from P applied at different initial P rates, and further seasonal P additions. In the first season, triple super phosphate (TSP) was added at rates of (0, 15, 30, 50, 100, 150 and 250 kg P ha⁻¹, and maize yield and P uptake was assessed during 10 consecutive seasons. Additional treatments were included where an initial application of 100 kg P ha⁻¹ was supplemented with seasonal additions of 7 kg P ha⁻¹, supplied as TSP, manure or *Tithonia*. Residual benefits of maize in terms of increased grain yields were high with cumulative yields ranging from 17.4 to 54.8 t ha⁻¹ when P was applied at rates above 100 kg P ha⁻¹. Resin-extractable P increased significantly with initial P addition but decreased rapidly with time, particularly for treatments with one-time high dose P application. Economic evaluation of these technologies revealed that application of initial P as 100 kg P ha⁻¹ with seasonal additions of 7 kg P ha⁻¹ as TSP would give the best marginal returns to investment.

Keywords: *P balance, P modeling, P recovery, P uptake*

Effect of Sources of Organic Inputs on Phosphorus Sorption and Chemical Properties of Some Acid Soils of Zambia

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Abstract

Most acid soils in the high rainfall areas of Zambia, characterized as region III, are depleted of phosphorus (P) and have low base saturation, high exchangeable aluminium and extractable iron. Soil acidity and its associated low P are the major limitations to crop production in this region. The objective of this study was to evaluate the effect of sources of organic inputs on P sorption and chemical properties of benchmark acid soils of region III. The organic inputs were dried at 60° C and ground to pass through a 2 mm sieve before being added to the soil. Five-grams of ground tithonia diversifolia prunings, common bean, and maize residues were added to 95 g of each of the study soils. Distilled water was added to saturation and the moisture content was adjusted to field capacity every 4 days. The soils were incubated for 90 days at 25° C. During incubation the soils were mixed every sixth day to enhance uniform contact of organic inputs with the soil particles. At the end of incubation period, the soils were dried and retained for P sorption studies, and chemical analysis using established methods. The effect of each source of organic input on P sorption and exchangeable aluminium, calcium and magnesium was evaluated. The organic inputs that were most effective in decreasing P sorption and increasing soil pH and contributing nutrients such as nitrogen (N) and potassium (K) to the study soils are recommended to be integrated with mineral fertilizers to improve crop production of acid soils.

Keywords: *Exchangeable aluminium, organic input, P sorption, soil acidity, Tithonia diversifolia.*

Long-Term Effects of Organic and Inorganic Fertilizer Application on Phosphorus Availability in Semi-Arid Eastern Kenya

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Abstract

Decline in crop yields is a major problem facing smallholder farmers in semi-arid Kenya and the entire Sub-Saharan region. Particularly, many soils of semi-arid Eastern Kenya are characterized by phosphorus (P) and nitrogen (N) deficiencies due to low native nutrients reserves in soils. Inorganic fertilizers are unaffordable to most smallholder farmers at current producer prices, limiting their use on farms. While N can be replenished through biological fixation, there is no equivalent process for the introduction of P in soils. Consequently, phosphorus deficiency is now a major constraint to food production. Two long-term field experiments were established at Machang'a site to assess long-term effects of manure and inorganic P fertilizers on soil P availability. The first experiment began in 1989 and treatments were; control continuous manure at 5 and 10 t/ha/yr, residual manure at the same rates and NP fertilizer at 51 and 12 kg/ha/yr respectively. The second experiment began in 1994 and was planned to supplement the first experiment by giving information on the effects of a one time application of 250 kg/ha TSP on long-term P availability. Results indicated that repeated manure application at 10t/ha/yr significantly increased the level of plant available P and maintained the highest concentration of P fractions. Though inorganic fertilizers raised the level of bioavailable P fractions, this was comparatively low to manure effects. The residual value of a one time application of 250 kg/ha TSP was observed to maintain high soil P-test values for close to 10 years.

Keywords: *Fractionation, manure, nutrient deficiency, triple-super phosphate*

Selecting Indigenous P Solubilising Bacteria for Crop Improvement in Nutrient Deficient Acidic Soils of Southern Cameroon

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Abstract

Phosphorus is one of the major limiting factors for crop production on many tropical and subtropical soils. The concentration of soluble phosphorus (P) in soil is usually very low. These low levels are due to high reactivity of soluble P with calcium, iron or aluminium that leads to P precipitation. Some soil micro-organisms are effective in releasing P from inorganic sources through solubilization and from organic pools by mineralization. About 187 isolates of P solubilizer's (PSM) were obtained from soil and root samples collected in four provinces situated in two out of the five agro-ecological zones of Cameroon, on young and old oil palm-trees rhizosphere selected for their economical importance in Cameroon. They were tested for purity on agar plates and their efficiency in mobilizing phosphorus from insoluble sources were evaluated in liquid media containing sparingly Ca-P, Al-P and Fe-P. As mechanisms of phosphate solubilization, it appeared that Ca-phosphate solubilization resulted from combined effects of pH decrease and carboxylic acids synthesis. However, the synthesis of carboxylic acids was found to be the main mechanism involved in the process of Al- and Fe-phosphates solubilization. Both were mobilized at pH 4 corresponding to their natural occurrence by citrate, malate, tartrate, on much lower level by gluconate and trans-aconitate. Green house trials using maize inoculated with pre-selected 10 PSM isolates showed a significant improvement of plant yield and phosphorus uptake from 49 to 200% according to isolates. Some of these bacteria have been identified as *Pseudomonas fluorescens*, the plant growth promoter and soil borne disease biocontrol agent.

Keywords: *Plant yield, phosphorus uptake, phosphate solubilizing micro-organisms, organic acids.*

Greenhouse Evaluation of Agronomic Effectiveness of Unacidulated and Partially Acidulated Phosphate Rock from Kodjari: Effect of Crop Species and Mixed Crop on Plant P Nutrition

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Abstract

Greenhouse study was conducted to determine the agronomic effectiveness of unacidulated (KPR) and partially acidulated (KAPR) Kodjari phosphate rock relative to Triple Superphosphate (TSP). The available phosphorus of a ferruginous soil (pH, 6.2) was labelled with a $^{32}\text{PO}_4^{3-}$ solution, and the soil was amended with 50 mg P kg⁻¹ as ground KPR, KAPR and TSP. Two plants, maize and cowpea were grown alone or in association. After 60 days growth period, shoot yield, P uptake and real coefficient of P utilization (RCU %) were determined. Dry matter yields and P in dried tops increased by KAPR and TSP application however, with KPR, no significant difference with the control was recorded. Also in KPR treatment the dry matter yield and P uptake for maize and cowpea, grown in association decreased in all treatments. The agronomic effectiveness of KPR, KAPR and TSP in terms of RCU% was classed in this order: KPR < KAPR < TSP. The average values of RCU% in KPR treatments of pure or mixed culture were very low (0.3 %) indicating that KPR was not dissolved in the soil. In contrast they were high in KAPR and TSP treatments. In KPR treatments planted with maize alone or in association, RCU% values were higher than those measured with cowpea. This indicates that maize seemed to use KPR more efficiently than cowpea due to organic acids actions excreted by its roots and higher root densities. At last, the association did not increase significantly the use of KPR by plants.

Keywords: *Agronomic effectiveness, dissolution, mixed-cropping, plant species, phosphate rock,*

The Potential of Increased Soybean Production in Uasin Gishu District resulting from soil acidity amendment using Minjingu Phosphate Rock and agricultural lime

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Abstract

In Kenya, soil acidity is a major contributor to declining soil fertility and 20% of the soils are acidic and are considered to be of low fertility. Most farmers are unaware of the benefits of liming acid soils and hence blame seed and fertilizers for low yields. A study was carried out during the 2005 LR and 2006 LR at Kuinet in Uasin Gishu District of the Rift Valley Province in Kenya to delineate the effects of Minjingu phosphate rock (MPR) and agricultural lime as liming materials on yields of soybeans intercropped with maize. The maize responded to application of soil amendment materials for the first season with the DAPL treatment giving the highest maize yields of 6.19 t ha⁻¹ compared to the control which gave 1.36 t ha⁻¹. Soybean yields were disappointingly low in the first season with the DAPL treatment and control treatment giving yields of 0.32 t ha⁻¹ and 0.14t ha⁻¹, respectively. This however changed significantly after the variety was changed in the second season, with yields going up to 0.68 t ha⁻¹ for the TSPL treatment. From the study, it was concluded that there is potential for growing soybean in Uasin Gishu District of Kenya. However, a study and/or research is recommended to screen and identify a suitable variety for increased soybean yields in this District.

Keywords: *Declining soil fertility, soil acidity, liming, MPR, soybean yields*

Predicting phosphorus mineralization and maize yield in high P adsorption soils using plant quality indices.

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Abstract

Phosphorus has been found to be the most limiting nutrient for maize production on acid soils of sub-Saharan Africa, including high P-fixing soils of Rwanda. Using high rates of inorganic P fertilizers has been suggested as one of the strategies for managing high P-fixing soils, although it remains inaccessible to small scale farmers. The integration of inorganic and organic materials is an alternative option to improve P availability on these soils. Incubation and field studies were conducted with the objective of determining plant quality indices for predicting P mineralization and maize yield. Treatments compared were the control, limestone at 2.5 t ha⁻¹, TSP at 25 and 50 kg P ha⁻¹, leaf of *Calliandra*, *Tithonia* and *Tephrosia* each at 25 and 50 kg P ha⁻¹ respectively, *Calliandra*, *Tithonia* and *Tephrosia* each combined with TSP at equivalent rate of 25 and 50 kg P ha⁻¹ respectively. Application of *Tithonia* independently at high rate (50 kg P ha⁻¹) showed higher net P mineralization above 200 mg P kg⁻¹. Total plant phosphorus (TP), total plant carbon (TC), C: P and C: N ratios predicted P mineralization ranging from 64% to 84%. Total plant P showed the highest coefficient of regression. Plant quality indices such as TP, TC, N, C: N and C: P ratios predicted maize yields from 59% to 83%. These plant quality indices are the best tested predictors of P mineralization and maize yield, and therefore can efficiently be used to screen agroforestry species P sources.

Keywords: *Maize yields, plant quality indices and phosphorus mineralization*

Use of “Prep-Pac” Product to Improve Maize and Legume Yields, Legume Heights and Improved Farm Income in the Nutrients Depleted Soil of Western Kenya

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Abstract

Western Kenya region contains 40% of the country's population on only 15% of the country's land area, with population densities ranging from 500 to 1200 persons per km². This has resulted to reduced land sizes, continuous cropping with no addition of fertilizers due rising poverty levels, high rates of soil nutrients depletion and food insecurity. 'PREP-PAC' an integrated nutrient management package that targets the replenishment of 'lost' nutrients in the widespread low fertility patches, was felt to be a simple, effective and affordable package that can be adopted by resource poor farmers. PREP-PAC was tested on a small scale farm in Nyabeda, Siaya District western Kenya for three continuous seasons. The farm was characterized by low pH (5.35), low % carbon content (1.84), Olsen P (1.12 mg P/ka and low total nitrogen (0.27%) and classified as sandy clay loam (FAO classification). MBILI intercropping system involving seven legumes, intercropped with maize (*Zea mays*) was used. The treatments were arranged in a 7x2 factorial, in a randomized complete block design, each treatment replicated four times. PREP-PAC application significantly ($p < 0.01$) increased legume and maize grain yields. A significant increase ($p < 0.01$) in legume heights five weeks after planting was reported. Economic analysis indicated a significant ($p < 0.01$) increase improved farm income hence concluded that PREP-PAC can be utilized under MBILI intercropping system towards nutrient replenishment and food security in Western Kenya

Keywords: *Economic benefits, legume heights, maize and legume grain yields, MBILI intercropping system, PREP-PAC*

Responses of indigenous legumes species to mineral P application for soil fertility restoration in smallholder farming systems of Zimbabwe

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Abstract

Developing alternative soil fertility management options for resource-constrained farmers is vital for increasing food security in many parts of Africa where soils are constrained by nitrogen (N) and phosphorus (P) deficiency. This study investigated the population dynamics and P response of indigenous legumes as organic nutrient sources in smallholder farming systems of Zimbabwe. Single super phosphate (SSP) was broadcast and incorporated to 20 cm depth at 26 kg P ha⁻¹ before indigenous legume species mostly of the genera *Crotalaria*, *Indigofera* and *Tephrosia* were broadcast in mixtures on surface at 120 seeds m⁻² species⁻¹ on disturbed soil. The study was conducted in 2005/06 rainfall season under low (450-650 mm yr⁻¹) to high (>800 mm yr⁻¹) rainfall conditions. Application of P had no significant (P>0.05) effect on legume species composition and establishment patterns but positively increased biomass by 20-60%. Instead, P increased and influenced the biomass and composition of non-legume species. Abundance of *Richardia scabra* was reduced by 20-38% while that of *Cynodon dactylon* increased with SSP application, leading to a significant (P<0.05) increase in overall non-legume biomass. Indigenous legumes derived 61-90% of their N from the atmosphere with amounts fixed ranging from 5-120 kg N ha⁻¹ under semi-arid conditions to 78-267 kg N ha⁻¹ under high rainfall. N-fixation of indigenous legumes increased by 32% and 18% under low and high rainfall respectively. P application moderately increased biomass productivity but resulted in substantial increase in nitrogen fixation rates. Further research is required to quantify potential P benefits to subsequent cereal crops.

Keywords: *Biomass productivity, N₂-fixation, Indigenous legumes establishment, Phosphorus management, Species dynamics*

Extractable Bray-1 Phosphorus and Crop Yields as influenced by Addition of Manure Integrated with Phosphatic Fertilizers of Various Solubilities in an Acid Soil

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Abstract

Extractable soil phosphorus (P) varies with the solubility of phosphatic fertilizers. Extractable bray-1 P (B1P) and *Setaria anceps cv. kazungula* response to P in a treated acid soil were monitored. Soil treatments comprised; Triple super phosphate (TSP), Gafsa phosphate rock (GPR) or Christmas Island phosphate rock (CIPR) at 0 to 300 kg P ha⁻¹ with or without manure. Monitoring was done bimonthly for 14 months and experimental design was randomised complete block with three replications. Results indicated that extractable Bray-1 P (B1P) in decreasing order was; TSP>GPR>CIPR, consistent with their solubilities. An integration of manure and fertilizers resulted in much higher extractable B1P than sole fertilizers or manure. Over time, P availability decreased at a fast rate for the first six months and later was relatively constant. The DMY exhibited quadratic relationships with P rates. Maximum DMYs (6-11 t ha⁻¹) were attained at 150-200 kg P ha⁻¹ and declined above that rate. Average setaria dry matter yields (DMY) were not significantly different (6.1 to 6.6 t ha⁻¹). Yields per harvest increased to a maximum (11 t ha⁻¹) at 2-6 months and then declined to 2-4 t ha⁻¹ after one year. Cumulative yields (20 to 55 t ha⁻¹) were not significantly different for the various fertilizers. Manure-CIPR integration increased DMY but manure-GPR and manure-TSP depressed DMY. Yield depression was associated with high P causing nutrient imbalances in the soil. The study demonstrates the need for balanced fertilization, particularly in the use of high fertilizer levels as advocated in the Africa green revolution.

Keywords: *Manure, Phosphorus availability, Phosphatic fertilizers*

Soil Nutrients Transformations in a Tropical Oxisol: Effect of continuous land cultivation.

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Abstract

The long-term dynamics of emerging nitrogen (N) and phosphorus (P) constraints in degrading soil were investigated along a 100-year chronosequence in the agricultural highlands of western Kenya. Treatments included control (no P and N), N (0, 30, 60, 90 and 120 kg N ha⁻¹) and P (0, 25, 50, 75 and 100 kg P ha⁻¹). Mineral N, available P decreased, and P adsorption capacity increased with age since conversion. The long rain (LR) season control grain yield (GY) declined rapidly in the first 25 years of cultivation and then more gradually approached an equilibrium within a 60- to 100- year time period, at which point GY was only 16% of that of the young conversion GY (6.4 Mg ha⁻¹). Application of either N or P alone significantly increased GY in both the LR and short rain (SR) seasons. However, there was a much greater yield increment response to N and P when applied together (ranging from 1 Mg ha⁻¹ to 3.8 Mg ha⁻¹), with the greatest responses on the oldest conversions. N was more limiting than P on the old conversions. This study clearly indicates that in the LR season N and P productivity responses are significantly affected by age of conversion due to differences in ISF. Land productivity recovery strategies need to consider ISF in determining N and P input requirements, as well as the synergistic effects of N and P if climate rather than fertility limited productivity levels are to be sustained.

Keywords: *Nitrogen, Phosphorus, western Kenya, soil degradation, conversion age*

Effect of Phosphorus Sources and Rates on Sugarcane Yield and Quality in Kibos, Nyando Sugar Zone

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Abstract

One of the causes for declined sugarcane yields is low soil nutrient levels especially the most limiting ones, Nitrogen (N) and Phosphorus (P). This is further aggravated by inadequate or lack of nutrient replenishment. The study conducted at KESREF-Kibos, experimental field on a *Eutric Vertisol* evaluated the effect of four P sources, single super phosphate (SSP), triple super phosphate (TSP), diammonium phosphate (DAP) and rock phosphate (RP) and four P levels (0, 17, 34 and 52kg P ha⁻¹) on yield and quality of sugarcane varieties KEN 82-808 and CO 421. P sources significantly influenced yield of variety CO421 at second ratoon harvest the trend being DAP>RP>TSP>SSP. Effect of P sources on quality was not significant. Application of P increased population of millable stalk and yield compared with the control (0kg P ha⁻¹) in both KEN 82-808 and CO 421. Highest yield was recorded when P applied was 34kg P ha⁻¹ and lowest in control (0kg P ha⁻¹) the trend being 34>17>52>0kg P ha⁻¹. Effect of P rates on quality was not significant. It is concluded that fertilizer P sources can be applied to supply P. P plays a significant role on yield parameters than on quality parameters. The level 34kg P ha⁻¹ (80kg P₂O₅ ha⁻¹) is appropriate to maintain the crop to second ratoon harvest for increase yield.

Keywords: *Phosphorus, Rates, Sources, Sugarcane, Yield*

Complementary Nutrient Effects of Organic and Inorganic Fertilizers on Maize Production in the Smallholder Farms of Meru South District, Kenya

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Abstract

Low soil fertility is a major constraint to maize production in the smallholder farms of MeruSouth District. This is mainly attributed to the mining of nutrients due to cropping without external addition of adequate nutrients. Inorganic fertilizers are expensive hence unaffordable by most smallholder farmers. The use of organic matter to increase and maintain soil fertility is being considered as a solution to help the low-income smallholder farmers. A study was conducted in Mucwa location, Meru South District to determine the levels of complementarity between organic and inorganic amendments on maize yields. The experiment was set in a complete randomized block design (CRBD) with three replicates. The treatments were compared with the response obtained from control. The highest grain yields of 5.5 Mg ha⁻¹ and 4.2 Mg ha⁻¹ were realized from sole application of calliandra during the 2005 Short rains and 2006 Long rains cropping seasons. Results obtained indicated that the use of either organic or combined organic/inorganic N soil amendment appear to be superior to using inorganic amendment sources alone.

Keywords: *Maize, organic/inorganic soil amendments, soil fertility*

Soil Inorganic N dynamics and N uptake by maize following application of legumes, tithonia and manure and inorganic fertilizer in central Kenya

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Abstract

In the smallholder farms of central Kenya, the rate of soil nitrogen (N) loss is higher than the rate of replenishment resulting in N deficiency. Farmers lack financial resources to replenish N through application of chemical fertilizers. This study evaluated the contribution of some organic materials solely applied or combined with inorganic fertilizer to soil inorganic N and uptake of N by maize. The experiment was a randomized complete block with 3 replicates that was established in 2000. Soils and maize samples were taken at 2, 4, 6, 8, 12, 16 and 20 weeks after planting maize (WAP) and analysed for inorganic N and nitrogen content, respectively. The amounts of soil inorganic N at 0-15 cm soil depth and amounts of N taken up by maize varied among the different sampling dates, treatments and between the seasons. The treatments that had sole tithonia, leucaena and calliandra applied recorded the highest amounts of soil inorganic N especially in 2004 LR when rainfall was poor. During 2002 LR, when rainfall was fairly distributed, soil inorganic N increased from 0 to 4 WAP and generally reduced from 6 weeks up-to 20 WAP. The increase in soil inorganic N at the start of the season was attributed to nitrogen flush (Birch effect) and rapid decomposition of the organic materials while the reduction that followed was attributed to uptake of N by maize coupled with leaching. The amount of soil inorganic N was found to be generally higher during 2004 LR (when rainfall was poor) than 2002 LR probably due to the restricted uptake of N by the maize crop during 2004.

Keywords: *Organic materials, Soil inorganic N, Uptake of N by maize*

Effect of manure application on soil nitrogen availability to intercropped sorghum and cowpea at three sites in eastern Kenya.

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Abstract

A trial was conducted where sorghum and cowpea were intercropped at three sites with different natural concentrations of soil phosphorus (1.0, 7.0 and 26.3 mg kg⁻¹ Olsen-P) and with biannual cropping. There was a total of five field treatments namely goat manure applied at rates of 0, 5 and 10 t ha⁻¹ annually for six years, and at 5 and 10 t ha⁻¹ annually for four years followed by two years without manure. Continuous manuring at 10 t ha⁻¹ created the same amount of soil N as 5 t ha⁻¹ manure so the residual effects were the same for 5 and 10 t ha⁻¹ manure and the effects were the same at all sites. In the season studied, between 1.8 and 4.1% of the native soil N was mineralized and taken up by the crops. 11% of the manure residual N (applied between two and six years previously and remaining in the soil) was taken up and this fraction was the same in all soils. Recently applied manure N contributed significantly more to crop N in the most nutrient-deficient soil. On the soils with Olsen-P ≥ 7 mg kg⁻¹, cowpeas obtained a significant extra 32 kg N ha⁻¹, attributed to biological N fixation (BNF). If Olsen-P was < 6 mg kg⁻¹, BNF was negligible.

Keywords: *Intercropping, Manure, Nitrogen fixation, Phosphorus, Residual effect, Sorghum bicolor, Vigna unguiculata*

The Effects of Integration of Organic and Inorganic Sources of Nutrient on Maize Yield in Central Kenya

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Abstract

Low soil fertility is one of the major constraints to food production in the central highlands of Kenya. This phenomenon calls for intervention in order to fight food insecurity in this densely populated part of Kenya. Majority of the farmers use the old recommendations, which were general for central Kenya, while other meander in the maze of guessing depending on crop performance or availability of manures or fertilizers. To answer this noble call, an experiment was set up in two districts of Central Kenya; Kirinyaga (Mukanduini village) and Maragua (Kariti secondary school). The experiment was an RCBD design, which consisted of manure as single applications and manure in combination with varying and increasing rates of nitrogenous fertilizer and replicated three times. The results showed that application of manure alone at 5 t ha⁻¹ was not sufficient enough for high crop performance although higher yields above the control were reflected but on addition of nitrogen higher yields were obtained even at the lowest rates of 20 kg N ha⁻¹. Nitrogen response curves showed that application of Manure 5 t ha⁻¹ and N in form of calcium ammonium nitrate up to 40 N kg ha⁻¹ is gives yield increases but in excess of that yields decreased. This indicated that the best quantity of nitrogen to add to manure 5 t ha⁻¹ is 40 kg N ha⁻¹.

Keywords: *Maize yield, manure, N-fertilizer, N-response*

Nitrogen Use in Maize (*Zea Mays*) -Pigeonpea (*Cajanus cajans*) Intercrop in Semi- arid Conditions of Kenya

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Abstract

A field experiment was conducted at Jomo Kenyatta University of Agriculture and Technology between 2001 and 2002 to determine nitrogen use in maize-pigeonpea intercrop system. The experiment was laid out as a randomized complete block design replicated four times. Treatments included two pigeonpea maturity types; two long duration (erect and semi-erect) and one medium duration type intercropped with maize (Katumani) or sole crop. Data on plant total nitrogen uptake, litter fall, N fixed and soil mineral N were determined. Results showed that intercropping increased maize grain concentration compared to sole maize, indication of nutritional quality improvement. Long duration cultivars had the highest plant N uptake and contributed high amount of N through litter fall and biological fixation compared to medium duration. Soil mineral N increased over time, probably due to soil N mineralization or pigeonpea N contribution through litter fall decomposition which ranged from 3.9-7.6 t/ha. N contribution through the litter fall was beneficial to subsequent maize crop, in plots previous intercropped with pigeonpea compared with continuous maize cropping. This study showed that late maturing pigeonpeas may play an important role in low input maize production systems primarily through N cycling, (probably through capture of deep soil N pool and litter) and through biological nitrogen fixation and this improves maize yield and quality.

Keywords: *Nitrogen uptake, N fixation, maize, pigeonpea, intercropping, residual effect, soil mineral N*

Natural and antropic determinant of carbon and nitrogen stocks in soils in agro-ecosystems of Burkina Faso

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Abstract

Two land management effects on C and N supplies and their dynamics was carried out in order to define plots C and N stocks models for a more complex modelling multi agents system (MAS). For that purpose 112 farmers plots judiciously selected were sampled in horizons 0-10 and 10-20 cm and analyzed. Moreover 26 pedological profiles were described and 12 of them sampled along the whole profile for C, N analysis to estimate C and N stocks and dynamics for deeper layers. Results show that apparent density (D_a) is not significantly different in the two farming systems and cultivating does not affect this one. D_a is not affected by the various land uses. Moreover D_a in the two horizons 0-10 and 10-20 cm are significantly different. Fine elements content is not significantly different in the two farming systems. Soil is neither affected by the land uses, nor even by cultivating. On the other hand fine elements ratio varies significantly when moving from 0-10 cm horizon to the lower one 10-20cm. C and N stocks are mainly a function of fine elements content (clay + fine silt in %). Cultivating does not affect significantly stocks. The two farming systems show a significant difference of average stocks of C, N. These same stocks in the 0-10 cm horizon are higher than stocks of the 10-20 cm horizon. For all soil, all land uses confused, average C, N stocks for the 20 first centimetres respectively 14,12 t ha⁻¹ and 0,9 t ha⁻¹. The study suggests that management is the major determinant of C storage as well as soil texture (clay+ fine silt in %) and those act mainly on the first 10 centimetres soil. C and N contents and stocks beyond 20 cm are related to soil depth rather than land management.

Keywords: *carbon stock, soudano–guinean savanna, carbon sequestration, management mode, Burkina Faso.*

Effect of N and P Fertilization on Soyabean (Glycine Max (L) Merr) Growth in Acid Soil

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Abstract

Soybean (*Glycine max.* L. (Merr)) offers potential as a high protein substitute for human consumption and cash for smallholder farmers in sub Saharan Africa. Soil acidity and nutrient mining have been identified as the major constraints limiting crop production by smallholder farmers in SSA. A field trial was conducted over two seasons to determine the effect of rate of N and P fertilizer application on the growth of soybean under acid soil conditions. Four P rates (0, 7.5, 15 and 22.5 kg P ha⁻¹) were combined with two N application rates (0 and 30 kg N ha⁻¹) and 2 lime rates (0 and 1 500 kg ha⁻¹) on a sandy clay loam site previously under a grass fallow. Application of lime did not improve dry matter and grain yield ($p > 0.05$) of soybean. However, liming significantly ($p < 0.05$) improved nodule number and nodule dry matter yield (ave. 56% and 81%, respectively). Phosphorus enhanced nodule development, while N suppressed (ave. 65%) the development and growth of nodules. It was concluded that the acidic soil conditions and low P had no effect on the soybean growth, but were not favorable for biological nitrogen fixation.

Key words: *Biological nitrogen fixation, lime, soil acidity, soybean*

N₂ fixation and P uptake of soybean at two low-P soils of southern Cameroon

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Abstract

Genotypic differences in N₂ fixation and the efficient acquisition of phosphorus were evaluated among 12 soybean genotypes grown at two acid soils low in available P of southern Cameroon. Field assessments were carried out in 2001 and 2002 using three P sources: 0P kg P ha⁻¹, 90 kg P ha⁻¹ as phosphate rock (PR), and 30 kg P ha⁻¹ as triplesuperphosphate (TSP) and on a Typic Kandiudult (TK) and Rhodic Kandiudult (RK) soil. Shoot dry matter, nodule dry matter, ureide concentration, N₂ fixation, and P uptake were assessed at flowering and grain yield at the harvest maturity. Shoot dry matter, nodule dry matter, ureide concentration, N₂ fixation, P uptake and grain yield significantly varied with site and genotypes ($P < 0.05$). On TK soil, nodule dry matter ranged from 0.3 to 99.3 mg plant⁻¹ increased significantly with P application ($P < 0.05$). N₂ fixation measured using the ureide assay method ranged from 25.3 to 44.7 kg N ha⁻¹ on TK and from 18 to 38 kg N ha⁻¹ on RK soil. At low level of P availability, the grain yield of the soybean genotypes correlated significantly with shoot dry matter, and N₂ fixation, but loosely to nodule dry matter per plant. Two groups of soybean genotypes contrasting in N₂ fixation and P uptake at low available P soil were identified to further investigate the whole-plant mechanisms responsible for differences in P acquisition efficiency.

Keywords: *N₂ fixation; P-uptake; soybean.*

Effects of leguminous plant residues and NPK fertilizer application on the performance of yam (*Dioscorea rotundata* 'cv' ewuru) in south western Nigeria

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Abstract

The effects of cultivating and incorporating residues of previous *Pueraria phaseoloides* and *Glycine max*, with application of NPK fertilizer on performances of yam was evaluated at the Teaching and Research Farm, LAUTECH, Nigeria. There were nine treatments: incorporation of residues of the legumes (5 t DM ha⁻¹), application of the recommended NPK fertilizer rate for yam (90-50-75 kg NPK ha⁻¹) in the zone or 50% of the recommended rate (45-25-37.5 kg NPK ha⁻¹), alone and in combination with residues and a control without residues or fertilizer. The treatments were laid out as randomised complete block design replicated four times. Cultivation of previous legumes reduced soil nematode population (> 200%) compared with situation without legumes. Application of 50% of the recommended NPK rate with or without incorporation of residues slightly improved yam tuber yield. Fertilizer application enhanced Arbuscular mycorrhizal (AM) colonization of yam roots but, AM colonization was lower (about 50%) in plots where *Pueraria* residues was incorporated compared with other plots. Fertilizer application increased N concentration in yam leaves while P concentration was lowest in the control (0.152%) and highest in *Pueraria* residues+50% recommended NPK rate (0.21%) treatment. Combined application of plant residues with NPK fertilizer improved soil organic carbon, N, Ca, and Mg compared with application of NPK fertilizer. From these results, 50 percent of the recommended NPK rate for yam in the zone may be adequate and incorporation of residues with reduced NPK fertilizer application may be a sustainable soil fertility management option for continuous yam production.

Keywords: *Arbuscular mycorrhizal colonization, combined application of plant residues and mineral fertilizers, Dioscorea rotundata 'cv' ewuru, nematode population, southwestern Nigeria*

Influence of Agro-ecology on the Efficiency of Nitrogen Utilisation by Maize in Western Cameroon

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Abstract

Field trials were conducted for two seasons to study the efficiency of fertilizer nitrogen utilisation by maize and reduce the cost of maize fertilisation in two agro-ecological zones of Western Cameroon. Treatments consisted of five rates of nitrogen, 0, 30, 60, 90 and 120 kg ha⁻¹ as urea. Utilisation of applied N by maize for grain production was more efficient in the mid altitude zone than in the lowland area. Grain yield increase per unit of applied N was 6.2 kg in the lowland zone but could go as high as 30 kg in the mid altitude zone. Optimum fertilizer rates for maize production are 40 kg and 80 kg ha⁻¹ respectively for the two agro-ecologies. Factors such as soil texture, low organic C content, lower solar radiation and substantial sub-soil NO₃-N accumulation may be responsible for lower N requirement for maize production in the lowland forest zone and consequently have an impact on the value of applied N fertilizer. Significant poor residual effects were recorded in the mid altitude zone. Therefore a full dose of the optimum rate is obligatory for each maize crop in that zone.

Keywords: *Efficiency, maize, nitrogen, residual effect, Western Cameroon*

Enhancing productivity through the integration of grain legumes in maize cropping systems in Central Kenya

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Abstract

Declining land productivity is a major problem facing smallholder farmers in Kenya today. This decline results from a reduction in soil fertility caused by continuous cultivation without adequate addition of external inputs. Improved agronomic measures integrating grain legumes into maize cropping systems can enhance nutrient use efficiency and overall system's productivity. Trials were established in two sites in Central Kenya (Mukuuni and Machang'a) to evaluate contribution of various legumes (beans, cowpea and groundnut) and plant spacing to overall productivity of the intercropping system. The conventional spacing (a legume row alternating a cereal row) was compared to MBILI spacing (two legume rows alternating two cereal rows), both with and without P. In Mukuuni (more fertile) neither legumes nor maize responded to P application, legume yield was increased by on average 40% and maize yields more than doubled by P application in Machang'a. At Mukuuni, groundnut produced poorly (<500 kg/ha); beans yielded slightly but significantly better than the other legumes. At Machang'a, highest legume yields were obtained with cowpea. At both sites, legume yields tended to be higher when planted at the traditional spacing, irrespective of legume species or P application; though not consistently significant in all seasons. Contrarily, at Machang'a, maize yields were generally highest when planted using MBILI spacing, provided P was applied. Without P application, higher yields were observed for maize in the traditional spacing, but only when intercropped with beans. Maize yields were significantly higher with traditional spacing when intercropped with groundnut, while in MBILI spacing; highest yields were observed for maize intercropped with beans.

Keywords: *Grain legumes, intercropping, MBILI spacing, P fertilizer, traditional spacing*

Effects of mineral substances on chemical composition and dry matter production of organs of cassava (*Manihot esculenta*)

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Abstract

In order to determine nutritional values of organs of cassava (*Manihot esculenta*) in rural area, effects of minerals substances on chemical composition and production of dry matter were evaluated. Plant were submitted to 4 levels of fertilisers' enrichments [manure potassic (K), phosphatic (P), phosphatic and potassic (PK) and nitrogenized, phosphated and potassic (NPK)]. Water, nitrogen, potassium, phosphorus, sodium, total proteins and total lipids contents were determined in different organs (leaves, shoots and tubers). After a 9 months growing period, results showed that nutritive solutions enriched with K, PK and NPK, significantly increased the organic compounds contents of the leaves ($P < 0,05$). Furthermore, adding chemical fertilizers with high phosphorus content, significantly improved the lipids contents of the leaves (25%). Nutritive solutions enriched with NPK positively influenced the dry biomass produced in different organs of *Manihot esculenta*. Total proteins contents in the leaves and in the tubers produced in the medium enriched with NPK were higher (70 mg/g DM and 30 mg/g DM respectively) than those in the plants cultivated on the control media (17 mg/g DM and 9 mg/g DM respectively). The utilization of fertilizer in combination with NPK as a straightening manure would allow the improvement of the chemical composition and production of dry matter of the cassava in rural area.

Keywords: *Fertilizer, Manihot esculenta, nutritional value, rural area*

Nitrogen and carbon mineralization patterns of indigenous legumes as influenced by their chemical composition

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Abstract

Nitrogen-fixing indigenous legumes can be harnessed to enhance soil fertility replenishment of smallholder farms. However, nutrient release from such organic materials is largely determined by the chemical composition. A study was conducted to determine the chemical quality of indigenous legumes mainly of the genera *Tephrosia*, *Crotalaria* and *Indigofera*, and their C and N mineralization using a leaching tube method under laboratory conditions. All the legumes had >2% N. With the exception of *Macrotyloma daltonii*, all the legume species had a lignin content of >15%. Total polyphenols ranged from 1-2.5% for all the legume species. Despite the relatively high lignin content, most of the legume species mineralized >70% of the added N within 155 days of incubation. *Eriosema ellepticum*, *Crotalaria pallida* and *Tephrosia longipezi* had mineralized >40% of the added N within 21 days of incubation. Mixed biomass from indigenous legume fallows (indifallows) cumulatively mineralized 69% of the added N compared with 54 and 42% for biomass generated in natural fallows and sunnhemp (*Crotalaria juncea*. L) fallows, respectively. *Crotalaria cylindrostachys* immobilized N throughout the incubation period despite the relatively high N (2.3%) and low polyphenol (1.8%) content. Cumulative evolved CO₂ was correlated to the initial legume N content ($r^2=0.91$). The results apparently suggest that indigenous legumes can potentially contribute to the N requirements of crops in smallholder farming areas. However, the major challenge lies in regulating the N mineralization to enhance crop uptake, given that most of the legume species had mineralized >50% of the added N within a month.

Keywords: *Indigenous legumes, N mineralization, lignin, smallholder, quality*

The Effect of Organic Based Nutrient Management Strategies on Soil Nutrient Availability and Maize Performance in Njoro, Kenya

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Abstract

A field experiment based on the concept of organic nutrient management was conducted in Njoro, Kenya to test the effect of improved legume fallows; crotalaria (CR), lablab (LB) garden pea (GP) and natural fallow (NF, as control) on available soil N and P, and maize performance. The experimental design was a split plot fitted to a randomized complete block. The main plots were two cropping systems involving improved legume fallows and NF preceding (i) sole maize (M); NF-M, CR-M, LB-M and GP-M, and (ii) maize bean (M/B) intercrop; NF-M/B, CR-M/B, LB-M/B and GP-M/B. The sub-plots were two residue management types; residue incorporation and residue removal with manure (FYM) incorporated instead. Residue incorporation resulted into higher concentrations of N and P in soil than FYM in both cropping systems. Under sole maize, grain yield ($t\ ha^{-1}$) following LB (4.6) was significantly higher than after CR (3.5), GP (3.3) and NF (2.2). In the M/B intercrop, maize grain yield following LB (3.9) was significantly higher than after GP (2.4) and NF (2.8) with no significant differences in yields following CR (3.1) and LB (3.9). Maize dry matter (DM) yields followed a similar trend. Overall, maize grain and DM yields were higher in sole maize cropping system than in M/B intercrop but an additional $0.5-0.6\ kg\ ha^{-1}$ of bean grain yield was realized in the latter cropping system. The improved fallow legumes enhanced soil productivity, besides the harvested seeds providing supplementary protein sources, with resultant higher yields of the succeeding crop.

Keywords: *Improved legume fallow; maize; Njoro; nutrient availability; organic based nutrient management*

Influence of Conventional and 'Mbili' (Maize-Legume) Intercropping Systems on Yield, Nutrient Uptake and Rooting Characteristics of Intercrops in Western Kenya

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Abstract

Variations in rooting and nutrient uptake are envisaged from the complex nature of spatial arrangements of intercrops. This study was undertaken to enhance the understanding of 'MBILI' (Managing Beneficial Intercrops within Legume Intercrops) over conventional intercropping system in relation to yield, nutrient uptake and rooting characteristics of intercrops. On-farm experiments were carried out in Bungoma and Siaya Districts of Western Kenya in a 2×2×2 factorial arranged as a randomized complete block design with four replicates. Two intercrops, groundnuts/beans with maize were planted within 'MBILI'/conventional at two nutrient levels 0 and 150 kg DAP ha⁻¹ (27 kg N/ha; 30 kg P/ha). Yields, nutrient uptake and utilization of intercrops were measured while root sampling was done at legume flowering stage. Bungoma 2003 (long rains) had the highest groundnut yields, ranging from 430 to 893 kg ha⁻¹ for the 'MBILI' control and 'MBILI' fertilized plots, respectively. Maize yields were relatively high in Siaya 2003 (long rains) than in other sites and seasons with 'MBILI' at 27 kg N/ha; 30 kg P/ha (within maize/groundnut intercrop) giving the highest yields 4,218 kg ha⁻¹. The N and P uptake in the legume and maize grains in all sites were significantly ($p < 0.05$) affected by the nutrient level and row arrangement. Root density was higher and roots grew deeper in the 'MBILI' system than in the conventional system. Thus, roots in 'MBILI' system were able to access N at deeper layers and therefore reduce dependency on N₂ fixed leading to a greater overall resource capture.

Keywords: *Spatial arrangements yield, rooting characteristics.*

Interaction between Resource Quality, Aggregate Turnover, Carbon and Nitrogen Cycling in the Central Highlands of Kenya

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Abstract

Combined use of organic (OR) and mineral sources (MR) of nutrients is accepted as one of the most appropriate ways to address the problems of declining soil fertility and poor crop yields facing small-scale farming in sub-Saharan Africa. A field study was conducted at Embu in Central Kenya to investigate the effect of OR and MR management on aggregate turnover, C sequestration and N stabilization. The study comprised of ORs of differing quality; *Tithonia diversifolia* (high quality), *Calliandra calothyrsus* (medium quality), *Zea mays* stover (medium quality), *Grevillea* sawdust (low quality) and farmyard manure applied at a rate of 4 ton C ha⁻¹ with or without 120 kg N ha⁻¹ mineral fertilizer. Soil organic matter (SOM) fractions from soils sampled from the top soil (0-15cm depth) at the establishment of the field trial in 2002 and before the long rains in 2005 were analyzed for C, N and C-13 signatures. In 2005, SOM fractions C and N quantity was higher for both the sole and combined application of tithonia, calliandra, stover and manure compared to the initial (2002) total soil C and N. High quality ORs had the highest SOM input compared to low quality ORs while medium quality ORs contributed most to the formation of stable macroaggregates and SOM accumulation. Therefore, both OR quality and MR should be considered when devising soil management options for soil fertility and crop production.

Keywords: *Aggregate turnover, crop production, mineral N fertilizer, organic resource quality, soil organic matter*

Grain Legume Rotation Benefits to Maize in the Northern Guinea Savanna of Nigeria: Fixed-Nitrogen vs other Rotation Effects

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Abstract

The yield increases often recorded in maize following grain legumes have been attributed to fixed-N and 'other rotation' effects. These effects have not been quantified in the legume/cereal rotation system of the Sub-Saharan West Africa. Field trials were conducted between 2003 and 2005 to separate the effects on maize following grain legumes in the northern Guinea savanna of Nigeria. Maize was grown on plots previously cultivated with two genotypes each of soybean (TGx 1448-2E and SAMSOY-2) and cowpea (IT 96D-724 and SAMPEA-7), maize, and natural fallow. The plots were split into four N fertilizer rates (0, 30, 60 and 90 kg N ha⁻¹) in a split plot design. The total effect was calculated as the yield of maize following a legume minus the yield following maize, both without added N and the rotation effect was calculated as the difference between rotations at the highest N fertilizer rate. The legume genotypes fixed between 16 and 50 kg N ha⁻¹ of their total N and had an estimated net N balance ranging from -22 to 3 kg N ha⁻¹. On average, maize following legumes had higher grain yield of 1.2 and 1.3-fold compared with maize after fallow or maize after maize respectively. The results also indicated that the magnitude of the fixed-N and other rotation effects varied and were influenced by the contributions of the grain legumes to the soil N-balance. SAMPEA-7 had the lowest contribution to other rotation effects of 16% in 2004 while this increased to 45% in 2005.

Keywords: *N balance, N contribution, N₂-fixation, Northern Guinea Savanna, Rotation effects*

Use of Tithonia Biomass, Maize Residues and Inorganic Phosphate on Bean Yield and Soil Properties in Rwanda

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Abstract

Lack of adequate nutrient supplies both organic and inorganic sources are the principal constraints to bean production in Rwanda. Experiments on two sites in Rubona, Butare, Rwanda were conducted to assess the effect of *Tithonia diversifolia* biomass and maize residues applied alone or in combination with Triple Super phosphate on the yield of climbing bean (Var. G2331) and soil chemical properties. The combination of Tithonia and Maize residues produced more yield in 2 sites respectively of 3.3 t ha⁻¹ and 1.6 t ha⁻¹. The Tithonia addition has followed with 2.9 tons ha⁻¹ and 1.7 tons ha⁻¹. The above treatments have also improved the soil chemical properties except Bray 1 P. The combination of Tithonia and TSP has been good to solve the P problem and increased soil pH at 0.2 to 0.5 and reduced exchangeable aluminium toxicity. The high performances of Tithonia application on yield confirm its capacity to increase yields than inorganic fertilizers at equal N, P and K rates.

Keywords: *Acidic soils, Aluminium toxicity, decomposition*

Effects of Leguminous and Non Leguminous Hedges in Management and Productivity of Arable Steep Lands of the Central Highlands of Kenya

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Abstract

Moderate to steep landscapes and severe soil, water and nutrient losses characterize over 40% of arable land in the central highlands of Kenya. To study the effectiveness of biological methods in management and enhancement of productivity of these arable steep lands, we established contour double row hedges of sole calliandra, leucaena and napier and combination hedges of either calliandra or leucaena with napier. These hedges were established on slopes exceeding 5%, pruned regularly and the resulting biomass cut into fine pieces, which were then incorporated into the plots they served for a duration of 20 months. We observed significantly higher soil pH ($P = 0.013$), Ca ($P = 0.001$), Mg ($P = 0.042$) and C ($P = 0.032$) after 20 months of trial, relative to the initial conditions. The first season registered higher soil losses ($P = 0.004$) than the second season for hedge treatments and vice versa for the control. Twenty months old combination hedges of leguminous and napier improved soil fertility concurrently with soil conservation across all the slope categories examined. This was in contrast with other hedges which mainly had one of these benefits but not the two. We conclude that well spaced, managed and combined contour hedges of leguminous trees and napier have a potential for controlling soil and nutrient losses across a range of slope categories while simultaneously enhancing soil productivity.

Keywords: *Soil erosion, soil fertility, maize production*

The Effect of Farmyard Manure Amendment on Soil and Rice Production in the Office Du Niger Zone of Mali

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Abstract

From 2001 to 2004, a study was conducted in the "Office du Niger" zone of Mali to determine the combined effects of farmyard manure and N and P fertilizer applications in rice production system. Twenty five treatments were set-up in a factorial arrangement with 5 levels of manure (0, 1, 2, 3, and 4 tons manure per ha), 5 levels of nitrogen (0, 30, 60, 90, and 120 kg N per ha) and replicated 4 times. With a basal application of 2 tons of manure per ha, rice paddy yield reached a maximum of 6.5 tons when N was applied at increasing rate up to 90 kg N ha⁻¹. When organic manure was applied at a rate greater than 2 tons, rice paddy responded linearly up to 120 N and reached 7 to 7.8 tons per ha. Increasing rates of manure (1 to 4 tonnes per hectare) improved paddy yield but not the straw and the total biomass yields. Without manure, crop yields were levelled at 5.5 tons ha⁻¹ with increasing rates of N. The results indicated that, annual application of low quality organic resources such as the farmyard manure can significantly improve soil physical and chemical properties and rice paddy yields. The results also suggest that with application of 3 to 4 tons of manure, nitrogen fertilizer rate can be reduced by 40 kg N per hectare.

Keywords: *Mali, manure, nitrogen, Office du Niger, rice yield response*

Residue quality does not influence long-term C and N stabilization

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Abstract

To fully benefit from the Integrated Soil Fertility Management approach to combine organic and mineral inputs, the linkage between input quality and soil structural dynamics needs to be understood. Our objectives were 1) to determine how input quality and root growth control aggregation, and 2) to assess how these relationships influence C and N stabilization. We sampled two trials in Kenya located at Embu, a clay soil, and Machanga, a loamy sand. The trials were initiated in 2002 with different quality residue inputs (no input, high quality *Tithonia diversifolia*, medium quality *Calliandra calothyrsus*, and low quality maize stover), applied at a rate of 4 Mg C ha⁻¹ alone and in combination with 120 kg N ha⁻¹ mineral fertilizer. Maize was grown in the plots each season, and a section of the plots was left uncropped. Soil samples (0-15 cm) were collected in March 2005 to assess aggregation and C and N stabilization. Residue additions increased macroaggregation at Embu, and cropping increased aggregation at Machanga. At Embu adding organic residue, regardless of the quality, and cropping significantly increased total soil C and N. This increase was also observed in the macroaggregate and microaggregate-within-macroaggregate fractions. Input treatments had little effect on C and N concentrations at Machanga. Nitrogen fertilizer additions did not significantly alter C or N contents at either site. We conclude that residue quality does not effect the long-term stabilization of soil organic C and N, only increased residue quantities lead to a long-term stabilization.

Keywords: *aggregation, fertilizer, residue quality, roots, soil organic matter*

Contribution of cowpea, pigeonpea and greengram rotation to nitrogen requirement of maize on a Ferralsol in Tanga – Tanzania

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Abstract

A glasshouse incubation of soil from field experiment where cowpea, pigeonpea and greengram were grown in rotation with maize was carried out at Mlingano Agricultural Research Institute. The objective was to study the N mineralization of the soil and its potential to supply N to the maize crop following legumes rotation. The experiment comprised of eight treatments which included the three legumes in rotation with maize, with maize stover removed or retained on the plots and continuous maize with the stover removed or retained. The maize was grown during long rains and the legumes during short rain seasons. Soil sampling for the incubation was carried out before maize planting from treatment plots at 0- 20 cm depth and sieved through a 6mm screen while fresh, then 250g sub samples were incubated in 500ml wide mouth volumetric flasks at 60% field capacity for 42 days. Destructive samplings were done at 14-day intervals and analysed for mineral N. Much of the mineralization occurred between 0 – 14th day. Seventy one percent of the mineralized N was obtained during this period when maize plants N demand is low. It was concluded that although substantial quantities of N are released through mineralization in this cropping system, the released N is not in synchrony with maize plants demand. Supplementation with mineral N fertilizer applied as top dressing is therefore necessary.

Keywords: *Legume for increasing maize yields, residues, maize stover, nitrate leaching, nitrogen mineralization*

Residual Benefits of two Cowpea Genotypes and Natural Fallow to Subsequent Maize in the Northern Guinea Savanna of Nigeria

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Abstract

Increased yields of maize grown after cowpea than maize has been attributed to enhanced N-availability and other rotation effects. Improvement in soil chemical properties has been indicated to be one of the most important rotation effects. Soil properties and grain yield were evaluated where different crop rotations were used. Two promiscuous improved cowpea lines (IT 96D-724 and SAMPEA-7), natural fallow and a hybrid maize (Oba Super 2) grown in 2003 were followed by a test crop of maize in 2004 with and without nitrogen (N) fertilizer (0 and 90 kg N ha⁻¹). Rotation and N fertilizer had significant ($P < 0.05$) influence on the organic carbon and total N contents and unfertilized continuous maize resulted in the lowest values. Soil total N of maize plot following SAMPEA-7 was slightly higher (0.920 g kg⁻¹) than that following IT 96D-724 (0.870 g kg⁻¹). Cropping systems had no significant ($P > 0.05$) effect on soil pH, while the main effect of fertilizer on exchangeable cations was highly significant with rotation systems involving cowpea having lower values than continuous maize. Fertilization significantly affected exchangeable Ca and K concentrations only. The average increase of both cowpea cultivars were 50% higher than that of maize-maize and 22% higher than that of the fallow-maize system. Lack of interaction between rotation and fertilizer N effects indicates that the changes in the soil properties may explain the yield difference between cowpea rotations and continuous maize. The study showed that crop rotation increases maize yield even in the absence of inorganic fertilizer.

Keywords: *Crop rotation, exchangeable bases, organic carbon, soil pH, total nitrogen*

Seedbed types and Integrated Nutrient Management Options for Cowpea Production in the Southern Rangelands of Semi-Arid Eastern Kenya

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Abstract

The Southern Rangelands of Kenya are difficult environments prone to frequent droughts. The effect of the flat (farmer practice), tied-ridging and contour furrows seedbed types and integrated nutrient management practices on the performance of rainfed cowpeas was studied on-farm at the southern rangelands of Kenya during the 2006 short rains season. The treatments without fertilizer in combination with the flat seedbed had significantly higher number of pods than the tied-ridging and contour furrows seedbed types. The tied-ridging seedbed produced the highest number of branches while the flat and contour furrow seedbeds produced the highest pods and grain yields. The tied-ridging in combination with 10t ha⁻¹ manure produced significantly higher number of pods, branches, pods and grain yields than both flat and contour furrows seedbeds. Under the 10t ha⁻¹ farmyard manure + 20kg N ha⁻¹ + 20kg P ha⁻¹ soil fertility option the flat seedbed produced the highest number of pods and the contour furrows the highest number of branches, pods and grains yields. The flat, tied-ridging and contour furrows seedbeds in combination with 5t/ha manure produced the highest number of pods, pod and grain yields while the contour furrows produced the highest number of branches. Under 5t ha⁻¹ manure + 20kg N ha⁻¹ + 20kg P ha⁻¹ the flat seedbed produced the highest pod and grain yields. The tied-ridging seedbed in combination with farmyard manure enhanced cowpea performance and grain yield even though performance was best under the flat seedbed on incorporation of inorganic fertilizers to manure.

Keywords: *Cowpeas, drought, integrated nutrient management, seedbed types, soil fertility*

Effect of soil acidity on nodulation and yield of selected soybean cultivars commonly grown in southern Africa

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Abstract

The inclusion of soybean (*Glycine max. (Merr)*) in the cropping systems of smallholder farmers in sub Saharan Africa (SSA) can improve soil N status and the diet of most households which have been affected by the HIV/AIDS pandemic. The selection of soybean cultivars tolerant to soil acidity can sustain productivity in the smallholder areas where most soils are acid is and lime is not readily available. A 2-season study was conducted to assess the tolerance of selected soybean cultivars to soil acidity (pH = 4.6) under field conditions. A split plot design with lime as the main factor and soybean cultivar as sub factor was used with 4 replications. Safari and Magoye showed highest tolerance to acidity in terms of nodule number and weight in the first season. Grain yield in acid soil was similar across cultivars implying that the varieties whose nodulation was affected by acidity later recovered possibly due to N mineralization from the soil. Liming significantly ($p < 0.05$) increased grain yield of Safari (ave. 18.2%) and Magoye (ave. 23.2%). It was concluded nodulation was sensitive to soil acidity and any tolerance mechanism of soybean would involve this stage of plant growth. In low N and acid soils typical of smallholder areas of Zimbabwe, where N fixation is critical in the supply of plant N, selection of relatively acid tolerant cultivars such as Safari and Magoye would ensure economical grain production.

Keywords: *Cultivars, lime, soil acidity tolerance, soybean,*

Genetic Diversity of *Bradyrhizobia* Nodulating Promiscuous Soybean Varieties in Soils amended with Phosphorus and Lime in Two Contrasting Sites in Kenya

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Abstract

Research was carried out to determine genetic diversity of indigenous *Bradyrhizobia* strains nodulating seven introduced promiscuous soybean varieties grown in two sites differing in rainfall and soil chemical characteristics in Kenya. Genetic diversity was assayed using the Polymerase Chain Reaction-Restriction Fragment Length Polymorphism (PCR-RFLP) markers by amplifying the 16S-23S rDNA intergenic spacer (IGS) region. The differences in fingerprints served as the basis of grouping the strains into IGS groups. Results indicated that strains nodulating promiscuous soybean varieties in Kenya can be grouped in 18 different polymorphic intergenic spacer groups. The three most predominant IGS groups were I, III, II, IV and VI which constituted 43.4%, 24.2%, 8.4%, 7.7% and 7.3% respectively of all the analyzed nodules from the two sites while IGS group VII, IX, X, XI, XII, XIV, XVI, XVII, XVIII constituted less than 1%. The polymorphism identified in *Bradyrhizobia* populations from the two sites represent a valuable genetic resource that has potential utility in the selection of more competitive strains for use in inoculants.

Keywords: *Agro-ecological zone, Bradyrhizobia, promiscuous soybean, PCR-RFLP*

In-vitro selection of soybean accessions for germination induction and reduced attachment of *Striga hermonthica* (Del.) Benth on associated maize

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Abstract

Production of maize in Western Kenya is adversely affected by *Striga hermonthica*. Integrating of legumes as intercrops is one of the ways of reducing density of *S. hermonthica* in soil and improving the livelihood of subsistence farming communities. Legume species and varieties however vary in their ability to stimulate suicidal germination of *S. hermonthica* seeds of same or different populations. A study was conducted to select soybean (*Glycine max*) accessions with ability to stimulate germination of *S. hermonthica* seeds from Western Kenya. The cut-root technique was used to screen 32 soybean accessions with *Desmodium*, *Mucuna* and maize varieties Nyamula, KSTP92, and WH502 as checks. Fourteen soybean accessions (selected from through the cut-root experiment), *Desmodium* and *Mucuna* were grown in association with maize variety WH502 in pots inoculated with *Striga* seeds. There was a significant variation among soybean accessions in inducing germination of *Striga*. The relative germination of *Striga* seeds by soybean accessions ranged from 8% to 66% compared to 70% for synthetic germination stimulant Nijmegen 1[®]. Accessions TGX1448-2E, TGX1740-2F, Tgm1576, TGX1876-4E, TGX1831-32E, TGX 1871-12E, Tgm944, Tgm1419, Tgm1039 and Namsoy4m had the highest relative germination percentage. Most accessions that stimulated high germination of *Striga* seeds increased the *Striga* attachment by 6% to 95%. There was a negative correlation ($R=0.7$) between maize shoot dry weight and intercrop shoot dry weight. Accessions TGX1831-32E, Tgm944, Tgm1419 and Namsoy4m had high stimulation but low attachment hence making them potentially important trap crops.

Keywords: *Maize, soybean, Striga hermonthica, suicidal germination*

Assessment of Soil Management Practices In East African Highland Cooking Banana (*Musa Spp.* AAA-EA) Systems in Uganda

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Abstract

Banana is the most important food crop in Uganda. However, there has been a decline in production, attributed to declining soil fertility, drought, pests and diseases and crop management factors. This study tries to quantify the contribution of these factors to yield loss in order to identify opportunities to improve production. The on-farm study was carried out in 179 plots in central, south, southwest and east Uganda. About half were 'demonstration' plots from a USAID-funded project, while the rest were 'control' plots, representing farmer practices. Control plots received manure (48% of the plots) and mulch (22 %) applications, whereas demonstration plots received manure (46%), mulch (64%) and inorganic fertilizer (100%, with N, P, K averaging 52, 5, 59 kg ha⁻¹yr⁻¹). Weevil corm damage and nematode-induced root necrosis was slight and averaged 3% and 8% respectively for both plots types. Demonstration plots had higher yields (47%) compared to control plots. The increase ranged from 12.3 (Mpigi, central) to 4.3 t ha⁻¹yr⁻¹ (Luwero, central). Farm gate bunch prices declined from 0.17 to 0.07 USD kg⁻¹, when moving from central Uganda to southwest Uganda. Minimum yield increase to off-set increased costs of the demonstration plots (i.e. fertilizer, mulch) ranged from 1.4 (Mukono, central) to 4.7 t ha⁻¹yr⁻¹ (Bushenyi, south-west). Benefit cost ratio of the demo plot technologies ranged from 8.0 (Wakiso, central) to 1.1 (Bushenyi). The study concludes that there is scope for increased input use in banana systems in Uganda, but that regional variations in crop response and input/output prices have to be taken into account.

Keywords: *Highland bananas, nutrient inputs, mulch, market price fluctuations*

The potential of *Ipomoea stenosiphon* as a soil fertility ameliorant in the semi-arid tropics

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Abstract

There is potential for smallholder farmers in Zimbabwe to use locally available plant resources to improve soil fertility and crop production. The challenge is to identify species with high nutrient concentrations and large amounts of above ground biomass. Such a potential species is *Ipomoea stenosiphon* (Hall) A. Meeuse, a plant species indigenous to Zimbabwe, Malawi, Mozambique and Zambia, and is currently being used by farmers in Zimbabwe. The aim of this study was to determine its productivity and variation in shoot nutrient concentrations on different soil types, its N mineralization potential and effect on maize productivity. *I. stenosiphon* grown on clayey soils had significantly higher shoot macro-nutrient concentrations than when grown on sandy soils (N: 43 vs. 11 g N kg⁻¹ soil, P 4.6 vs. 2.5 g kg⁻¹ soil, K 4 vs. 1.5%). Laboratory incubation of *I. stenosiphon* shoot biomass showed greater (P<0.05) N mineralization than many other agroforestry species although it was inferior to *Leucaena leucocephala* and *Acacia angustissima* because of their higher N content of 3.2% and 3.03% respectively, compared to 2.3% for *I. stenosiphon*. Field evaluation as an organic nutrient source in semi-arid areas of Zimbabwe showed an increase in maize grain yields of 111% and 161% at two study sites after applying *I. stenosiphon* biomass at 75 kg N ha⁻¹. These yields showed an average N fertilizer (ammonium nitrate) equivalency of 83%. The study showed the high capacity for acquisition of soil nutrients in *I. stenosiphon* biomass, with corresponding high levels of mineralization and crop production.

Keywords: *Biomass transfer, fertiliser equivalence, Ipomoea stenosiphon, nitrogen mineralization.*

Innovations in Cassava Production for Food Security and Forest Conservation in Western Côte D'ivoire

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Abstract

To support food security and reduce human pressure over the Taï National Park, Côte d'Ivoire, we introduced two improved cassava varieties, innovative farming techniques and processing technologies at the western fringe of the park in 2004. The strategy was to: i) increase cassava productivity on reduced surfaces; ii) limit conflicts for access to arable land; iii) increase the added value of cassava; iv) and form a new generation of producers. After the multiplication of introduced germplasm using mini-cuttings technique with three groups of producers, communal fields were established thanks to multiple stem harvestings. After these two community-based multiplication steps, farmers transferred the improved varieties to their individual fields and average yield was estimated at 20 t/ha. The experience resulted in a massive and rapid distribution of improved varieties in the Taï region. Indeed, trained farmers were hired by neighbouring villages to replicate the experience, without any incentive, and two years later, more than a dozen of villages planted improved varieties. Parallel to this, two women were trained in "attieke" production and entrusted with transferring this skill to peers. "Attieke", cassava semolina obtained after fermentation is a widely consumed and commercialised food in Côte d'Ivoire. This training was particularly relevant for Taï, where "attieke" is often not available because of poor production standards. The induced diversified source of income may reduce poaching and land-use conflicts, but this remains to be evaluated in a sound fashion.

Keywords: *Cassava, farming innovations, food security, improved varieties, Côte d'Ivoire*

Integrated Soil Fertility Management Involving Promiscuous Dual-purpose Soybean and Upland NERICA Enhanced Rice Productivity in the Savannas

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Abstract

Use of integrated soil fertility management (ISFM) involving an appropriate dual-purpose, nitrogen-fixing grain legume, limited chemical fertilizer, and resilient rice variety may restore soil fertility and enhance rice productivity in fragile upland rice ecosystems. A two-year on-farm study was carried out at Egline in the southern (SGS) and Oake in the northern Guinea savannas (NGS) of Benin Republic to evaluate the contribution of dual-purpose soybean varieties (*Glycine max*) to grain yield of upland NERICA rice fertilized with low N level. In 2005, four dual-purpose, promiscuous soybean varieties (cv. TGX 1440-1E; TGX 1448-2E; TGX 1019-2EB; and TGX 1844-18E), a popular improved soybean variety (cv. Jupiter) and local rice (control) were sown in 10 farmers' fields. In 2006, drought-tolerant upland interspecific rice (NERICA 1) was sown in all the plots and received only 15 kg N ha⁻¹. Soybean grain yield and grain N uptake were similar in both savannas, but nodule production, shoot dry matter and shoot-N were higher by at least 40% in NGS than in SGS. Soybean cv. TGX 1440-1E (late-maturing) ranked the highest in nodule number, dry matter, and shoot- and grain-N accumulation in NGS, while TGX 1448-2E (medium-maturing) was superior to other varieties in the NGS. Grain yield of NERICA 1 rice following one-year rotation with soybean cv. TGX 1440-1E was 150% greater than yield obtained from farmer's control of two-year continuous rice cropping without nitrogen. Results indicate that integrating an appropriate dual-purpose soybean in an ISFM package can enhance rice productivity in resource limited smallholder production systems.

Keywords: *Crop rotation; ISFM; NERICA rice; Promiscuous soybean; Savannas*

Effect of Al toxicity and liming acid soils on the growth of selected maize cultivars grown on sandy soils in Southern Africa

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Abstract

The majority of smallholder farmers who cultivate acidic soils in sub Saharan Africa (SSA) have limited or no access to lime. Differential tolerance to acidity by crop species can be exploited to sustain crop production without liming where production would be uneconomic. A study was conducted under greenhouse (nutrient solutions) and field conditions (Domboshawa Training Centre and Chendambuya smallholder area, Zimbabwe) from August 2002 to June 2004 to evaluate the effects of soil acidity on the growth of eight maize cultivars commonly grown in Southern Africa. There were significant ($p < 0.001$) cultivar tolerance by Al toxicity in terms of total root length (TRL), relative root length (RRE), and shoot and root dry matter weight. In terms of Al tolerance indices (ATI), cultivars DK 8031 and SC517 were the most and least tolerant varieties, respectively. Liming significantly increased grain and stover yield at one of the three sites in all cultivars except PAN 413. At the other two sites, liming depressed grain and stover yield in both seasons. It was concluded root growth parameters can be used screen maize cultivars commonly grown in Southern Africa for tolerance to soil acidity. Response of maize to liming seems to depend on exchangeable soil Ca-to-Mg ratio with positive with positive responses being recorded where the ratio is low, i.e. low Ca content. More studies are required to determine thresholds limits where Ca fertilisation is necessary.

Keywords: *Ca-to-Mg ratio, maize, soil acidity tolerance, cultivar*

An African Green Revolution requires a secure source of Phosphorus: Alternative sources and improved management options of P

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Abstract

An African green revolution cannot succeed without a secured supply of mineral fertilizers. This is particularly true of phosphorus, one of the key essential macronutrients. In most tropical soils, P is one of the main limiting plant nutrients and its deficiency is a major constraint for better crop production. This is mainly attributable to: (i) the low total P content in soil, (ii) the relative unavailability of inherent soil P for plant uptake, and lastly, (iii) the relative speed at which applied soluble sources of P such as inorganic P fertilizers and manures become fixed or changed to unavailable forms. It is clear that mining P minerals and spreading P fertilizers over the landscape is not sustainable in the long run. Cultural practices which can secure P sources and which conserve P should be made use of. Some of the measures necessary to adequately address the P problem can be listed as nutrient cycling through the recycling of crop residues, green manures, animal manures, domestic and industrial wastes, the integration into the cropping system of P-mobilizing plant species which show the ability to improve P uptake even from less labile P forms and store P in the aboveground biomass even in excess of their needs, and, biological means making use of mycorrhiza to help extract fixed P from deep soils under low pH conditions. African Green Revolution must put a lot of emphasis on integrated soil fertility management (ISFM), which combines the use of plant residues and inorganic P fertilizers exploiting their high potential for increasing crop production and ensuring sustainability. Increased production and productivity should never be based on addressing the constraints surrounding inorganic (mineral) fertilizers alone.

Keywords: *Integrated soil fertility management (ISFM), Phosphorus, P-mobilizing*

Use of phosphate rocks to alleviate phosphorus deficiency

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Abstract

Research in Australia has added to our understanding of the role that phosphate rocks (PRs) may play in managing phosphorus deficiency. This understanding indicates that a range of interacting factors determine whether a particular PR will be an agronomically-effective P source, compared with traditional water soluble P fertilizer, in a specific farming system. The factors include the nature of the PR itself, together with climate, soil, plant and management considerations. The key issue is whether the rate of P release from the dissolving PR particle is sufficient to enable the food plants to take up the dissolved P fast enough to grow satisfactorily in the P-deficient soil, and produce adequate yields. Assessing this suite of interacting factors, along with economic and supply chain issues, is necessary to determine how effective a locally-available PR might be in the farming system.

Keywords: *Agronomic efficiency, Farming systems, Phosphate rocks*

Effect of long term application of organic and inorganic resources on soil properties and maize yield at Kabete, Kenya

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Abstract

An experiment was established during the short rain season 1999 to assess the fertilizer equivalencies of organic and inorganic nutrient sources. Three organic resources, *Tithonia diversifolia* (tithonia), *Calliandra calothyrsus* (calliandra) and *Senna spectabilis* (senna) were applied singly or in combination with inorganic fertilizer in the form of urea to supply an equivalent of 60 kg N ha⁻¹. The above treatments were compared to an N fertilizer response curve involving application of urea at the rate of 0, 30, 60 and 100 kg N ha⁻¹. Results from this trial consistently showed higher maize grain yields in the treatments receiving combinations of organic and inorganic nutrient sources compared to the sole and control treatments. On average, Tithonia plus 30 kg N ha⁻¹ gave the highest grain and biomass yields. This trend could be attributed to improved synchrony in nutrient release and uptake by the crop. The organic resource gave a fertilizer equivalency of 130, 72 and 68% for tithonia, calliandra and senna respectively. Analysis on whole soil showed minimal changes in the whole soil carbon and nitrogen. However, higher proportions of C and N were observed in the aggregate size fractions. An analysis on the carbon-13 signature of the soil fractions testified that the application of the C3 organic resources was responsible for this shift in the SOM composition observed in at site.

Keywords: *Carbon-13, fertilizer equivalency, soil organic matter*

Rotational effects of cowpea genotypes and P fertilization on the yield of sorghum on P-deficient soils of Sudan and Sahel savannas of West Africa.

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Abstract

Adoption of cereal/legume rotation is a sustainable strategy for increasing cereal yields and improving soil fertility by subsistence farmers in West Africa, but little progress has been made on how different crop varieties and previous P fertilization will influence such a system. Field experiments were established at Minjibir (Sudan savanna, Nigeria) and Toumnia (Sahel savanna, Niger Republic) to assess the effects of cultivation of fifteen cowpea genotypes to which rock phosphate (RP) and SSP fertilizers were previously applied, on subsequent sorghum. Phosphorus fertilizers, (0, 90 kg P ha⁻¹ as RP and 30 kg P ha⁻¹ as SSP) were the main factors and cowpea genotypes were the sub factors arranged in a randomized strip plot design replicated three times. Grain yields of rotation sorghum were significantly higher than those of continuous sorghum. Cowpea genotypes exhibited variations in their effects on grain yields of subsequent sorghum. For example, at Minjibir mean grain yield of rotation sorghum with cowpea IT 98K-476-8 (2843 kg ha⁻¹) was 54% higher than that of continuous sorghum (1295 kg ha⁻¹). Previously applied P fertilizers significantly affected grain yield of sorghum in the order SSP > RP > 0P; this effect was more pronounced at Toumnia than Minjibir. Soil available P varied with cowpea genotypes and P fertilizer application and it was highest in plots that received RP, followed by SSP and least under 0P treatment. Generally, AMF colonization of roots of rotation sorghum was higher than that of continuous sorghum.

Keywords: *Cowpea/sorghum rotation, P fertilization, grain yield, Arbuscular Mycorrhizal Fungi (AMF), Sudan and Sahel savanna*

Evaluation of shoot and root traits for identifying P-use efficient soybean genotypes

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Abstract

Soybean production and utilization have increased tremendously in Nigeria over the last 20 years due to the adoption of new varieties that have superior agronomic traits compared to traditional genotypes. The soils for soybean production are inherently low in available-P and grain yield returns to external P application are generally low. To overcome P deficiency and its effect on crop productivity, the planting of varieties that are more efficient at acquiring P from low and sparingly soluble soil-P pools has been proposed. Field trials were conducted at Mokwa and Shika in the Nigerian savanna in 2004 and 2005 with eight soybean genotypes, previously selected for high grain yields. The purpose of the trials was to examine the variation in traits for P uptake and incorporation efficiency of the soybean genotypes under different P regimes (0, 20, 40, and 60 kg ha⁻¹). At Ibadan, greenhouse pot experiment was conducted in 2005, with P applied as 0, 25, and 50 mg P kg⁻¹ soil, to examine the variations in root-based P uptake efficiency traits in these genotypes. Significant P and genotype effects were recorded for grain yield and total P in grain at both locations in both years. Phosphorus incorporation efficiency was significantly influenced by P rate, genotype, and plant phenological growth stage at both locations in both years. Application of P to greenhouse-grown soybean genotypes influenced root length significantly. The study revealed that soybean genotypes may use different shoot and root traits for enhanced P-use efficiency in tropical soils.

Keywords: *Nigerian savanna; P use efficiency traits; Soil P availability; Soybean*

Diagnosis of Soil and Plant Nutrient Constraints in Smallscale Groundnut (*Arachis Hyopeae*) Production Systems of Western Kenya Using Infrared Spectroscopy

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Abstract

Soil fertility is a major biophysical problem that has led to problems of food insecurity, ecosystem degradation and poverty. Nutrient depletion and groundnut rosette epidemics have attributed to a decline in groundnut yields by 25% in the past decade in SSA. One of the major constraints to properly assessing current status, trends and processes of soil nutrient is the high level of costs involved when using conventional soil analytical methods. Previous studies have demonstrated that infrared spectroscopy may permit rapid and cost effective analysis of tropical soils that could provide new opportunities for farmers to diagnose and manage soil/plant constraints. An integrated management approaches that link diagnosis of nutrient deficiencies and crop diseases epidemics using infrared spectroscopy is quite important since, small-scale farmers have abandoned conventional methods all together and work on trial and error methods. This has led to escalating levels of inappropriate nutrient management strategies and options in small-scale groundnut production systems, exacerbating food insecurity. This study tested the potential of infrared spectroscopy for predicting and mapping soil/plant nutrient constraints in the small-scale groundnut production systems of western Kenya. Stable calibration models were developed for several key soil properties in the near and mid infrared spectral regions. Principle component (PCA) was used to assess the influence of soil properties and derive soil fertility indicators (SFIs) that were developed from principle component scores. Significant correlations were observed between the Soil organic carbon and SFI 1. The soil fertility indicators was successfully calibrated to soil reflectance measured in the laboratory with cross validated R^2 values of 0.89 and 0.79 for mid and near infrared respectively which permitted developing of soil fertility scores for assessing soil fertility status.

Keywords: *Arachis Hyopea*, groundnut yield, infrared spectroscopy, soil fertility indicators

Variation in Agronomic Attributes between Old and Modern Mexican Hybrids of Maize in Water and Nitrogen Unfavorable Environments

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Abstract

Field worked was conducted to study the response of modern (MH) and old (OH) hybrids, and a variety of landraces (L) under irrigation (I) and drought (D) conditions with two levels of nitrogen (160 kg N ha⁻¹ and 80 kg N ha⁻¹). Drought decreased grain yield (GY), final biomass (FBM), grains per ear row (GPER) and individual grain weight (IGW) by 24%, 18%, 7% and 6% and plant height (PH), and length (CL) and diameter of cob (CD) by 51 cm and 0.5 and 0.2 cm respectively. Low nitrogen reduced FBM by 6% and PH by 11 cm, silking date and anthesis – silking interval were delayed by two days (24 °Cd) under drought. MH had greater GY than OH and L in average of drought and nitrogen treatments. GY ($r = 0.07, P < 0.05$) and FBM ($r = 0.68, P < 0.05$) were positive and significantly correlated with year of hybrid release in average of drought and nitrogen treatments, and genotypes (excluding L genetic materials); a gain of 57 kg ha⁻¹ for grain yield and 128 kg ha⁻¹ year⁻¹ for biomass was determined. On the other hand, anthesis – silking interval was negative and significantly associated with year of hybrid release ($r = -0.76, P < 0.05$). This study reveals that greater biomass and a shorter anthesis – silking interval may be the key issues to improve grain yield of maize for water and nitrogen limited environments.

Keywords: *Drought, genetic variation, hybrid, silking*

Within-farm variability in soil fertility management in smallholder farms of Kirege location, Central Highlands of Kenya

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Abstract

Smallholder farms in Central Highlands of Kenya exhibits a high degree of heterogeneity, determined by complex set of socio-economic and biophysical factors. The farms consist of multiple plots managed differently in terms of allocation of crops, nutrient inputs and labour resources; making within-farm soil fertility gradients caused by management strategies a common feature. In most cases nutrient inputs are preferentially allocated to home fields whilst outfields are neglected. A monitoring study involving nutrient inputs, flows and balances was conducted in Kirege Location, where 9 case study farms were used. The study was to compare the intensity of soil fertility management between home fields and outfields. It also compared soil fertility management practices between three different resources endowment classes to reveal important differences in patterns of fertility management. The farms were visited to record movement of nutrients-containing materials using a monitoring protocol covering household, crops, livestock, soil and socio-economic aspects of the farm. Data obtained was analyzed using IMPACT program version 2.0 to obtain total nutrient inputs and balances at field and farm levels and statistical analysis done using GenStat discovery edition 2. Results revealed that mean N inputs over all resource endowment classes decreased with distance to the homestead (from 94 to 22.9 kg_{ha}⁻¹), as did Olsen-P (from 54.6 to 15.6 kg_{ha}⁻¹) and K (from 193 to 34 kg_{ha}⁻¹). Due to this heterogeneity in smallholder farms, there is a need for a more targeted approach to soil fertility intervention that differentiates between farm fields, agro-ecological zone and resource endowment status.

Keywords: *Nutrient inputs; soil fertility gradients; home fields; outfields; heterogeneity*

Interactive effects of different nutrient resources and soil moisture on the growth of maize (*Zea mays* L.) in a semi-arid area in Zimbabwe

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Abstract

A two-year (2005/6 and 2006/7) study was conducted in semi-arid central Zimbabwe to determine the effect of combining selected nutrient resources with moisture conservation on maize (*Zea mays* L.) growth. The nutrient resources were: 240 kg ha⁻¹ PKS fertiliser; 18 t ha⁻¹ manure; 10 t ha⁻¹ manure + 240 kg ha⁻¹ (14% P 13% K 5% S) fertiliser; 35 t ha⁻¹ leaf litter; 52 t ha⁻¹ anthill soil; and a 0 kg ha⁻¹ control. Mineral N was applied to fertiliser only and fertiliser + manure treatments at 60 kg ha⁻¹. A split-plot design was used with nutrient resource as the main plot and tillage practice as the subplot, and five farmers' fields were used as replicates. In 2005/6 addition of different nutrient resources under conventional tillage increased grain yield (12.5% m.c.) by 102-450 %. Grain yield was lowest in the control (551 kg ha⁻¹) and highest in the manure plus fertiliser treatment (3032 kg ha⁻¹). For each treatment, introduction of tied ridging further increased grain yield by 27% (fertiliser only) to 96% (leaf litter) indicating the importance of integrating nutrient and water management in semi-arid areas where moisture stress is frequent. In the tied ridging treatment in 2005/6, yield was lowest in the control treatment (997 kg ha⁻¹) and highest in the manure plus fertiliser treatment (4167 kg ha⁻¹). Similar trends were recorded in 2006/7. Farmers can effectively optimise maize yields by practising moisture conservation practices for which simple tools and modest labour resources are required as additional inputs.

Keywords: *Moisture conservation; nutrient resource; post-emergence tied ridges, conventional tillage*

Performance of Improved Cowpea Varieties in the ASALs of Eastern Kenya under Integrated Soil Fertility Management

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Abstract

A study was carried out in the Arid and semi-arid lands (ASALs) of Kenya to investigate the effect of integrated soil fertility management (ISFM) on growth and yield of nine improved cowpea varieties. The study was implemented at two sites, Kavuthu 1223 m.a.s.l. and Ndunguni 1082 m.a.s.l., with contrasting rainfall amounts. Treatments applied included a control, manure at 2.5 t/ha, TSP at 15 kg/ha and a combination of manure and TSP at the single rates. Nodule numbers and weights, biomass production at 50% flowering and at maturity, and seed yields were recorded in the long and the short rains of 2006. The data collected was analysed using GenStat Discovery Edition 1, GenStat Procedure Library Release PL12.2. Results obtained showed that nodule numbers, biomass production and seed yields were in overall higher in the short rain season than in the long rains. For example in the long rains nodule numbers, root weight, and shoot biomass ranged between 1 to 26; 33 kg/ha to 142 kg/ha, and 616 to 2557 respectively compared to the short rains where same parameters ranged between 1 to 69; 58 kg/ha to 338 kg/ha, and 700 kg/ha to 3499 kg/ha respectively. Variety performance and treatment effects varied with season and site. However the results further indicated that shoot biomass production and seed yield were enhanced by a combination of manure and TSP especially in the drier site, Ndunguni. The results indicated that there is need to add inputs to enhance cowpea production in the ASALs of eastern Kenya.

Keywords: *Arid and semi-arid lands (ASALs), Biomass production, Cowpea, Integrated soil fertility management (ISFM),*

Using forage legumes to improve soil fertility for enhanced grassland productivity of semi-arid rangelands of Kajiado District, Kenya

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Abstract

A two phase study was conducted in the semi-arid rangelands of Kajiado District, Kenya with an aim of studying the effect of forage legumes on soil fertility improvement and grassland productivity of natural pastures. During legume evaluation phase, *Neonotonia wightii* (Glycine), *Macroptilium atropurpureum* (Siratro), *Lablab purpureus* cv. Rongai (Dolichos), *Mucuna pruriens* (Velvet bean) and *Stylosanthes scabra* var. Seca (Stylo) were screened for adaptability and growth performance. Results of soil analysis showed that soil pH, organic carbon, nitrogen and potassium significantly increased after two years of study, due to the large amounts of organic residues produced by the legumes (particularly the perennials). However, calcium significantly decreased while phosphorus had a non-significant decrease from the soil. After integration of Glycine, Siratro and Stylo into natural pastures during the second phase of the study, the crude protein content of grasses intercropped with legumes increased from 7.1% to 14.3, 11.9 and 10.2%, respectively. Grasses intercropped with legumes also had higher digestibility contents than grasses in monoculture stands. The study concluded that addition of organic residues by the introduced forage legumes improved the soil fertility status and in addition, livestock fed on fodder from grass/legume mixed pastures and the manure they produced may be of higher quality than those fed on natural pastures alone.

Keywords: *Forage legumes; Grass/Legume intercrops; Grassland productivity; Semi-arid rangelands; Soil fertility*

Incorporating green manure in the subsoil markedly increases cereal grain yields

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Abstract

Field experiments were undertaken over two years to determine whether the incorporation of organic amendments in dense, clay subsoil, that previously had been hostile to plant root growth, might improve wheat yields. The two organic amendment treatments involved adding 20 t/ha of pellets of green lucerne shoots (*Medicago sativa*) and dried poultry manure, both having high N concentrations (~3% N). Other treatments included the deep incorporation of fertilizer N and P (100 kg MAP/ha), coarse sand (20 t/ha), and gypsum (10 t/ha), and deep ripping alone. All materials were incorporated to a depth of 30-40 cm beneath a friable sandy loam topsoil in May 2005, in a paddock near Ballan, in south west Victoria, Australia. A crop of red winter wheat, cv Amarok, was sown in June 2005, using commercial farming practices, and harvested in January 2006. The key finding was that the organic amendments resulted in marked yield responses, with wheat grain yields increasing from 7 t/ha in control plots up to 13 t/ha in the organic amendment plots. These yield responses exceeded smaller responses to the inorganic amendments. The large responses to deep organic amendments are attributed to the stimulation of root growth in the subsoil, which increased the supply of deep soil water and nitrogen to the crop, during the grain filling period. This delayed the senescence of flag leaves which are the major organs supplying photosynthate to developing wheat grain. The results are consistent with other research in Australia that has found that increases in rainfall productivity (yield/mm rainfall) can occur if the wheat crop is able to access additional plant-available water in deep subsoil layers during in the grain filling phase of crop growth.

Keywords: *Green manure, soil water, productivity*

Multi-functional properties of mycorrhizal fungi for crop production: The case study of banana development and drought tolerance

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Abstract

This work discusses the potentials of arbuscular mycorrhizal fungi (AM fungi) for nutrients uptake and for drought tolerance of banana/plantain. They may stimulate plant beneficial properties: flowering, development and crops yields in African soils. When their activity is low, inoculation with selected strains could be use for restoration. Banana/plantain need water and is very sensitive to drought stress and diseases. The potential benefit of banana-AM fungi symbiosis was tested after 90, 60 and 30% soil field capacity during 40 days. Under nursery conditions, plant growth, leaf surface and dry weight are significantly stimulated by mycorrhiza on oxisol and andosol. AM fungi inoculation provided 30% more water to banana after 40 days of stress, water use efficiency were correlated with drought tolerance. AM fungi inoculated micro propagated banana provide bigger bunch than non inoculated ones under farm conditions in an oxisol. How can we develop this approach in banana production system? The cost/benefit ratio of inoculation should be determined to envisage its incorporation into nursery. The use of mycorrhizal fungi for a sustainable agricultural production in Africa is needed.

Keywords: *Arbuscular mycorrhizal fungi, banana/plantain, drought, water use efficiency.*

Potential for Reuse of Human Urine in Peri-Urban Farming

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Abstract

The possibility of recycling human urine for maize and vegetable growing was assessed on-farm, in a peri-urban Kyanja parish, Kampala District, Uganda. The objectives were to demonstrate to farmers and other stakeholders, the potential for using urine and develop guidelines for use of urine in farming. Field plots measuring 1.5x6m were established on 20 farmers' fields and planted with maize (*Zea mays* L.), *Nakati* (*Solanum aethiopicum*), Kale (*Brassica oleracea* L.) and Spinach (*Spinacia Oleracea* L.). Urine was applied at 10% (0.5:5 urine to water), 20% and 30%. Each concentration was applied weekly, bi-weekly and monthly. Urine:water mixtures (20L) were applied to each bed while the control received water only. Urine application significantly increased maize height and fresh yield; 30% urine weekly application gave highest benefits. Weekly application of 10% urine increased *Nakati* yield from 8.3 to 22.2 kg/plot, within 2 months and yielded nearly the same biomass as that treated to 20% urine weekly. Weekly application of 20% urine increased yield of Kale from 2.4 to 5.5 kg/plot, and spinach from 6.6 to 17.1 kg/plot within 2 months. These represented the highest, most economical biomass yields compared to other treatments. Weekly application outperformed bi-weekly, and least on once a month. From these findings we propose the following guidelines: Maize, apply 30% urine weekly for 8 weeks. *Nakati*, apply 10% urine weekly for 8 weeks. Kale, apply 20% urine weekly. Spinach, apply 20% urine weekly. Since Kale and Spinach can grow for about 1yr, prolong urine application for continued harvesting.

Keywords: *Ecological Sanitation; Closing the loop; Nutrient recycling; Urban Agriculture; Food security*

Evaluation of Human Urine as a Source of Nitrogen in the Co-Composting of Pine Bark and Lawn Clippings

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Abstract

The introduction of urine diversion toilets in South Africa has created opportunities for the recycling of human urine in agriculture. One of such possibilities is the use of human urine as a source of nitrogen during the composting of organic wastes. This study evaluated the possibility of (i) replacing urea fertilizer with human urine as a source of N in the co-composting of pine bark and lawn clippings; and (ii) minimizing the possible N loss during composting by encouraging struvite ($\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) precipitation with the addition of magnesium oxide (MgO) + single super phosphate (SSP) fertilizer or rock phosphate (RP) to the composting mixtures. Results showed that composting progressed faster where urine rather than urea was used as the source of nitrogen, as reflected by early attainment of peak thermophilic temperatures (65°C). The faster composting of the urine based composts translated into a 22% greater degree of degradation relative to the urea enriched compost. After 84 days of composting, inorganic N ($\text{NO}_3 + \text{NH}_4$) was 45% higher in the urine treated compost than the urea treated materials possibly as a result of the greater degradation observed in urine enriched compost mixtures. Struvite crystals were observed in the MgO, SSP, RP and urine treated composts but the elemental composition of the struvite crystals varied with the composting mixtures. However, none of the precipitated struvite crystals contained ammonium but potassium suggesting that the precipitated struvites were not effective in the conservation of nitrogen in the composting mixtures.

Keywords: *Pine bark, Human urine, Composting, Inorganic N and Struvite*

Phenotypic Characterization of Local Maize Landraces for Drought Tolerance in Kenya

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Abstract

Maize is one of the most important staple food crops in Kenya. Drought is one of the main problems contributing to the low crop yield. Improved crop genotypes have been developed but farmers continue to grow the local landraces. An experiment was conducted to identify the local landraces suited for the dry areas and determine their phenotypic characteristics as a step towards yield improvement. The experiment was conducted at the Kenya Agricultural Research Institute (KARI), Masongaleni farm Kibwezi, located at an elevation of 650 metres above sea level, altitude 2° 21.6' S and longitude 38° 7.3' E, and agro-ecological zone VI about 400mm of rainfall per annum. Sixty four landraces were evaluated in a lattice design experiment under irrigation with moisture stress at flowering. The genotypes varied significantly in the days to tasselling, days to silking (ASI) and yield. Some local landraces had the low ASI (1-5 days) compared to those from the highlands with ASI of upto 16 days. Maize yield varied from 8 ton/ha to 1 ton/ha. Stress at reproductive stage reduced maize yield by upto 82%, with genotypes having lowest ASI recording the lowest yield loss. The controls (Katumani Composite B and Dryland composite) had losses of 62% and 68% when subjected to moisture stress at flowering. The results led to the conclusion that local landraces hold potential for improving maize for drought tolerance.

Keywords: *Drought, flowering, maize landraces, yield*

Performance of Cotton-Maize Cropping System as Affected by Ploughing Frequency and Soil Fertility Management in Burkina Faso

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Abstract

On-farm experiments were conducted on two soil types (Lixisol and Luvisol) in the western cotton area of Burkina Faso with the objective to develop sustainable water and soil fertility management techniques that improve cotton-maize productivity. The hypothesis that organic and mineral fertilizers in addition to reduced ploughing frequency may improve cotton (*Gossypium hirsutum*) and maize (*Zea mays L.*) productions was tested. The treatments were combination of two tillage regimes (annual ploughing, AP and ploughing/scarification, RT) with and without compost application and mineral fertilizer inputs. The treatment annual ploughing with compost addition (AP+Co) had the highest soil water content (WC) on both the Lixisol and the Luvisol. The cotton yield increase of 46% and 36% on reduced tillage plot with compost additions (RT+Co) compared to the control in the Lixisol, and the Luvisol respectively. In the Lixisol the highest maize grain yield was recorded in the annual ploughing plot with the additional amount of nitrogen equivalent to the compost nitrogen content. Reduced tillage together with compost additions had the highest maize yield in the Luvisol. These results confirmed the hypothesis that reduced tillage with organic and mineral fertilization improved cotton and maize productions.

Keywords: *Burkina Faso, compost, cotton-maize, ploughing frequency, soil water content, yield*

Decomposition of Genetically Engineered Maize Residue under Field Conditions

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Abstract

Crop plants genetically modified (GM) for resistance to pests represents a tool to decrease the amount of chemical pesticides used in agriculture. Genetic modification of crops for a specific purpose could result in an additional unintended effect on plant structure and function, which may have ecological implications. We assessed crop effects of Bt maize modified to produce the Bt endotoxin on decomposition using Bt and non Bt maize as a standard exogenous material using 2-mm mesh fibreglass litter-bags, under field conditions over a sixteen week period. Treatments were two maize varieties (transgenic Bt-maize DKC 78-15B and corresponding near isogenic maize CRN 3505) x four maize residues (stem and leaves from transgenic Bt-maize MON810 each and the corresponding near isogenic maize CRN 3549) with six harvest periods in a completely randomized design. Percent ash free dry mass loss increased over time and varied with litter type and source. Biomass decomposition was faster with leaves than stems for both residue types. There were slight differences between mass losses from both litter types when grown under genetically and non-genetically modified maize. Decomposition rates and the half-life values (t_{50}), the time it takes for loss of 50% of the amount of the organic material to occur, was estimated from best-fit models. The residues were also assessed with respect to selected chemical and resource quality characteristics. Knowledge of these processes is essential to the understanding and development of post harvest soil management strategies for genetically modified crops.

Keywords: *Genetically modified maize, decomposition, model, soil.*

Field inoculation of woody legumes with microsymbionts (rhizobia and mycorrhiza fungal): an evaluation of successes and failures in Africa.

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Abstract

In the past, much work has been done in Africa on the isolation of rhizobial strains nodulating legumes. Practical demonstrations of the value of rhizobial inoculation are rare, because most work has been done under controlled, rather than field conditions. In the present study, we describe results obtained in the field (research station and farms) on the utilization of selected microsymbionts (Rhizobium and mycorrhiza fungal) for inoculating tree legumes and improving their growth and biological nitrogen fixation in Africa. The synergic effect of the dual inoculation has been clearly demonstrated with *Acacia mangium* and *Calliandra calothyrsus* in irrigated perimeters in Senegal. On the other hand in Kenya, the impact of the dual inoculation on the forage production by *Calliandra calothyrsus* in several sites has not been clearly demonstrated in the field (3 sites). But meanwhile, the same inoculum tested with the same *Calliandra calothyrsus* provenances in Zimbabwe has significantly improved in the field (2 sites) the biomass yield produced by the trees. With African Acacias, the lack of rain in dry lands prevented a positive effect of inoculation on the growth of seedlings planted in the field after four months of growth in nursery. The inoculation of mature trees of *A. senegal* in the field has been effective and has significantly improved the yield of gum-arabic. Through our work, we have obtained information and results on the limitations of field rhizobial inoculation for improving tree growth for forage, firewood and litter production and in some cases soil fertility as well.

Keywords: *Mycorrhiza; Native and Exotic Tree legumes; Nodulation; Rhizobia; Symbiotic N₂ fixation;*

An evaluation of Lucerne varieties suitable for different agro ecological zones in Kenya

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Abstract

In order to choose suitable varieties with high yield and good quality for cultivation, 8 Lucerne varieties, including seven foreign ones (WL 625 HQ, KKS 9595, WL 414, Robusta, KKS 3864, SA Standard, WL 525 HQ) and a local check Hunter River were studied on farm in seven different agro ecological zones (AEZ) in the long and short rain seasons 2006 using a randomized block design with two replications. Each plot was cut two times in both seasons to evaluate herbage production of the tested varieties. Results showed that dry matter yield (DM) from varieties were significantly different between sites in both short ($P < 0.05$) and long ($P < 0.001$) rains seasons. Robusta and WL 525 HQ yielded significantly ($P < 0.05$) more DM yield compared to the local check Hunter river in both wet mid and highland zones while SA Standard yielded significantly ($P < 0.001$) more DM in both mid and high dry land zones across all seasons. There was a significant AEZ \times Variety interaction on leaf: stem ratio in both short ($P < 0.001$) and long ($P < 0.05$) rains seasons. In both rain seasons, WL 414, WL 625 HQ and KKS 3864 had significantly ($P < 0.05$) higher leaf: stem ratio in that order to the local check Hunter river across all zones. Similarly, in both rain seasons, age at harvested significantly affected DM yield ($P < 0.05$) and leaf: stem ratio ($P < 0.005$) of all varieties across all zones.

Keywords: *DM yield, leaf, harvesting age, lucerne, stem ratio*

Effect of Indigenous Cyanobacteria Strains on Plant Growth and Nitrogen Content of Degraded Soils of the Eastern Cape Province in South Africa

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Abstract

Some cyanobacteria strains could be an economically attractive, ecologically sound alternative to chemical fertilizers because of their ability to fix nitrogen. As a result of lack of information on these effects in South Africa, a glasshouse study was conducted to evaluate the nitrogen fixation benefits of cyanobacteria strains 3g and 7e, indigenous to South Africa, and 9v from Tanzania, in a split split-plot design. Suspensions of cyanobacteria were uniformly applied to potted soils with or without maize seeds planted. After 6 weeks, the maize biomass was harvested and the top 15 mm of the soils mixed, before a second maize crop was grown for six weeks. Inoculation with strains 3g, 7e and 9v resulted in maize dry matter increases of 9.7, 9.1, and 10.4%, respectively, in the Fort Hare soil and 17.3, 22.3, 18.04%, respectively, in the Hertzog soil, at the first harvest. At the second harvest, the dry matter increases were 8.7, 10.3, and 24.07%, in the Fort Hare soil and 12.9, 14.8, and 19.01% in the Hertzog soil. Tissue N and N uptake also increased significantly with inoculation in both soils at both harvests. Soil nitrate N was higher where soils were inoculated and not cropped than cropped control in the first harvest. After the second harvest, soil ammonium N was highest in the 7e treatment for the Fort Hare soil, when cropped twice, and for Hertzog soil cropped once, relative to the control. The study suggested that cyanobacteria strains 3g and 7e have potential benefits in maize growth and for soil N improvement.

Keywords: *Cyanobacteria; dry matter; nitrogen fixation, soil N improvement, tissue N*

Arbuscular Mycorrhizal Dependency of Nine Different Tissue Cultured Banana Cultivars

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Abstract

The effect of four arbuscular mycorrhizal fungi (AMF) on growth and nutrition of nine different most popular commercial tissue cultured banana cultivars in Kenya and Uganda was investigated under greenhouse conditions. The banana plantlets at weaning stage were inoculated with one of the four AMF (i.e. *Glomus etunicatum*, *Glomus intraradices*, *Glomus mosseae* and *Gigaspora albida*) and a control (without AMF). Three sequential harvests were done at 8, 18 and 22 weeks after inoculation. At each harvest, plant height, fresh weight of shoots and roots, leaf surface area and shoot dry weight were measured. Fresh roots were processed to assess mycorrhizal colonization. Relative mycorrhizal dependency (RMD) of the various cultivars was calculated. The oven-dried shoots were analyzed for macronutrients. Inoculation with *Glomus* species resulted in significantly higher growth parameters compared to controls and *Gi. albida* in all the nine tested banana cultivars. Shoot nitrogen, phosphorus and potassium was also significantly higher in *Glomus* species inoculated plants than the *Gi. albida* and the non-inoculated plants. These results indicate that *Glomus* species can be used to enhance growth and nutritional status of bananas.

Keywords: *Arbuscular mycorrhizal fungi (AMF), banana cultivars, colonization, mycorrhizal dependency, nutrient content.*

Multi-functional properties of mycorrhizal fungi: field results from inoculation response and perspectives for crop production

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Abstract

The main objective of this work is to show multi-functional properties of microbial resources for crop production. Beneficial organisms such as arbuscular mycorrhizal fungi (AM fungi) may be very useful for a sustainable agricultural production in African countries where soil fertility and drought are serious limiting factors. AM fungi can stimulate plant functioning: nutrient uptake, tolerance to drought, soil acidity, disease and pest; contributing to improving crops yields in African soils. In conditions where their activity is low, inoculation with selected strains could be used for restoration. This work reviewed some results obtained after experimentation using some crops under diverse agro-ecological zones of Cameroon. A workshop was done to explain the use of this technology. Inoculation of AM fungi may increase yield from 50% to 200% depending on crops and environmental factors. Legumes, vegetables, fruit trees showed higher response to inoculation compared with cereals. The benefit of banana-AM fungi symbiosis was tested for growth and drought tolerance. The results showed that plant growth, leaf surface and dry weight are significantly stimulated by mycorrhiza. AM fungi inoculation provided 30% more water to banana after 40 days of stress, water use efficiency and phosphatases activities were correlated with drought tolerance. AMF inoculated banana provided more suckers and bigger banana bunch than others. To develop this approach, the cost/benefit ratio of inoculation should be determined to envisage its incorporation into nursery. The use of mycorrhiza to overcome constraints which are limiting factors for a sustainable agricultural production in Africa is needed.

Keywords: *Arbuscular mycorrhizal fungi, inoculation, multi-functions, water use efficiency.*

Arbuscular Mycorrhizal Fungi (AMF) in the rhizosphere of bananas in farming systems of Central Kenya

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Abstract

Arbuscular Mycorrhizae are beneficial to banana. Indigenous AMF have evolved with the crop and are more adapted to prevailing soil environmental conditions. They may therefore enhance establishment, survival and subsequent productivity. There is no information on AMF associated with banana systems. A survey was undertaken in central Kenya to establish AMF in the rhizosphere of bananas. AMF spores were morphologically identified and counted from field soils and trap cultures. Sorghum, soybean, cooking (Kibuzi) and a desert (Giant Cavendish) banana cultivar were used as trap plants. A total of 22 AMF species were present comprising of 12 *Glomus* spp., 7 *Acaulospora* spp., 2 *Scutellospora* spp. and 1 *Gigaspora* sp. Banana cultivars significantly ($p= 0.002$) affected spore abundance, with slight variations noted in the probability of occurrence of AMF. Except for Grand naine, Chinese dwarf and Lacatan, all TC cultivars had high species richness and diversity. Two local cooking cultivars had the highest species diversity (Shannon index). Soybean had higher species richness than sorghum and the two banana cultivars. A proportion of 80% of AMF species from rhizosphere of banana systems associated with other hosts with only two *Glomus* spp. specifically associated with two banana cultivars. Spore abundance was highest in sorghum > soybean > Kibuzi > Giant Cavendish. Shannon diversity index was highest for soybean > Giant Cavendish > sorghum > Kibuzi. *Acaulospora* species accounted for 65.4% of the total spore abundance while only 18.1% represented the two most abundant *Glomus* spp.

Keywords: *Arbuscular mycorrhizae banana systems, rhizosphere*

Exploring the Potential of Beneficial Soil Fungi to enhance Productivity in Agricultural Systems

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Abstract

Soil microorganisms are crucial to maintenance of soil function. They play key roles in structure formation, nutrient cycling, nutrient uptake and root health. *Trichoderma* sp. and Arbuscular Mycorrhizal Fungi (AMF) are soil beneficial fungi. *Trichoderma* improves soil health through suppression of soil borne plant diseases by producing antifungal antibiotic, produce growth promoting hormones which enhance root and plant development and induce resistance in plants. Several species are used commercially as bio-control agents against plant pathogenic fungi. AMF play a major role in nutrient uptake, contribute to soil aggregate formation, control of pests and pathogens and maintain plant species diversity. A study was undertaken by the GEF project on sustainable management of Belowground Biodiversity (BGBD) to evaluate impact of land use gradients on the beneficial fungi. Eleven *Trichoderma* species were isolated, including the commercially utilized *Trichoderma harzianum*. Soil type, LUT's and soil management practice influenced the distribution and abundance of *Trichoderma* spp. Napier induced high abundance and richness of *Trichoderma* and can be used in crop rotations or in combinations with other crops to naturally maintain high levels of the fungus in the soils. Twenty two AMF species were identified with Acaulosporaceae and Glomaceae most dominant. Spore abundance was highest in cropping systems and colonization low, an indication of disturbance while species diversity was highest on LUT's without crops and low in cropped systems. Since fertilizer is not an option in agricultural systems in Africa, the benefits of these organisms documented can be enhanced and utilized to improve fertilizer use efficiency.

Keywords: *Abundance, land use, management, Mycorrhizae, Trichoderma*

Effects of selected soil chemical and biological properties on maize yield in biomass transfer agroforestry systems

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Abstract

Effects of *Calliandra calothyrsus*, *Tithonia diversifolia* and *Tephrosia vogelii* green manure applied independently or combined with triple super phosphate (TSP) and limestone on soil chemical and biological properties that influence maize yield were evaluated on an Ultisol of Rubona, Rwanda. Treatments compared were the control, limestone at 2.5 t ha⁻¹, TSP at 25 kg P ha⁻¹ and 50 kg P ha⁻¹, leaf of *Calliandra*, *Tithonia* and *Tephrosia* each at 25 kg P ha⁻¹ and 50 kg P ha⁻¹ respectively, *Calliandra*, *Tithonia* and *Tephrosia* each combined with TSP at equivalent rate of 25 kg P ha⁻¹ and 50 kg P ha⁻¹ respectively. Leaf biomass, TSP and limestone were applied four consecutive seasons. Limestone led to significant increases in soil pH followed by *Tithonia* combined with TSP at 50 kg P ha⁻¹. All treatments reduced significantly exchangeable acidity and aluminium compared to the control. A combination of organic materials with TSP at 50 kg P ha⁻¹ improved soil organic carbon, microbial biomass carbon (MBC) and phosphorus (MBP). The same treatments contributed in inorganic P fractions increases from 3.6 to 109.5% than green manure applied independently. Only the combination of *Tithonia* with TSP increased inorganic P fractions by 1.6% to 52.2% compared to TSP alone. The combination of green manure treatments with TSP in the proportion of 25% significantly increased grain yield from 24 to 508%. Inorganic P fractions, soil carbon, MBC and MBP values were strongly correlated with maize yield, confirming the crucial role of these soil properties in improving maize yield.

Keywords: *Biomass transfer, maize yield and soil chemical and biological properties*

Decomposition and nutrient release from mixed plant litters of contrasting quality in an agroforestry parkland in the south-Sudanese zone of West Africa

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Abstract

We investigated under field and laboratory conditions the decomposition and nutrient release from mixed leaf litters of *Faidherbia albida* and *Vitellaria paradoxa* in the south-Sudanese zone of West Africa. Litterbags containing *F. albida* and *V. paradoxa* litters in varying proportions were placed on the soil surface and buried in plots receiving the following treatments: no fertilizer (control); nitrogen; phosphorus as Triple Superphosphate (TSP); and phosphorus as rock phosphate from Burkina Faso (BP). At each litterbags collection date, the undecomposed litter from each species was separated, and its remaining mass, nitrogen, phosphorus and potassium contents were determined. *F. albida* decomposed faster (k-values ranged from 0.031 to 0.131 week⁻¹) than *V. paradoxa* (k-values ranged from 0.015 to 0.086 week⁻¹) and released more nutrient than *V. paradoxa*. Mixing litters accelerated the decomposition rate of *V. paradoxa*, but did not affect the decomposition rate of *F. albida*. Decomposition was faster in the N and TSP plots than in the control and BP plots, and buried litter decomposed more rapidly than surface litter. In the early stages of decomposition, nitrogen was immobilized by *V. paradoxa* litter, but only in the control and N plots. Also under laboratory conditions, *F. albida* litter decomposed more rapidly than *V. paradoxa* litter as the microbial specific growth rate were 0.135 h⁻¹ and 0.069 h⁻¹, respectively. Results indicated that leaf litter from indigenous tree species can be used to optimize nutrient supply for crops, and that mixing litters of contrasting qualities is a promising management option for regulating their decomposition rates.

Keywords: *Faidherbia albida*; litter decomposition; microbial respiration; mineral fertilizers; *Vitellaria paradoxa*

Enhancing productivity of crops through sustainable management and conservation of plant-pollinator biodiversity and pollination services

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Abstract

Pollinators are well known to provide key ecosystem services to both natural and agro-ecosystems. Pollination is essential for the maintenance of diversity in wild flowers, and is indirectly responsible for the persistence of other guilds that depend upon floral resources, such as herbivores and seedeaters. Animal pollinators are thought to contribute between 15% and 30% of global food production and bees are recognised to be the most important pollinating taxon. The majority of agricultural crops in eastern and central Africa depend on pollinator populations from adjacent semi-natural and natural habitats for their productivity (yield increase). However, the value of pollinators is unknown in eastern and central Africa. A study was undertaken to improve our understanding of the habitat characteristics that moderate the value of plant-pollinator communities, especially in agricultural landscapes. The study aimed mainly at assessing the economic value of pollination services. This paper presents results for data collected so far for 2 years in Uganda. Several pollen vectors were inventoried and were found to play a significant role in increasing yield of cash crops and of vegetables/fruits. Pollination services are crucial for sustaining livelihoods and improve human life in Africa. Pollination service is a critical service. Promoting green revolution in Africa will also imply the conservation of these vital ecosystem services

Keywords: *Plant-pollinator biodiversity, income increase, livelihood improvement, pollination services conservation, green revolution achievement*

Effects of Conservation Tillage, Crop Residue and Cropping Systems on Soil Organic Matter Dynamics and Maize-Legume Production: A Case Study of Teso District

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Abstract

Tillage intensity reduction and use of cropping systems which maximize residue addition to the soil have been efficient agricultural practices to maintain or increase soil organic matter which has declined to very low levels. In this study, effects of conservation tillage, crop residue and cropping systems on the dynamics of SOM and overall maize-legume production were investigated in Western Kenya. The experiment was a split-split plot design with 3 replicates with crop residue management as main plots and cropping systems as sub-plots. Nitrogen was applied in each treatment at 4 rates (0, 30, 60, and 90 kg N ha⁻¹). Phosphorus was applied at 60 kg P/ha in all plots except 2 intercrop plots and control plot. The farm was characterized by low carbon content of 0.83% and total N of 0.08% with the soil classified as loamy sand. Data analyses were done using SAS. Inorganic fertilizer (N and P) showed significant effects on yields with plots receiving 60 kg P ha⁻¹ + 60 kg N ha⁻¹ giving higher yields of 5.5 t ha⁻¹ compared to control plots whose yields were as low as 1.8 t ha⁻¹. There was a slight increase in SOM content in the third season in crop residue plots. Long-term studies are needed to show the effects of crop residue, cropping systems and nutrient input on sustainability of SOM and crop productivity.

Keywords: *Conservation tillage, Crop-residue, Intercropping, maize yields, SOM,*

Challenges for replenishing soil fertility in depleted fields: evidence from long-term trials in Zimbabwe

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Abstract

Gradients of decreasing soil fertility with increasing distance from homesteads commonly occur on smallholder farms in sub-Saharan Africa due to differential resource management. A study was conducted for five seasons (2002-2006) on fields closest to homesteads (homefields) and outlying fields (outfields) of two smallholder farms on a sandy and clayey soils to assess maize yields after applying 100 kg N ha⁻¹ yr⁻¹ with different rates of P (0, 30, 50 kg ha⁻¹ yr⁻¹) from single super phosphate (SSP) or cattle manure. In the first four experimental seasons, maize yields in homefield control plots were greater than in the outfields of farms on a granitic sandy and a red-clay soil. Application of large amounts of manure (~17 t manure ha⁻¹ yr⁻¹) for three seasons was necessary to significantly increase maize yields on the sandy outfields. There were no significant grain yield responses to addition of fertilizer N and SSP in the outfields over the first four seasons. In the fifth season, Ca and micronutrients (Zn, Mn, B) were added to assess of the potential to increase maize yields in these fields by targeted micronutrient fertilizer application, but their effects were masked by poor rainfall. A cost-benefit analysis revealed that more than five years were required for farmers to off-set the costs of replenishing soil fertility in degraded fields by applying large amounts of manure.

Keywords: *Manure, micronutrients, soil fertility gradients*

Breeding Common Bean for Tolerance to Low Fertility Acid Soils in East and Central Africa

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Abstract

Bean production in eastern Africa is severely constrained by low soil phosphorus, nitrogen and acidity. Resource-poor smallholder farmers cannot afford and rarely apply fertilizers and other soil amendments to their bean crops. A strategy based on the identification of genotypes adapted to soils with inadequate nutrient supply and low pH associated nutritional disorders as a component of integrated soil management is now considered as the most appropriate approach to improving bean productivity in this region. More than 1337 bean genotypes were screened at nine sites in Kenya, Rwanda, DR Congo and Uganda to: (i) Identify lines tolerant to low soil nitrogen, phosphorus and aluminium and manganese toxicity; (ii) Conduct participatory evaluation with farmers to identify lines that combine tolerance to low soil fertility stress factors with marketable grain types. Soil analyses showed that all test sites had acid soils (pH 4 to 4.8) with low levels of available N, P, organic matter and moderate to high levels of aluminium saturation (40-60%). More than 50 bean lines tolerant to low soil nitrogen and phosphorus, and Al/Mn toxicity were validated with farmers in Uganda, Tanzania, Kenya, Madagascar, DR Congo and Rwanda. Genetic analyses showed that tolerance to low soil P and N was largely additive. Ten bean lines tolerant to low soil nitrogen, acid soil complex and five tolerant to low P have been released in six countries. Wider dissemination of low soil fertility tolerant lines has the potential of increasing productivity and profitability under low input bean production system.

Keywords: *Common bean, genotypes, selection, soil fertility, tolerance*

Soil fertility variability in relation to the yields of maize and soybean under intensifying cropping systems in the tropical savannas of north-eastern Nigeria

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Abstract

In north-east Nigeria, there are two types of fields (compound and bush) which are variable in soil fertility. This variability is either induced by management practices or by differences in texture. This influences the efficiency of resource use to increase crop yields on the fields. To address field soil fertility variability, some soil fertility parameters in 0-15 cm depth soil samples from farmer's compound (64) and bush (73) fields in southern Guinea (SGS) northern Guinea (NGS) and Sudan savanna (SS) zones were related to soybean and maize yields. Sand and silt contents significantly influenced soybean and maize yields in compound fields in SGS and NGS, respectively. Clay content had significant effect on soybean yield in compound fields in SGS and bush fields in NGS. Soil pH (range 5.23-8.03) and total N (range 0.14-4.90 g kg⁻¹) significantly influenced soybean yields in bush fields in SGS and NGS, respectively. Organic C (range 2.2-23.6 g kg⁻¹) significantly influenced soybean yields in bush fields in SGS and maize yields in fields in SS. Available P (range 0.30-11.30 mg kg⁻¹) and exchangeable K (range 0.15-1.79Cmol kg⁻¹) were important variables for soybean yields in compound fields in SGS and bush fields in NGS and for maize yields in bush fields in SS. Soil pH, organic carbon and available P were identified as critical in some of the fields. Addition of organic inputs, rotation of maize and soybean varieties tolerant to striga and drought stresses and application of N and P fertilizers but targeted to specific field situations are recommended.

Keywords: *Available phosphorus, Bush fields, Compound fields, Organic carbon, Soil fertility*

Survival and Soil Nutrient Changes during Five Years Growth of Sixteen *Faidherbia albida* Provenances in Semi Arid Baringo District, Kenya.

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Abstract

Sixteen provenances of *Faidherbia albida* were planted in a randomized complete block design (RCBD) with five replications in April 1997 at Noiweit in semi arid Baringo District of Kenya. The objectives were (1) to investigate the pattern of genetic variation and performance among the 16 provenances to determine their suitability for introduction in this environment, and (2) to assess the soil fertility development under *Faidherbia albida*. Assessments of growth variables and soil properties were done in October 1997 (six months after planting) and March 2002 (five years after planting). There were significant differences ($P < 0.05$) in height and diameter growth among provenances at six months but not five years. Survival percentage was higher among the Eastern and Southern African provenances, while four of the five West African provenances had 0% survival at five years. Soil data showed significant increase ($P < 0.05$) in soil pH, organic C, total N, available Olsen P and exchangeable (Na and K); a significant decrease ($P < 0.05$) in exchangeable (Ca and Mg); and no significant difference ($P > 0.05$) in exchangeable Al in five years.

Keywords: *Arid and semi arid lands, diameter and height, genetic variation, provenances, soil fertility*

Influence of Land Use and Cropping Systems on the Soil Monosaccharides Content: Induced Effects on Soil Aggregation in the Western Cotton Area of Burkina Faso

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Abstract

Soil organic carbon (SOC) and more precisely its labile pools play a pivotal role in the sustainable soil fertility management of poorly-ranged swelling clays soils in sub-Saharan Africa. The role of soil monosaccharides was assessed, based on a large typology of land use intensity. Thus 33 plots were sampled at a depth soil of 0-15 cm, considering field-fallow successions and tillage intensity. Six monomeric sugars (arabinose, xylose, glucose, galactose, glucosamine, mannose) accounting for 12 to 15% of SOC content has been extracted. The soil total sugars contents are significantly reduced by crop setting. But this depletion is more affecting hexose monomeric sugars (glucose and mannose), in particular that of microbial origin (mannose). The first ten cropping years after old fallow lands induces a loss of 63 % in mannose contents while annual ploughings practice in continuous cropping system leads to the greatest depletion (80%). As soon as the cropped plots are reconverted into fallow lands the soil monosaccharides contents record a renewed growth and rapidly get closer to the equilibrium level observed in the old fallow lands. Like soil polysaccharides contents, the amounts of soil water stable aggregates get lower as function of tillage intensity. But the total soil sugars explain only 13% of soil aggregation variability against 25% induced by galactose + mannose. Therefore, the soil monosaccharides from microbial neo synthesis could be considered as early indicators of SOC content depletion and key elements for soil aggregation.

Keywords: *Cultivation intensity; fallow, monosaccharides, water stable aggregates*

Cation flux in incubated plant residues and its effect on pH and plant residue alkalinity

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Abstract

Plant residues offer a viable alternative to the costly and non-readily available commercial lime in addressing the constraint of soil acidity among the rural small-holders. The liming potential of the residues, attributable to excess cations over inorganic anions, exists in either available or non-available forms. This study investigates cation flux and its effect on pH and plant residue alkalinity of four plant residues, maize (*Zea mays*), soyabeans (*Glycine max*), leucaena (*L. leucocephala*) and gliricidia (*G. sepium*) upon incubation for 100 days with and without application of lime in an acidic Zambian Ferralsol. Initial characterization of base cation content ranged from 239-879 (Ca²⁺), 188-458 (Mg²⁺) and 298-477 mmol_c kg⁻¹ plant material (K⁺). Of these between 26-60, 62-92 and 76-96% in that order were water soluble. On incubation up to 70 % Ca²⁺ and at least 80% Mg²⁺ and K⁺ added in the residues were initially present eventually increasing to 84 and 95% respectively. Potential alkalinity were 373 (maize) 1264 (Soyabeans), 794 (leucaena) and 1024 (gliricidia) mmol_c kg⁻¹. Of this between 42% (gliricidia) and 52% (leucaena) constituted available alkalinity. Exchangeable aluminium was absent or appeared in insignificantly very low amounts towards the end of the incubation while base cations were fixed. There was initial dependence of pH on both total cation concentration and residue alkalinity but this relationship was later lost suggesting incomplete activation of the non-available fraction of the potential alkalinity. Nitrogen mineralization affected both cation flux and residue alkalinity. This study highlights the importance of residues on amelioration of major cation deficiencies and aluminium phytotoxicity.

Keywords: *Cation flux, nitrogen mineralization, plant alkalinity, soil acidity, Zambia*

Integrated Striga Management in Kenya

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Abstract

Striga hermonthica is a serious pest of cereal crops in west Kenya. It has infested about 217,000 ha of maize cropland resulting in 182,000 t of maize grain loss per year worth about \$29 million. A two-year pilot project was developed by the African Agricultural Technology Foundation and six non-governmental organization partners to explore opportunities for better striga management. Three approaches and five management options were evaluated over two years; 1) striga tolerance (KSTP 94 and WH 502), 2) legume suppression (Push Pull and MBILI) and 3) imazapyr seed dressing of herbicide resistant maize (*Ua Kayongo*). *Ua Kayongo* resulted in the greatest maize yield (2.60 t grain ha⁻¹) largest returns (\$371 season⁻¹) and reduced striga expression (0.5 striga stems plant⁻¹). In contrast, the striga susceptible hybrid (H513) control produced 1.58 t grain ha⁻¹, returns of \$228 season⁻¹ and was infested by 2.6 striga stems plant⁻¹. The other striga managements were also effective, producing between 2.10 and 2.46 t grain ha⁻¹ and infested by 0.5 to 1.4 striga stems plant⁻¹. In addition, *Ua Kayongo* was field tested on over 13,000 farms during two years and farmers' impressions of the variety were extremely favorable. Clearly, imazapyr seed treatment is a breakthrough technology in striga control but its combination with other, more agro-ecological management approaches, particularly suppression by intercropped field legumes is necessary. Moreover, it is unlikely that commercialization of *Ua Kayongo* seed alone is sufficient to reach a full cross-section of striga's impoverished victims, suggesting that additional incentives triggering farmer collective action are required before this technology can achieve its full impact.

Keywords: East Africa, imazapyr-resistance, maize, plant parasite, *Ua Kayongo*

Evaluation of Site Adaptability, Biomass Productivity and Quality of Selected Improved Fallow Species in a Ferralic Arenosol at the Coastal Region in Kenya

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Abstract

Inherent low soil fertility, continuous cultivation without nutrient inputs, nutrient losses through leaching, unsustainable farming methods of slash and burn leading to nutrient losses are some of the major causes of low crop yields at the Coastal region. Short term-improved fallow technology has been successfully associated with soil fertility improvement and increase in crop yields in several parts of Kenya but has not been adequately evaluated at the Coastal Kenya to give firm recommendations. An on-farm experiment was established in Malindi District as a RCBD with eight treatments replicated thrice in 2006. Six species were evaluated at two intervals: six and twelve months after planting (MAP) for their site adaptability, biomass productivity, nutrient accumulation and leaf quality. The overall objective was aimed at identifying potential leguminous fallow spp. for transfer at the Coastal region. *Mucuna pruriens* gave significantly ($p < 0.05$) higher foliage biomass yield of 2.3 t/ha and 22.9 t/ha at 6 and 12 MAP respectively. All species tested except *S. sesban* had Nitrogen > 2.5 % with Phosphorus and Potassium contents being low in all species. Lignin contents were < 15 % except in *Tephrosia* spp. while all species tested had low polyphenol contents of < 4 % at 6 MAP. Results indicate that *Mucuna pruriens*, *Tephrosia candida* and *Tephrosia vogelii* are potential species for the Coastal region and their production can be enhanced in order to have recyclable amounts of nutrients that can be used to ameliorate the inherent low fertility soils at the Coast and subsequently enhance crop yields.

Keywords: *Biomass quality, Coastal region, improved fallows*

Land and Water Management Research and Development in Arid and Semi-Arid Lands of Kenya

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Abstract

Increasing demographic pressure in the arid and semi-arid lands (ASALs) in Kenya has resulted in the use of non-sustainable farming practices and subsequent environmental degradation, characterized by declining soil fertility, widespread land degradation and loss of biomass and biodiversity. Rainfall in these areas is low, unreliable and erratic and these drylands are prone to prolonged and recurrent droughts. As a result, crop production is low and insufficient to meet the food demands of the increasing population. Food insecurity is a major threat to the livelihoods of the resource poor smallholder subsistence farmers in these areas. Due to the limited possibilities of increasing the area under cultivation, the solution to meeting the demand for food and surplus for sale by the rapidly increasing population lies in increasing productivity through development of simple, effective and sustainable integrated soil fertility and water management technologies. Consequently, a lot of research work aimed at developing appropriate soil and water management technologies for these areas has been undertaken by research and development organizations in Kenya. This paper reviews, summarizes and highlights the major findings of research on options for improving soil fertility and for conserving soil and water in the ASALs. Socioeconomic factors are considered as well as their interaction with intervention measures such as tillage, water harvesting, soil conservation, integrated nutrient management, soil and water and crop management. The knowledge gaps in the various technological options tested are identified and future research needs are suggested.

Keywords: *Arid and semi-arid lands, Kenya, land and water management, soil fertility*

Water Harvesting And Integrated Nutrient Management Options For Maize-Cowpea Production In Semi-Arid Eastern Kenya.

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Abstract

Field experiments were conducted for four years at Emali, Makueni District in Kenya to compare the effect of tied ridging and integrated nutrient management practices on the yield of rainfed maize (*Zea mays* L.) and cowpeas (*Vigna unguiculata* L.). The main treatments were tied ridging and flat bed (traditional farmers' practice) as main plots. Farmyard manure (FYM) at 0 and 5 t ha⁻¹ in a factorial combination with nitrogen (N) fertilizer at 0, 40, 80 and 120 kg N ha⁻¹, phosphorus (P) fertilizer at 0 and 40 kg P₂O₅ ha⁻¹ and crop management were the subplots in a split plot in a Randomised Complete Block Design (RCBD). The results show that tied-ridging significantly ($P < 0.05$) increased maize grain yields by 12% when compared to flat tillage. Maize grain and stover yields were significantly increased by 79% and 61%, respectively, when manure was applied. Cowpea grain yields in tied-ridging were 25% more than in flat tillage treatments and the highest cowpea grain yield was 1354 kg ha⁻¹. Intercropping maize and cowpea lowered maize grain yield by more than 50% and 11% without and with nitrogen at 40 kg N ha⁻¹, respectively and also reduced cowpea grain yields. However, crop rotation increased the yields of both maize and cowpea. Combining tied ridges with manure and inorganic fertilizers increased crop yields when compared to when either of them is used separately. Thus, integration of in situ water management with integrated nutrient management has a potential in increasing food production in arid and semi-arid areas of Kenya.

Keywords: *Integrated nutrient management, Kenya, Semi-arid lands, Soil fertility, Water harvesting*

Biophysical characterization of Oasis soils for efficient use of external inputs in Marsabit District: Their potentials and limitations

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Abstract

The biophysical site characterization was carried for irrigated oasis farming in Kalacha, where production has declined to an extent that farmers abandoned their farms and opted for forage production. The objective for carrying out the characterization work was to identify technologies and locally available resources not only for efficient utilization of limited water and nutrient, but also to reverse the declining soil quality for long-term production. The land attributes used in differentiating the soils into mapping units were geomorphology, nutrient availability, salinity and sodicity hazards, infiltration rate and drainage conditions for various crops. Productivity index for each soil mapping unit was determined by the regressed relationships between crop production and the soil quality indicators. Between Unit PIL1 was classified as Calcic Solonetz well drained, with productivity index of 22%. The most limiting factors were found to be nitrogen and high sodium concentrations. Unit PIL2 comprised well drained, stratified Salic Fluvisols, with productivity index of 26%. The most limiting factors were low nitrogen level, high sodium and salt concentrations. Unit PIL3 had excessively calcareous, moderately drained and strongly stratified soils, classified as Calcaric Fluvisols with productivity index of 21%. The major limitation was nitrogen. Unit PIL4 comprised firm soils, overlying cemented sub-soils with high carbonate concentration, classified as Calcic Solonchaks, with imperfect to poor drainage conditions, and having productivity index of 12%. The major limitations were poor drainage, high sodium concentration and low fertility status. The soil productivity can be improved by prescribing the required inputs to address the specified limitations.

Keywords: *Land characteristics, oasis soils, productivity index, water and nutrient use*

Analysis of Spatial Variation of Soil Fertility Gradients in Smallholdings in Tropical Africa Using Geostatistical Techniques: Case Studies from Vihiga and Siaya Districts of Western Kenya

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Abstract

Adoption of soil fertility management technologies in Western Kenya has been minimal at best, and one of the main reasons given is the highly heterogeneous (biophysical and socio-economic) conditions within which smallholder farmers operate. A study was carried out to quantify the variability of soil fertility at different spatial scales and formulate domains for better targeting of soil fertility management recommendations. Farms were selected using hierarchical Y-frame sampling design and all fields within each farm characterized. Top soil samples were collected at a depth of 0-20 cm and the sampling points georeferenced using a global positioning system (GPS). Geostatistical techniques of semivariography were used to explore the spatial structure of soil fertility gradients. Mixed effects modeling was used to confirm relationships, while accounting for spatial correlation structures, and understanding the variance of predicted soil organic C at different spatial scales. Predicted soil organic C was found to be spatially correlated and the spatial structure was modeled using experimental semivariograms fitted with spherical and exponential models. On average, all the variogram models gave a nugget/sill ratio of between 0.5-0.6, indicating moderate spatial correlation. The high nugget variances shown by most of the fitted models indicate high micro-scale variations. Analysis of estimated variance components showed that field (residual) effects accounted for the greatest percentage (62.5%) of the variation associated with random effects. Future soil fertility management strategies in western Kenya in particular and tropical Africa at large should account for the large spatial variability of soil within smallholder farms.

Keywords: *Semivariograms, Soil fertility, Soil Organic Carbon, Spatial variability, Western Kenya*

Spatial patterns of soil properties as influenced by soil fertility management in small-scale maize farms in Njoro, Kenya

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Abstract

Soil testing by small-scale farmers in rural Kenya is relatively uncommon for several reasons key among them is lack of information on the possible benefits and limited access to testing laboratories. However, most of the farmers are aware of soil fertility variations within their farms which influence their management decisions. The purpose of this study was to assess spatial variation in soil quality as influenced by slope and soil management. Soil sampling was done in 37 small - scale farms in Njoro division of Nakuru district at 0-20 cm depth in March 2006. Sixty five percent of the farmers used inorganic fertilizers predominately DAP, 15 % used only farmyard manure, 15% used both organic and inorganic fertilizer, while only 6% did not use any soil fertility amendments. Most of the farms had a pH (CaCl₂) of less than 5.2, Twenty seven percent of the farms had a pH lower than 4.0. Organic C ranged from 1.6 to 5.8%, with a median value of 2.6%. Most of the farms were P deficient with a NaHCO₃ extractable P of less than 15 mg kg⁻¹. All farms had sufficient amounts of extractable K. Total N ranged from 0.12 to 0.33% with 76% of the farms with low N content (< 0.2%). Farms amended with farmyard manure had higher organic C and total N levels in Kikapu with correspondingly lower C: N ratios. Overall most of the farms were acidic and of low soil fertility. Farmers were advised to apply lime and manure. Interestingly none of the farmers had heard of liming.

Keywords: *DAP, farmyard manure, nutrient levels, slope, soil test*

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 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.

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

Model Validation through Long Term Promising Sustainable Maize/Pigeon Pea Residue Management in Malawi

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Abstract

In 2005/06 season the Model Validation through Long-Term promising Sustainable Maize/ pigeon pea Residue Management experiment was in eleventh year at Chitedze and Chitala, and in eighth year at Makoka and Zombwe. The experiment was a split -plot design with cropping system as main plot and residue management sub plot. All treatments were subjected to two fertilizer regimes. First regime was no addition of inorganic fertilizer and second was addition of inorganic fertilizer at Area Specific Fertilizer Recommendation Rate. The evaluation was done at Chitala, Chitedze, Makoka and Zombwe. Significant differences ($P \leq 0.05$) were observed in maize grain yield among sites and cropping systems. Highest grain yields were recorded at Chitedze (5342 kg/ha). However, the response trend in grain yield to different cropping systems remained the same in all sites. Best yields were recorded in maize grown following pigeon pea in rotation system followed by maize intercropped with pigeon pea. The addition of inorganic fertilizer increased maize yield significantly. Removal or retention of crop residue in the field did not contribute any significant yield increase of maize across sites. For resource poor small holder farmers, growing maize/ pigeon pea in rotation and maize intercropped with pigeon pea seem to be more profitable in terms of resource utilization and soil fertility improvements.

Keywords: *cropping systems, grain yield, long-term, Maize/pigeon pea, sustainability, model validation, management.*

Simplifying RothC for biomass data assimilation in C sequestration contracts

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Abstract

Soil carbon (C) sequestration has been proposed as a transitional win-win strategy to help replenish organic matter content in depleted agricultural soils and counter increases in atmospheric greenhouse gases. Data assimilation and remote sensing can reduce uncertainty in sequestered C mass estimates, but simple soil organic carbon (SOC) models are required to predict tradeable amounts over large, heterogenous areas. This study compared the performance of RothC and a reduced 2-pool model on an 11-year fertilizer trial in subhumid West Africa. RMSE differences of 0.05 tC.ha⁻¹ between models on total SOC predictions suggest that for contractual purposes, SOC dynamics can be simulated by a 2-pool structure with labile and stable components. Faster and slower rates can be approximated as instantaneous and infinite decay. In these systems, simulations indicate that cereal residue incorporation holds most potential to mitigate transient C loss associated with land conversion to agriculture.

Keywords: *Carbon sequestration; Model simplification; RothC; Soil organic matter; Uncertainty.*

Soil carbon dynamics as a result of climate, cropping systems and soil type – rapid calculations using basic concepts

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Abstract

We have developed a relatively simple soil carbon model, the Introductory Carbon Balance Model (ICBM). The model has two compartments, young and old soil C, and only five parameters. The basic idea is to be able to make projections of soil C dynamics in a 30-year perspective even when detailed data are lacking. The information necessary is a rough estimate of annual carbon input to soil, a coarse measure of residue quality and some information about climate. If basic weather station data and water-related soil properties are available, a more exact projection can be made. Typically the model is used for making predictions in scenarios such as where all crop residues are either retained or removed from a field, how much soil carbon will have been gained or lost after 30 years? If only limited local data are available, rough estimates (climate zone, crop yield etc.) will make projections possible. Compared with more complex models, this approach is rapid and simple and does not necessarily give worse results. The model is available as an Excel spreadsheet, with which projections can be made and the effects of different agricultural treatments can be compared.

Keywords: *Agriculture; carbon sequestration; modeling; soil carbon*

Using the crop simulation model APSIM to generate functional relationships for analysis of resource use in African smallholder systems: aggregating field-scale knowledge for farm-scale models

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Abstract

The efficiency with which applied resources are utilized in sub-Saharan Africa is critical as the resources are scarce. Research efforts increasingly focus on whole farm productivity, emphasizing the importance of interactions and nutrient flows within the farm. Progress has been hampered by the complexity of the systems and wide management differences related to farmer resource endowment. Simulation modelling using summary models such as FIELD that utilize resource availabilities in relation to resource capture and utilization efficiencies can be useful to unravel this complexity. To this end, a detailed model, APSIM, was used to generate parameters and variables that can be introduced as descriptive functions in FIELD. We parameterized and tested APSIM based on field experiments carried out in western Kenya where nitrogen and/or phosphorus were applied. Nitrogen, phosphorus and rainfall capture efficiencies ranged between 0.22-0.85 kg kg⁻¹, 0.05-0.29 kg kg⁻¹ and 0.10-0.53 mm mm⁻¹, respectively, depending on soil nutrient and physical conditions. Variation in the fraction of radiation intercepted with plant density was adequately described by the function $y = 0.058x + 0.11$ within a range of 1.5-5.5 maize plants per m². Investigation of weed management using the model identified a weed-free period of at least five weeks from maize emergence for minimum yield loss from weed-crop competition. The simulations confirmed that resource use efficiencies decrease on moving from relatively fertile 'close' fields to 'remote' soils within the same farm, giving more impetus on the need to expedite the search for better-targeted management strategies for spatially heterogeneous farms.

Keywords: *APSIM, FIELD, functional scaling, resource-use efficiency, simulation models*

Combining Field and Simulation Studies to Improve Fertilizer Recommendations for Irrigated Rice in Burkina Faso

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Abstract

Development of improved fertilizer recommendations entirely based on field experiments is time-consuming and costly. We employed a combination of two simulation models and selected field data to develop alternative fertilizer recommendations (AFR) for irrigated rice in Bagré, Burkina Faso. Existing fertilizer recommendations (EFR) are 82 kg N ha⁻¹ (wet season) or 105 kg N ha⁻¹ (dry season), 31 kg ha⁻¹ P and 30 kg K ha⁻¹. The model RIDEV was used to improve timing of sowing date to avoid cold-induced sterility and timing of N fertilizer applications. The model FERRIZ was used to determine AFR, based on estimations of indigenous nutrient supply for N, P and K, yield potential (Y_{pot}), internal N, P, and K efficiency of rice, fertilizer N, P and K recovery fractions and fertilizer and rice prices. Simulations suggested decreasing P and K doses to 21 kg P ha⁻¹ and 20 kg K ha⁻¹ but to increase the N dose to 116 kg N ha⁻¹ in the wet season ($Y_{pot} = 8 \text{ t ha}^{-1}$) and to 139 kg N ha⁻¹ in the dry season ($Y_{pot} = 9 \text{ t ha}^{-1}$). AFR keeps the P-balance neutral, but a negative K balance was tolerated based on the high soil K supply. Compared to existing recommendations, yield gains of up to 0.5 t ha⁻¹ were simulated at equal costs. These yield gains were more than confirmed in farmers' fields during four consecutive growing seasons. AFR increased gross returns above fertilizer costs by an average of about US\$ 160 per season as compared to both farmers' practice and existing recommendations.

Keywords: *Burkina Faso, irrigated rice, nutrient management, simulation modeling*

Theme 3

**Factors that limit access to and adoption
of innovations by poor farmers**

Farmers' Perceptions and its Influence on Uptake of Integrated Soil Nutrient Management Techniques: Evidence from western Kenya

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Abstract

Soil fertility depletion and the attendant declining agricultural productivity in western Kenya have led to many attempts to develop and popularize integrated nutrient management (INM) technologies that could restore soil fertility. INM bridges the gap between high external input agriculture and extreme forms of traditional low external input agriculture. The main components of INM in western Kenya are chemical fertilizers, animal manure, improved fallows and green manures. It is not well understood why farmers who rely on agriculture for their livelihoods, either do not adopt or adopt the technologies slowly. However, it is acknowledged that soil depletion is insidious and slow process, hence farmers' perception of severity of the problem and associated yield losses are critical in deciding adoption of soil fertility enhancing technologies. The objective of this study was to evaluate farmers' perceptions of soil fertility depletion and assess its contribution to adoption INM practices. Data were collected from a random sample of 331 households in Vihiga and Siaya districts and analysed by descriptive statistics and logit model. Results show that most households (94.6%) perceived declining soil fertility to be responsible for the low crop yields and difference in perception between the two districts was insignificant ($P=0.141$). From logistic analysis, farmers' perception of soil fertility depletion had no significant influence on adoption of any INM component. Socio-economic and technology characteristics militated against adoption of INM components. Policy reforms should focus on education of farmers while enabling farmers to access necessary inputs.

Keywords: *Adoption, households, integrated nutrients, perceptions, soil fertility*

Interaction between Population Densities, Cultivable Area, Resource Use and Land Productivity in Savannas of West and Central Africa

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Abstract

The linkage between population densities, resource-use, cultivable area, and crop yields is poorly understood. These factors were examined to identify crop production constraints and their impact on land productivity in two agro-ecological zones (Sudano-sahelian zone (SSZ) characterized by high population density and the northern Guinea savanna (NGS) characterized by low population density). For most land parcels in the population interaction zones traditional staples (e.g. millet) generate less returns and are rapidly being replaced by high-valued crops (e.g. maize) and nonfarm profitable activities. Yields of major cereals were low. Common soil fertility constraints identified were acidification, low organic matter, N and P status, imbalance of exchangeable bases, salinity and erosion. Generally, soil quality (using soil quality index SQI) varied among major landscape units ($p < 0.05$) and was generally low ($SQI < 2$). Relatively high quality soils in the SSZ zone were found in more densely populated areas. Agricultural intensification is evident in the SSZ, but at a level not sufficient enough to improve soil quality to ecologically acceptable levels. In the NGS, soils were of low quality ($SQI = 1.18$) to good ($SQI = 2.78$). Soil quality on two resource-use domains (low-to-medium and medium-to-high) was not significantly different. However, the percentage of fields in the medium-to-high resource-use domain (28%) with good quality soils ($SQI > 2$) was two times that in the other domain (14%). The low percentage of good quality soils irrespective of resource-use indicates limited adoption of soil fertility improvement technologies. A broad perspective is needed to provide a measure of interaction between agricultural land and nearby population concentrations to properly target agricultural technologies.

Keywords: *Crop yield, Land productivity, Resource use, Savannas of west and central Africa, Soil quality*

Typologies of Smallholder Farms in Bukoba District, Northwest Tanzania

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Abstract

Dissemination of new technologies among farming communities in developing countries mainly follow blanket recommendations which usually ignore existing diversity among households. Using a multivariate technique by Plymouth Routines in Multivariate Ecological Research package (PRIMER), we established typologies of smallholder farms facing similar opportunities and constraints in the high and low rainfall zones of Bukoba District, North West Tanzania. In both zones, three farm typologies categorized as high, medium and low resource in both zones were differentiated by the degree of production orientation and soil fertility management. The degree of similarity within farm typology groups was 48%, 45% and 39% in the high rainfall and by 47%, 71%, and 44% in the low rainfall. The best explaining variables were level of education of head of the household, the number of cattle, and their management, amount of available labor to work on the farm and its productivity. This study identified the need for researchers and policy makers to consider existing diversity among the farming community when formulating alternative technologies and policies for sustainable development.

Keywords: *Multivariate analysis; socioeconomic variables; sustainable development*

The Dilemma of Using Fertilizer to Power the Green Revolution in Sub-Saharan Africa

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Abstract

Agriculture in over 84% of world farmlands is rainfed but yields just over half of the crops produced. In East Africa, 60% of the landmass is arid and semi-arid land (ASAL), where rainfall is inadequate for arable agriculture. Farmers must use recommended cultural practices including appropriate cultivars, fertility, seed, planting time, weeding and pesticide application. The produce must also attract competitive market prices. The ASAL environment is harsh. Rainfall is low, unreliable and bimodal and the seasons have unequal production potential. In Kenya, the Short rains contribute 55% of the annual rainfall while the Long rains contribute 35%. Frequent droughts cause crop failure raising the dilemma whether farmers can apply fertilizer to crops in either season. Fertilizer and hybrid seeds are expensive and farmers no longer keep sufficient livestock for manure due to small land units and lack of herdsmen occasioned by free primary education. Poor farmers plant inferior cultivars without fertilizer or manure and fail to apply pesticides or manage weeds. Illiteracy and low mechanization limit ability to maintain required plant population and planting is late due to inability to prepare land early. Crops are therefore unable to utilize all available moisture. Investing in production, including use of fertilizer is risky and can be done during the Short rains. The government must be courageous in formulating enabling policies. Policy should regulate use of land based on size and potential. Planting grass for livestock, not maize for humans, gives better results in ASALs. Overcoming these dilemmas empowers the ASALs to power the green revolution.

Keywords: *ASALs, bimodal, mechanization, production, risk*

Benefits of Integrated Soil Fertility and Water Management in semi-arid region

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Abstract

The synergistic effect of soil and water conservation (SWC) measures (stone rows or grass strips) and nutrient inputs (organic or mineral nutrient sources) was studied at Saria station, Burkina Faso. The reduction in runoff was 59% in plots with barriers alone, but reached 67% in plots with barriers + mineral N and 84% in plots with barriers + organic N, as compared with the control plots. Plots with no SWC measure lost huge amounts of soil (3t ha⁻¹) and nutrients. Annual losses from eroded sediments and runoff reached 84 kg OC ha⁻¹, 16.5 kg N ha⁻¹, 2 kg P ha⁻¹, and 1.5 kg K ha⁻¹ in the control plots. The application of compost led to the reduction of total soil loss by 52% in plots without barriers and 79% in plots with stone rows as compared to the losses in control plots. SWC measures without N input did not significantly increase sorghum yield. Application of compost or manure in combination with SWC measures increased sorghum grain yield by about 142% compared to a 65% increase due to mineral fertilizers. Yields increase did not cover annual costs of single SWC measures while application of single compost or urea was cost effective. The combination of SWC measures with application of compost resulted in financial gains of 145,000 to 180,000 FCFA ha⁻¹yr⁻¹ under adequate rainfall condition. Without nutrient inputs, SWC measures hardly affected sorghum yields, and without SWC, fertilizer inputs also had little effect. However, combining SWC and nutrient management caused an increase in sorghum yield.

Keywords: *Economic benefit, grass strip, nutrient input, sorghum, stone row*

Determinants Of Organic Fertiliser Use By Farmers In North Central Nigeria

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Abstract

A survey of 450 farmers was conducted in nine localities within North Central Nigeria to determine the factors that affect organic fertiliser use by farmers. A multi-stage sampling technique was used to administer 50 questionnaires in each locality and descriptive statistical tools were used to analyse the results. Farmer characteristics showed an average age range of 37-50 years, literacy rate of 12-58%, and a family size of 3-9. The results showed that all the respondents use some form of organic amendment for soil fertility management, although the bulk of the organic resource is acquired from external sources. The proportion of farmers that raise livestock ranged from 33% to 76% with an average per capita generation and consumption of farmyard manure of 1.05 t yr⁻¹ and 0.38 t yr⁻¹, respectively. Cattle dung was the most commonly used organic material with usage by 41% of the farmers; this was followed by crop residue at 28%. There were distinct locality and farmer variations in the use of organic fertiliser. The major factors that determine farmers' use of organic matter resource include access to mineral fertiliser, availability of the organic resource, family size and the educational background of the farmer. In one locality with a large number of migrant farmers, use of organic amendment was significantly lower on rented lands than on lands owned by the farmers. An over-view is made of the various purchasing and novel 'counter-trade' relationships that exist between farmers in some localities and itinerant 'Fulani' herdsman, and how these could be scaled up to improve access to organic manure by farmers in rural countryside.

Keywords: *Guinea savanna, organic matter resource, organic matter use, soil fertility management*

Opportunities for sustainable crop production: Contributions from organic resource quality and quantity

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Abstract

Opportunities for sustainable crop production are essential to overcome the decline in crop yields commonly observed in smallholder agriculture in the tropics. Therefore, in a three-year field studies initiated in 2003 major season in the semi-deciduous forest zone of Ghana, maize yield indices as influenced by 5 organic resource quality and a control un-amended treatment were evaluated. Results underscore the beneficial effect of organic resource application for sustainable maize grain yield. There was a huge immediate benefit in maize grain yield of 85-150% depending on the quality of the organic resource applied, which was almost lost in the subsequent minor season and reappearing in subsequent seasons but discriminated on the basis of the quality of the material. The quantitative effect of organic resource application on maize grain yield was evident in 2004 major season where 4 t C ha⁻¹ produced significantly ($P < 0.02$) higher maize grain yield than 1.2 t C ha⁻¹ and remained superior in subsequent seasons. *Leucaena leucocephala*, a class II material showed superior maize grain yield across the years but in the absence of inorganic N application. On the other hand, cattle manure progressively showed superior benefits to maize grain yield from 2004 minor season when combined with inorganic N (120 kg N ha⁻¹) application. While underscoring the significant contribution of combined application of organic resources and inorganic N to improved maize grain yield, such combinations should be guided by the quality of the organic resource as well as the quantity of application for maximum benefits.

Key words: *Crop productivity, organic resource quality, organic resource quantity, N management*

Innovativeness of Common Interest Groups in North Rift Kenya: A Case of Trans Nzoia District

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Abstract

One measure of group evaluation is the classical structure, conduct and performance (SCP) analysis approach. Ignoring the inter-relationships among actors in the agricultural value chain leads to poor intervention strategy designs. Common interest groups (CIGs) are farmer associations established with the purpose of promoting special interest of communities. The groups were formed to alleviate poverty, enhance food security and improve health status through income generation. Kenya Agricultural productivity project (KAPP) recognized the need to use (CIGs) as key actors in agricultural sector value chain for intervention. However, there was limited information on the structure and performance of the CIGs. This study aimed at examining the structure, conduct and performance of the CIGs. A baseline survey was conducted in Trans Nzoia district in 2006. Fifty seven randomly selected CIGs were interviewed using a semi structured questionnaire. SCP and logit models were used in data analyses. . The results show that most of the groups were: Women (23%), research (9%), health (9%), Youth (5%) and mixed (54%). There was evidence that most of the groups had devolution of power to various sub-committees. The life span of the groups was 5 ± 4.8 years with membership of 26 ± 15.1 . However, most (89%) of the groups were not registered. From logit regressions results, the major factors significantly influencing group external technical and financial support were; lifespan, group-type (women) and group special projects undertaken. This implies, for group sustainability, these factors may be considered. The CIGs form favourable targets for KAPP interventions for enhanced impact and improved community welfare.

Keywords: *Conduct, group, performance, structure*

Understanding cassava yield differences at farm level: lessons for research

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Abstract

Cassava is an important food crop in Africa. A range of improved varieties and IPM practices have been developed to maintain and increase its yields in response to emerging pest and disease problems. Much less attention has been given to ISFM and agronomic practices. Important yield differences in cassava are found between farmers. Using a farm typology approach and six case study sites in east Africa, yield differences between sites and farm types were quantified and factors contributing to the differences evaluated. Overall, yield differences are twice as large between sites (6 t/ha) as between farm types (3 t/ha), whereas within sites, cassava yield differences between farm types vary from 1.5 to 7.5 t/ha. While differences in agro-ecological conditions explain part of the variation found at site level, differences in management were important in explaining cassava yields between farm types. Richer households obtained significantly ($p < 0.001$) higher cassava yield (+3.2 t/ha) than poorer households. Hired labour input ($p < 0.01-0.05$), monocropping ($p < 0.05-0.15$) and timing of first weeding ($p < 0.01-0.1$) significantly explained yield differences between sites and farm typologies. Use of improved varieties was rarely linked to higher yield levels. Manure and/or inorganic fertilizer use is rarely targeted to cassava. To improve cassava production in Africa, more emphasis should be given to the development and dissemination of appropriate management practices, higher yielding varieties. R4D efforts in cassava should take into account and benefit from differences in cassava production that exist between farm types, while at the same time not lose sight of agro-ecological differences.

Keywords: *Cassava; Explaining yield differences; Sub-Saharan Africa; Management; Farm typologies*

Stakeholder Characterisation of the Biophysical and Socio-Economic Potential of the Desert Margins in Kenya.

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Abstract

The arid and semi-arid environment in eastern Kenya is composed of a range of socio-economic and bio-physical conditions that have not been characterised. The human population in such areas is on the increase making the area unsustainable for human, wildlife and natural resource utilization. A participatory characterisation was carried out to provide guidance towards sustainable utilisation of this environment. It was observed that the area has low fertility with flows for major nutrients being zero or negative. Soils are also highly susceptible to severe wind and water erosion. The vegetation consisting of *Acacia spp* and other wooded bushland is under constant decline due to deforestation for firewood and building materials as demand for agricultural land increases. The households have less than 50% of the total area as farmland with over 70% of them living below the poverty line. Pastoralism and arable farming is often in direct conflict with wildlife with the number of livestock to pastureland usually out of proportion. Crop failures of rain-fed agricultural production are common and occur in 3 out of every five years. Since the area suffers from serious moisture deficits, irrigation is practiced at various places but sometimes these offer inadequate methods leading to salinisation and sodification and ultimate abandonment. Kenya Agricultural Research Institute has undertaken, through three designated transects some GIS mapping and soil fertility studies. Appropriate soil and water management technologies are carried out in the area to enhance agricultural productivity.

Keywords: *Arid and semi-arid lands, biophysical and socioeconomic characterisation, Kenya.*

Bringing Soybean Production Closer to Farmer's Reality: Alternative Options for Inputs and Labour

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Abstract

The use of farm inputs in Migori District (south-western Kenya) is very low, leading to low yields and hence food shortage and unacceptably low income. As cash is lacking to access inorganic fertilisers, TSBF uses alternative soil fertility improvement technologies in this region, such as Promiscuous Dual Purpose Soybean and local inputs. In collaboration with the farmers we identified the problems perceived with soybean production and designed and conducted on-farm experiments to curb them. The experiments therefore focussed on labour reduction and input cost reduction, using the following treatments: for labour: point-placing with 2 weedings (reference), drilling at correct distance to avoid thinning with 1 and 2 weedings, broadcasting with one weeding; and for inputs: ashes, ½ ashes and ½ manure, DAP, ½ DAP and ½ manure, manure, ½ Tithonia and ½ DAP, all at a rate of 20 kg P ha⁻¹, and no input as a control. There was a significant increase in yield when applying input, but no significant yield difference between the different inputs. As DAP is difficult to acquire by most farmers, there was high interest among farmers in the use of ashes, manure, Tithonia and combinations of local inputs. The different labour options did not lead to significantly different yields. Labour use efficiency favoured the low labour treatments; broadcasting and 1 weeding. Partial budgets, dominance analysis and field day discussions with farmers will be used to conclude which labour and input treatments suit which types of farmers, depending on their available resources.

Keywords: *Collaborative research, local inputs, labour reduction, soil fertility improvement, soybean*

Nutrition and utilization for health and income generation: an incentive for the promotion of legumes in Kenya

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Abstract

Soybeans contains 40% protein and 20% oil and .Soybean is both food and nutria health which can support human wellbeing. This project addresses the utilization of soybeans through sustainable and participatory capacity building in soybean processing, nutrition and mentoring in its production and marketing to act as an incentive to boost production of soybeans at the grass-root levels. Adequate and appropriate nutrition which can be achieved through the consumption of a balanced healthy diet (consisting of locally available foods and fortified food and/or micronutrient supplementation when needed) is vital for the health and wellbeing of all individuals regardless of HIV status. Nutritional support helps to maintain the immune system and to sustain healthy levels of physical activity. Our methodology included visiting farmer associations, living positive groups and giving short talks on the goodness of soybeans and allowing question and answer sessions to ensure that our clients had a voice. Also training of trainers (ToT) for five days (ToT-5 days) and training of farmers (ToF) for two days (ToF-2 days) in processing and utilization of soybeans, hygiene, sanitation, basic business management, and nutrition education were involved. Soybean is incorporated into several locally eaten foods with taste tests carried out and analyzed to determine the degree of quality improvement. We incorporate or replaced soybeans in locally eaten dishes such as mandazi, ugali, porridges, chapatti and “omushenye” or potato dish to increase their protein content without changing the tastes.

Keywords: *Immune boosting, processing, HIV, soybeans, training and quality improvement*

Biological nitrogen fixation by rhizobia and mineral fertilizer savings: implications for green revolution in Africa

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Abstract

African smallholder farmers are generally poor and many are unable to afford fertilizers. Legumes are being introduced into farming systems for their N-fixing attributes and to reduce the pressure to purchase fertilizers. Support for projects aimed at increasing legumes and their roles in farming systems would be higher if economic value of the N-fixed can be demonstrated through valuation. Such information can lead to formulation of policies to increase legumes in the farming systems and to conserve soil microorganisms. Applying the knowledge gained from several past researches, complemented with assumptions on FAO-sourced data on soybean (*Glycine Max*) from 19 countries in Africa, this study attempted to test the hypothesis that “*Bradyrhizobial* population nodulating promiscuous soybean is so diverse and efficient and will give economic benefits (yields, N₂ fixation similar to specific *bradyrhizobium* nodulating American type of soybean through inoculation)”. The computation of economic value of nitrogen fixation was mostly based on methods of cost replacement and cost savings associated with the fixed nitrogen compared with the nitrogen fertilizer required to attain the level of nitrogen fixed. Result shows that the economic value of the nitrogen-fixing attribute of soybean in sub-Saharan Africa, especially the promiscuous varieties, ranges from 197 - 203 million US\$ with a mean of US\$ 199 million across 2002, 2003 and 2004. The study concludes with recommendations on how to increase the chances of smallholder farmers benefiting from the nitrogen-fixing attribute of LNB (Legume Nodulating Bacteria), especially since many cannot afford adequate quantities of fertilizers for increased productivity.

Keywords: *Africa; economic valuation; favorable policies; legumes; N₂-fixation.*

Crop Rotation Leguminous Crops as Soil Fertility Strategy in Pearl Millet Production Systems

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Abstract

Crop rotation is one of the strategies in crop and soil fertility management practices that is being implemented in Namibia to improve soil fertility and crop yield per area of land cultivated. The benefit of improved cultivars could only be realised if combined with other soil management practices that can improve soil structure thereby retaining fertility as well as moisture. In order to achieve the goals, experiments are being conducted at four different research stations in the northern Namibia communal areas. The experiments are carried out in each region of the four northern communal regions where pearl millet is predominantly grown. This project is an ongoing and has started during the 2004/2005 cropping season and is expected to end during 2009/2010 growing season. The experiments are being conducted on poor sandy soil selected specially for this purpose. Soil samples were taken for fertility analysis before each planting season. During the first growing season 2004/2005, all the plots were planted with the main crop (pearl millet) and on the alternating year 2005/2006 different crops including legumes (cowpea and lab lab), fallow and sorghum were planted in different plots. It is expected that the experiment will be concluded by 2010 for a meaningful impact to be noted. Results presented in this paper are preliminary and therefore it is expected for meaningful results to be drawn from the experiment later.

Keywords: *Soil fertility, Pearl millet, Leguminous, Crop rotation, crop yield*

Taking Soil Fertility Management Technologies to the Farmers' Backyard: The Case of Farmer Field Schools in Western Kenya

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Abstract

Farmer Field Schools (FFS) were introduced in western Kenya in 1999 to empower farmers with knowledge for informed decision-making. Taking cognizance of diverse farming systems, the FFS applied Integrated Production and Pest Management (IPPM) approach. IPPM involved training farmers on productivity enhancing technologies especially soil fertility and pest management, and how to access agricultural services-- extension and credit. However, the influence of the FFS on adoption of the technologies is not clearly understood. The objectives of this study were to assess adoption of soil fertility enhancing and pest control practices by FFS and non-FFS households; analyse farmers' access to credit and extension services; and evaluate households' social capital. Data were collected from a random sample of 400 households, comprising FFS and non-FFS members, and analysed by descriptive statistics and logit model. The main soil fertility-enhancing technologies adopted were chemical fertilizers (64%), farm yard manure (56%), and compost (13%). The mean application rate of chemical fertilizer was lower than recommended, but slightly higher among FFS households than non-FFS households ($p=0.149$). The main pest control method was use of local concoctions (50%). Whilst 69% of the households received extension advice, a paltry 3% accessed credit. Regarding social capital, 91% of the households had members in one or more social organizations/groups; of which the most important group for one-third of the households was "merry-go-round". We conclude that taking technologies to grass roots and improving farmer' knowledge requires concomitant improvement in access to complementary agricultural services for improved adoption and impacts.

Keywords: *Adoption, empowerment, farmer field schools, households, soil fertility*

To Conserve or not to Conserve: Exploring Smallholder Farmers' Knowledge Towards Soil Erosion and the Status of Conservation Farming across the Central Kenya Highlands

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Abstract

Human induced soil erosion across the arable lands in the Central Kenya highlands is a major threat to sustainable agricultural productivity. This is against the backdrop of disappointing uptake of recommended conservation farming measures by smallholder farmers' in spite of the intense efforts towards promotion of the appropriate conservation measures. This study therefore explored the knowledge of the farmers to the occurrence and effects of soil erosion and, the status of conservation farming at household-farm level by characterizing case study farms that represented distinguished generic farm types for two agro-ecologically dissimilar study sites. Trained enumerators carried out a formal farm survey by use of specific focused questionnaire for 48 households across the sites. The farmers were aware of the occurrence of erosion in their farms though the severity and risk varied across sites and farm types. The farmers understood the dynamics of the erosion process and were able to identify most of the factors responsible for occurrence of erosion as well as assessing the effectiveness of recommended conservation farming measures prior to implementation. The farmers also recognized various conservation farming measures for the control of erosion but the actual implementation varied depending on the site and farm type. The sources of conservation farming information for the farmers were site dependent and were mainly from either agricultural extension agents or other farmers. The smallholder farmers faced diverse constraints in the adoption of conservation farming measures that revolved around farm and household circumstances such as shortage of labour and capital.

Keywords: *Central Kenya, conservation farming, smallholder farmers, soil erosion*

Prioritizing research efforts to increase on-farm income generation: the case of cassava-based farmers to in peri-urban southern Cameroon

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Abstract

The growing group of poor subsaharan Africans and a trend of declining agricultural research budgets demand priority setting on technological improvements targeted to direct impact on poverty alleviation. However, the extent to which agricultural technologies benefit the poor remains questionable when not targeted to well defined client groups with specific socio-economic situation and associated restrictions and opportunities. In this light, it may be appropriate to de-emphasise on crop yield and re-emphasise on labour requirements as a parameter of succes of a technology. As a case study, this paper defines the problems and opportunities of commercialization of cassava production in the forest margins of peri-urban Cameroon. Cassava (*Manihot esculenta*) is the chief subsistence staple and mainly produced extensively in traditional mixed food crop fields in a short fallow rotation with virtually no use of external inputs. The urban demand for cassava products is growing yet yields are generally low and current production increments are mainly based on increased cassava growing area. Preliminary data from surveys in peri-urban Yaoundé indicate that technologies for sustainable intensification of cassava production should be targeted both at pre- and post harvest levels. Options for specific targeting of labour saving technologies will be discussed with emphasis on weed suppressing planted fallows, fallow vegetation management and herbicide use as well as post-harvest processing mechanisation. Farmers' participation from the start is key in this developing / introducing / adapting of technologies and ensures appropriateness and subsequently better adoption potential and hence, higher impact.

Keywords: *Cassava, impact, poverty aleviation, labour saving, technology targeting*

Cost-effectiveness of fertilizer use in the production of main crops in Cameroon

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Abstract

A survey of crop producers was carried out in the 10 provinces of Cameroon to assess the level of fertilizers use and their consumption status in the production of fertilizer-depending crops like maize, cotton, irrigated rice, Robusta coffee, onion, Solanum potato and tomato. To achieve that goal the study evaluated the cost-effectiveness of the fertilizer use for those crops and further identified strategy axes to be undertaken for an efficient use and increased levels of fertilizers. Results indicated that for onion, tomato and potato, it was highly profitable to use three types of complete fertilizers (NPKMgO 12-14-19-5, NPKMgO 11-11-12-5 or NPK 20-10-10) combined with urea (46% N). The crop yields margin ranged between 6000 -10000 kg ha⁻¹ with a gross benefit per ha comprised between USA\$1578 and \$3681. For cereals (rice and maize), it was moderately profitable to use the “special maize and rice fertilizer” (NPKSMgO 14-24-14-5-35) in addition to urea, meanwhile crop yields margin ranged between 1000 - 4000 kg ha⁻¹ with a gross benefit per ha fluctuating between \$585 and \$759. It was not profitable to use either “special cotton or coffee fertilizer” or NPK 20-10-10 plus urea on tree crops (cotton and coffee) as this led to have crop yields <1000 kg ha⁻¹ for a gross benefit ranging between \$302 and \$384. Crop yield increases through the use of improved cultural practices and increase in crop proceeds through the improvement of products quality and development of exports to sub-regional/regional markets were identified as the two main strategy axes capable of boosting the consumption level and improving the cost-effectiveness of fertilizers in the country.

Keywords: *Cameroon, consumption, crops, fertilizers yield margin, profit*

Bio-Socio-Economic Factors Influencing Tree Production in South Eastern Drylands of Kenya

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Abstract

Empirical evidence on key biophysical, social and economic factors and their interplay for enhanced tree production in drylands of Kenya is scarce and scattered. The thesis for the study was that tree production in drylands was mostly practiced by resource poor farmers who based their decisions on a multiplicity of bio-socio-economic factors. Data was collected through a survey covering 100 households using structured questionnaires. Sampling units were selected through multi-stage stratified random sampling procedures, and regression and descriptive statistics applied in analysis. It was observed that tree production was taken as a land use system by mostly youthful, poor and modestly educated farmers. Apart from tree varieties, and environmental and climatic conditions, tree survival was dependent on labour, type of farm enterprise, and availability of germplasm, market and farmer while tree technology adoption was dependent on farmer's age, capital assets, product price, and availability of water and farmer. Household male heads were heavily involved in all tree operations. Marketing of tree products was dependent on price, labour, capital assets, and technical know-how. It was concluded that tree production in the South Eastern Drylands of Kenya was practiced more with resource poor farmers who based their decisions on a multiplicity of factors. Measures aimed at increasing farmer accessibility to water and markets were crucial in enhancing tree production. Exploratory research on ways of enhancing growth rates and economic value of indigenous trees was urgent.

Keywords: *Adoption, land use system, markets, resource poor farmers*

Economic Analysis of Improved Potato Technologies in Rwanda

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Abstract

The Rwanda Agricultural Research Institute, in collaboration with CIP and PRAPACE, generated and disseminated over the three last decades, improved potato based technologies. Conducted in two major potato producing agroecological zones in Rwanda (hautes terres de laves and hautes terres du Buberuka), this study aimed at identifying the best-bet technological packages from five alternatives. Based on the minimum acceptable marginal rate of return criterion, results from a two-season on-farm trial revealed that three technological package, T2 (Improved seeds + Fertilizer "NPK" + Fungicide «dithane»), T3 (Improved seeds + Fertilizer «DAP» + Fungicide«dithane») and T4 (Improved seeds + Fertilizer "NPK" Fungicide«ridomil+dithane») are profitable in both zones. The same decision criterion shows also that T5 (Improved seeds + Fertilizer «DAP» + Fungicide"ridomi+dithane) is profitable only in the terres de laves zone whereas T1 ("improved seed + farmer practices") would be attractive to farmers only in Buberuka zone. The sensitivity analysis shows that all the treatments have almost the same trend and are very sensitive to the decrease in potato prices. Treatment T5 (Improved seeds + Fertilizer "DAP" + Fungicide "ridomil + dithane") constitutes however the less sensitive to the change in fertilizer prices whereas T2 (Improved seeds + Fertilizer "NPK"+ Fungicide «dithane») is the less sensitive to changes in pesticide prices in the "terres de laves" zone. The sensitivity analysis in Buberuka zone reveals that treatment T4, although superior to other treatments, becomes more sensitive to change in potato price beyond a 25% increase.

Keywords: *Marginal analysis, marginal rate of return, partial budget sensitivity analysis, technological packages*

Socio economic characterization of communities with different potato market linkages in the highlands of southwestern Uganda

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Abstract

Many countries in Africa have started implementing economic reforms that could lead to rapid growth and improved socio economic conditions of its growing populations. Uganda has been undergoing major economic reforms through stabilization, economic recovery and structural adjustment programs. Adoption of market liberalization policies has favored growth of private sector in the country demanding increased production at farm level, which in turn favors marketability of farm produce in competitive manner. When farmers are able to sale farm produce, it is expected that they are able to improve upon household incomes, acquire more assets as well as improving their livelihood. It is believed that after satisfying personal demands and prevailing favorable conditions farmers could increase farm outs through investing back into natural resource management. The study was conducted in *Kamuganguzi* sub County considering six parishes with similar biophysical characteristics. Three parishes (*Buranga, Kicumbi and Katenga*) had farmer field schools and were properly linked to city fast food restaurant while other three parishes (*Kasheregyenyi, Kyasano and Mayengo*) had no farmer field schools and lacked proper market linkages for potato. However, the impact of farmer field school and proper market linkages on the communities and categories of farmers benefiting from the process were still not clearly unknown.

Keywords: *Economic reforms, farmer field school, livelihood, market linkages production*

Economic Returns of the 'Mbili' Intercropping Compared to Conventional Systems in Western Kenya

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Abstract

In Kenya smallholder farmers practice maize – bean intercropping. Low nutrient levels in soils result in low yields for both crops. Farmers plant both maize and beans in the same hill or between maize rows result in low yields. In the MBILI system (Managing Beneficial Interactions for Legume Intercrops), the spatial rearrangement gives high legume and cereal yield. An on farm experiment was carried out in four districts (Bungoma, Siaya, Trans Nzoia and Uasin Gishu) of western Kenya in a randomized complete block design giving three intercropping systems (MBILI, Hill and Conventional), maize and two legumes (bean, soybean or groundnut) and two fertilizer levels (0 and 150 kg of DAP/ha) with three blocks. The aim was to compare grain yields and economic returns of the MBILI and conventional intercropping systems. Treatment effects were determined by ANOVA analyses using the General Linear Model of the SAS system. The Bungoma site had the highest groundnut yields for both long rains 2005 and 2006; bean yields under MBILI intercropping (1.4 t/ha). Kitale gave the highest soybean yields of 583 kg/ha from MBILI with fertilizer. The MBILI intercropping gave the highest maize yields (5 t/ha) in all the sites except Segla, while the controls gave low yields (1 t/ha) in all the sites compared to the fertilized intercrops. Economic analyses showed that MBILI gave the highest returns on capital. The distinct finding is that MBILI gave increased maize and legume yields compared to conventional intercropping systems.

Keywords: *MBILI, Intercropping, legume, cereal, Yield*

Modelling Applications for Soil and Water Management for maize production in the Drylands of Eastern Kenya

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Abstract

The traditional field experimentation approach (whether on-station or on-farm) is becoming increasingly inadequate in addressing problems related to complex agricultural systems. The conventional methods of experimentation, where multi-location trials are conducted over several years, are both time-consuming and expensive. One practical and cost-effective alternative is to use simulation models. Models enable effective investigation of a wide range of production scenarios over varying climatic and soil conditions. Over the past two decades, the crop growth modelling approach using dynamic process models has been adopted in Kenya to address problems related to effective and efficient management of natural resources. This paper provides a review of CERES-maize model adaptation and application for maize production and the APSIM model for evaluation of soil conservation practices in the drylands of eastern Kenya. CMKEN, the Kenyan version of CERES-maize, was used to simulate maize yields comparable to those experimentally derived (R^2 0.88), when tested under rainfed and irrigated conditions with varying cultivars, sowing dates, plant population and nitrogen fertiliser rates. After validation, the APSIM model accurately predicted maize yield (R^2 0.94) and was also tested for estimation of total soil, N and C losses, through runoff at KARI – Katumani, under similar conditions.

Keywords: *Carbon, maize, modeling, nitrogen*

Impact of different market types on investment in soil management technologies: A case study of Ugandan cotton

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Abstract

Cotton has been grown in Uganda since 1903. Despite this, fiscal and economic reforms geared to market-driven production have led to a decline in the production area. Greater private sector participation in national agricultural functions and elimination of public subsidies for input and product marketing has negatively affected the management of soils and NRM investment in many cash crops in Uganda. This study assesses the differences in the soil management technologies of the export and local markets for cotton which smallholder farmers are linked to. It was hypothesized that increased farmer-to-market linkages result in reduced investment in natural resource management (NRM) and increased exploitation of the natural resource base. A survey of 200 smallholder farmers was carried out in Lira, Northern Uganda. Results showed that certified organic export markets encourage the use of indigenous knowledge in managing soil fertility and increased investment in NRM to maintain their organic certification. Local market linkage through private local ginneries promotes conventional cotton production. The study found that the costs of soil management inputs is predominantly promoted and absorbed by other actors in the market chain of this linkage. Without this source of inputs, farmers are less motivated to use soil fertility enhancing inputs due to their expense. The recommended use of these inputs by farmers was less profitable due to the low prices set by the Cotton Development Organization (CDO) compared to the export market counterparts. The export market offered a premium price above the CDO price.

Key words: *Soil management technologies, farmer to market linkages, smallholders, cotton, export market, local market*

Overcoming market constraint to pro-poor agricultural Growth in the Eastern of DR. Congo, South Kivu

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Abstract

The opportunities and constraints facing the marketing of the agricultural production have been poorly documented in the DR Congo. To address this lack of information, a survey of the marketing opportunities and processing constraints facing agricultural markets was conducted in 11 rural markets in South-Kivu. The objectives of the study were to assess the marketing opportunities, which may increase farmers' income, create technology demand, and provide incentives for sustainable production, by investing in soil fertility improvement. The results have shown that (1) There are enormous marketing possibilities within and around the country: Main national towns receive an average of 29083t (48.4%) of the beans produced by small-holder farmers in the Kivu region and about 31 737t, (22.5%) is traded seasonally between DR CONGO, Rwanda, Burundi and Uganda, (2) smallholders have few alternative sources of income and lack capacity to access and use these market opportunities;. Most of the constraints are linked to limited market access and development, inhibiting economic and technological development, low economic activity, poor markets for agricultural input, output and finance, high transaction costs and risks and high unit costs, weak institutional and infrastructure environment, high cost and weak information access and property right. The study suggests that overcoming agricultural marketing constraints requires a strong information programme to sensitize farmers to take advantage of regional and national opportunities (potential market), a collaborative mechanism between public and private sectors, for improving access to agricultural services, including market information, instituting contractual enforcement measures and strategies for optimizing the utilisation of processing capacity.

Keywords: *Agricultural market, market constraints, opportunities*

Improving African agricultural market and rural livelihood through *warrantage*: Case of Jigawa State, Nigeria

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Abstract

Poor agricultural commodity prices are the key causes of poverty in many sub-Saharan African countries. Efforts to improve rural livelihoods must improve agricultural produce marketing. This study was carried out to ascertain how the *warrantage* (a micro-credit scheme) system can be used to improve agricultural marketing and livelihoods in *Madana* community, *Jigawa* State, Nigeria. The design was an action research approach, based on supervised enterprise project framework. Data was collected using questionnaires, interviews, and group and personal discussions. Analysis was carried out using qualitative and quantitative methods. Prior to intervention, farmers in the area sold their produce at low prices immediately after harvest to meet urgent cash needs, resulting to low returns on investment and limited use of improved farm inputs. A pilot phase led to the observation that farmers could overcome the above problem if offered the opportunity to hold onto the produce for few months after harvest to take advantage of high prices during lean season. This study was to scale-up the findings from the pilot phase. Through the *warrantage* system, farmers have been able to timely access subsidised farm inputs, increase production, store their produce and sell during the lean period when prices are high. The outcome include: farmers are increasingly able to meet their cash and other needs. The impact of the project has generated widespread interest among other farmers even outside the *Madana* community. They are adopting the *warrantage* system as a model for sustainable self-help and a robust means of improving their livelihoods.

Keywords: *Warrantage, Improved rural livelihoods, improved farm commodity prices, Nigeria*

Constraints in Chickpea Transportation in the Lake Zone of Tanzania

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Abstract

Chickpea (*Cicer arietinum*) is an important food legume providing food and income for farm families, used as medicine and provides the country with foreign earnings. Despite its importance, its marketing system still performs below par. The main objective of the study aimed at identifying the constraints facing traders in the chickpea marketing and determining the optimal quantities and costs of chickpea distribution from four supply sources to three markets. Eighty traders were interviewed using a structured questionnaire. The analysis was done using Statistical Package for Social Science and SOLVER- Microsoft Excel computer software. The findings indicate that the total cost of procuring chickpea was US\$ 47,745 that was much higher than the optimal total cost calculated at US\$ 37,710. Transport took up a large proportion of the marketing costs accounting for 45.3% of the total marketing costs. Transportation costs are high as a result of poorly maintained feeder roads, seasonal supplies of chickpeas, lack of information about prices and haphazard choice of transportation routes. To reach the optimal solution, the distribution schedule was re-allocated; thus increased the number of routes from nine to eleven and changed the quantities transported in different routes. This change would result in a reduction of costs by 21%. Moreover improvement of road network; storage facilities; farmers' market education and information; formation of traders' association; would reduce marketing costs and hence increase marketing efficiency.

Keywords: *Chickpea, constraints, marketing costs, optimal solution, transportation*

Mobilizing Producer Marketing Groups for Sustainable Production and Natural Resource Management: Prospects and Challenges for Achieving Impacts at Scale with “Green Revolution” in Africa

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Abstract

Achieving Green Revolution in Africa critically depends on organizing small-scale producers into marketing groups and strengthening their capacity to undertake collective action in natural resources management (NRM). This paper draws from a cross-sectional study of 100 producer marketing groups (PMGs) in Uganda. The paper presents a typology of PMGs based on their market readiness and innovation capacity, and investigates the factors that determine their capacity to compete in markets and to disseminate NRM innovations. The paper examines the PMG members' incentives to invest in ISFM, and the trade-offs and synergies between market access and soil fertility status for different categories of PMGs. The results, suggest that the chances of achieving impacts at scale with ISFM innovations can be improved by (i) improving functioning of input and output markets; (ii) strengthening innovation capacity and skills for experimentation in PMGs; (iii) strengthening social capital and connectivity to service providers and local government; (iv) promoting market institutional innovations for collective marketing (credit, market information system, financial management and business skills), and (v) identifying value chains and incentives that are strong enough to compensate for the risk in adoption; in combination with strategies to improve PMGs' skills that will contribute to their accumulation of financial, natural and human capital. The paper suggests that we need a better understanding of social resilience and sustainability of PMGs. Social resilience is the capacity of groups or communities to cope and adapt to changes in markets (products, prices, demand) and in the broader socio-ecological system.

Keywords: *Innovation, input-output markets; Natural Resource Management, producer marketing groups, scaling up, social capital, value chains.*

Enterprise prioritization and implications for Soil Fertility Management – The case of Kiambu district

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Abstract

High potential areas form the major food producing zones in Kenya. However, the small-scale farmers in such areas are not necessary food secure or income sufficient. In these high potential areas several factors, including declining soil fertility, hamper increase in farm household incomes by contributing to low and declining yields. Priority of enterprises selected and the objective of selecting the specific enterprise was hypothesized to influence Soil fertility management (SFM) options the farmers use. The objective of this study was to understand enterprise selection amongst 3 SFM classes (good (1), average (2) and poor (3)) in Kiambu district and its effect on their SFM techniques. The study was conducted amongst 99 farmers in Githunguri division of Kiambu district in AEZ classified as Upper midlands zone. Dairy was ranked highest by 88%, 78% and 60% of farmers in the 3 SFM classes respectively. This was followed by maize and potatoes (65% and 44% of all farmers respectively) as they provide stable food and income source, though lower compared to high value crops like tomato. Tomatoes received on average 85kg/ha N fertilizer followed by potatoes (27kg/ha N) and maize (25kg/ha N). This was supplemented by manure application at 14t/ha on napier, 12 t/ha on tomato, 8 t/ha on potato and 7 t/ha on maize/beans. All rates were lower than recommended. In developing and disseminating SFM techniques, researchers should consider the farmers priority enterprises, reasons for the selection as well as address the conflict between risk and fertilizer use in high value crop production.

Keywords: *Enterprise selection, Farmer classification, Soil Fertility Management,*

Participatory variety selection of pulses under farmer management in Kadoma District, Zimbabwe

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Abstract

A study was initiated in Kadoma District (29° 53'E and 18° 19'S), to select the best varieties from 3 cowpea varieties, 7 bean varieties and 7 soyabean varieties that performs well under local conditions (climatic and resource availability). It was also intended to assist farmers to develop their own criteria for evaluating different crop varieties. These three crops had been selected to address issues of food security (cowpea and beans) and income (soyabean and beans). Three factors were tested in 2005 i.e. source of nutrients, time of planting and pesticide application. The first experiment was established in late November 2005 and the second in late November 2006 based on results of the previous season. In 2006, the experiments tested botanical crude extracts on selected varieties i.e. 2 varieties of cowpea, 4 varieties of soyabean and 4 varieties of bean. Farmers' selection criteria included; disease tolerance, yield, grain characteristics (size, shape and colour), cooking time and taste. Pesticide application was important for cowpea and bean yield underlying the fact that pest control is still crucial for optimum yields. CBC1 (cowpea), UBR92/25 (bean) and Solitaire (soyabean) were considered to be the best pulse varieties that could be grown in Kadoma District with conventional pesticide applications.

Keywords: *Farmer evaluation, food security, grain legumes, participatory research*

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.

Keywords: *local soil classification, region of Gourma, small holders' farmers, soil fertility management, stone belt.*

Linking policy, research, agribusiness and processing enterprise to develop Mungbean (*Vigna radiata*) production as export crop from Senegal River Valley

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Abstract

Mungbean (*Vigna radiata*) is a short-duration and high nutritive value leguminous pulse crop. To allow Senegalese farmer to access to increasing Mungbean market, different stakeholders, policy maker and research, private and industry sector were brought together. First phase was, screening varieties and evaluating yield performance. In experiment 2004, 34 varieties were evaluated for their potential, whereas in 2005, ten best accessions were submitted to a second screening, including grain technological analysis for marketability. Considering mean yield level and stability criteria, Line 4, VC 6123 B-11, VC-6173 B-10, CDHA, VC 6123 A, Line 7, Line 6, VC 6379 (23-21), KPS 7 and Line 5 were retained following the first screening process. Global aboveground biomass average was 3677 kg ha⁻¹, ranging from 2707 kg ha⁻¹ by Line 5 to 4736 kg ha⁻¹ by VC 6379 (23-21). Harvest index varied between 0.47 by Line 6 to 0.59 in VC 6123 A, with global biomass average standing at 0.54. All varieties yielded higher than 1500 kg ha⁻¹ with a peak at 2222 kg ha⁻¹ by VC 6123 B-11. The performance of varieties was established as follows: VC 6123 B-11 > Line 4 > KPS 7 > VC 6379 (23-21) > Line 5 > Line 7 > CDHA > VC-6173 B-10 > VC 6123 A > Line 6. Using technological scoring criteria, Line 4, Line 6 and KPS 7 were chosen as best varieties for export purpose. Other varieties should be devoted to local use to enhance farmer's food security.

Keywords: *Mungbean, Senegal River Valley, Vigna radiata*

Linking research to market using farmers' field school approach

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Abstract

Many countries in Africa are undergoing economic reforms to reverse the wide spread and deepening poverty at the household level. Market liberalization is causing steep competition among the different stakeholders resulting in the need for spiral change in the production technologies. In the past, research was mostly geared towards food production and little was done to link it to market demands. Low adoption of agricultural technologies was mainly due to low participation of farmers in the technology development coupled by lack of market for produce. Linking research to market was done using farmer run farmer field school (FRFFS) approach in the highlands of southwestern Uganda. This was done after identifying potato as a possible enterprise for community's household income. Major constraints to potato production were bacterial wilt, late blight and low soil fertility. To perfect production, two FRFFS were set up in two sites and two experiments conducted on *Victoria* and *KachPot 1* varieties. Experiments involved integrated late blight management with four different spraying regimes of rodimil and agrozeb and planting on ridges and conventional planting with and without fertilizers. Complete block randomized design with two replicates was used. Performance of technologies was done basing on marketable yield. Results showed that, for each unit of money invested in using agrozeb every after 14 days, 2.9 extra units of money are generated, 2.6units with agrozeb, then rodimil when necessary. However, spraying with agrozeb, followed by rodimil then agrozeb, results shows a loss of 2.0 units of money for each unit invested.

Keywords: *Economic reforms, farmer run field school, market, research, technologies*

Market Access: Components, Interactions and Implications in Smallholder Agriculture in the Former Homeland Area of South Africa

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Abstract

While insufficient market access is recognized as a key institutional constraint to smallholder development in Africa, the generalities that characterize much of recent research on the subject mean that the mechanisms by which market access exerts influence are not well understood. Drawing on household-level data from the former “independent homeland” of South Africa, this paper employs the logistic model to isolate key components of market access, including access to market/price information, productive inputs, infrastructure, etc. Differences in the extent to which these factors constrain smallholder crop and livestock farmers buttress the expectation of greater policy impact from research that takes a wider view of market access. The paper fits the foregoing finding against the backdrop of South Africa’s troubled past that continues to negatively impact on its agricultural economy. How this history has influenced intra- and inter-sectoral relationships and coordination is discussed. The paper further presents results that shed light on how policy and smallholder support measures can be better targeted to address the problems of limited market access in the communal/rural areas in order to increase the use of agricultural inputs such as mineral fertilizers, enhance agricultural productivity and equity as well as improve overall rural livelihoods. Results will be extrapolated to other rural areas of sub-Saharan Africa which, in many respects, are similar to the former “independent homelands” of South Africa.

Keywords: *Agricultural productivity, institutional and technical constraints, market access, rural livelihoods, smallholders.*

Farm input market system in Western Kenya: constraints, opportunities and policy implications

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Abstract

Widespread and increasing rural poverty in sub-Saharan Africa (SSA) has been of great concern to the development community. Compared to other developing regions of the world, low use of inputs by smallholder farmers is one of the factors responsible for the gap between potential and actual yields. Market constraints reduce profitability in use of inputs and increase production risks. This study interviewed 130 farm input dealers in Kenya to analyze trends, inputs stocked, distance to markets, services to farmers, and constraints and suggest how to improve input delivery to farmers. Results indicate that although the number of agro-dealers is still small relative to population, there has been a steady annual increase (2-22%, with a mean of 16% across inputs) in their number from 2003 to 2005. DAP fertilizer (stocked by 92% of respondents) was the most frequently occurring. Others are CAN fertilizer (84%), Urea (78%), and NPK (40%). Input information (75% of respondents), credit (13%), bulk breaking (8%), and spraying (4%) were the other services provided. Selling price of inputs increased with distance to markets. The most important constraints faced by agro-dealers were transportation (53%), limited market (30%) and market information (21%), storage (13%), and inadequate business skill (12%). Policies and institutional frameworks suggested by dealers to streamline farm input trade were associated and government as the main proposed institution. The study concludes with suggestions on how to enhance efficiency of agro-dealers in input delivery. This is timely since SSA governments are presently creating structures to enhance input use.

Keywords: *Farm input delivery; input dealers; Kenya; market constraints; poverty and yield gap*

Fertilizer Policy, Trade and Marketing in Zambia

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Abstract

The nature of fertilizer marketing and pricing policies in Zambia were heavily interventionist in the 1980s and liberalized in the 1990s with both government and private sector participation. The demand for fertilizer in Zambia is estimated at 300,000 Mt per annum fluctuating to as low as only 100,000 Mt in some years. However, Government continues to be convinced that the private sector has not developed well enough to adequately serve the needs of smallholder farmers, especially in the more remote parts of the country. For example, only 20% of the 650,000 smallholder farmers used fertilizer during the 1999/2000 farming season. Fertilizer marketing has been affected by several constraints such as high cost, availability and poor supporting infrastructure. Currently, as from the 2002/2003 season, the government has been implementing the Fertilizer Support Programme (FSP) where the targeted 120,000 farmers are expected to pay upfront 50% of the total fertilizer cost. Due in part to this programme, coupled with favorable weather conditions, maize production increased by 64.4% to 1,424,000 Mt in the 2005/06 season. For sustainability purposes, however, government needs to have a clear exit strategy from the FSP to enable the private sector handle the production and marketing of inputs effectively; government needs to improve the infrastructure and the macro-economic conditions to facilitate effective fertilizer marketing; government should invest more in extension services; government should enforce fertilizer quality regulations in order to ensure adherence to minimum quality standards and government needs to develop strategic partners and form consortia (local and regional) for procurement of fertilizer and raw materials to cut costs.

Keywords: *Cost and availability, fertilizer constraints, marketing*

Policy framework for utilization and conservation of below-ground biodiversity in Kenya

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Abstract

The reasons for the lack of inclusion of below-ground biodiversity in the Kenyan policy and legal framework were sought through a purposeful survey. Gaps were identified in the relevant sectoral policies and laws in regard to the domestication of the Convention on Biological Diversity (CBD). Below-ground biodiversity had no specific schedule in any of the sectoral laws. Most sectoral laws were particular about the larger biodiversity and soils but had no specific mention of below-ground biodiversity. Material Transfer Agreements and Material Acquisition Agreements that are regarded as tools for the domestication of the CBD to guide transfers, exchanges and acquisition of soil organisms lacked a regulating policy. The lack of regulating policy could be attributed to the delay in approval of draft regulations by the Ministry of Environment while the lack of specific inclusion of below-ground biodiversity in Kenya's legal and policy framework could be as a result of lack of awareness and appreciation among stakeholders.

Keywords: *Below-ground Biodiversity; Convention on Biological Diversity; Material Acquisition Agreement; Material Transfer Agreement; Policy framework.*

Policy Issues Affecting Integrated Natural Resource Management and Utilization in Arid and Semi Arid Lands of Kenya

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Abstract

This paper analyses policy issues affecting utilization and management of natural resources in Kenya's arid and semi-arid lands (ASAL) that constitute 84% of the total landmass, supports 25% of human population, 54% of livestock and almost all wildlife. The ASAL has fragile natural resources, which require appropriate management strategies. Focused group discussions and single subject interviews were conducted involving various policy institutions and lobby groups to identify policy flaws in management and utilization of natural resources and recommend to policy makers for review. Privatization policy on land ownership was found to be unsustainable for resource development and utilization. It denies communities accessing communally utilizable resources and nomadic grazing systems. Conventional farming systems have failed to address soil and water conservation practices contributing to land degradation. The policy is unclear on appropriate areas for farming and livestock keeping. Wildlife conservation policies have impacted negatively on communities living in wildlife areas due to few direct benefits from wildlife. Yet the communities bear all the costs of living with wildlife. Existing marketing policies are unfavorable in guaranteeing markets for ASAL products. Water management and utilization policies favour large-scale farmers at the expense of pastoralists. Policies on energy conservation are unclear leading to excessive charcoal burning which degrades the environment. The government needs to review its national policies and invest more in development of human capital in rural areas to release pressure from the environment. There is also need to involve many stakeholders in policy formulation.

Keywords: *ASAL, Kenya, natural resource management, policies*

Drivers of Occupational Health and Environmental Safety Concerns during Pesticide Use among Small-scale Farmers at Sagana, Central Highlands, Kenya

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Abstract

Small-scale farmers in Sagana area of central Kenya constitute a population at risk due to intensive use of pesticides. The main drivers of the risks observed are farmers' own perceptions and attitudes towards pesticides. This paper examines these drivers with emphasis on farmers' susceptibility perception, severity of the hazards, and barriers to taking risk reduction measures, and cues to adopting safety behaviour when dealing with pesticide at the farm level. Data was collected by use of interviews conducted in 2006/2007 from a sample of 140 farmers. Perception scales were developed from interview items and were ranked along a modified 3-point likert-scale. Analysis of the items and scales showed that farmers had fairly high levels of perceived risk, perceived severity and perceived benefits of taking action to mitigate pesticide hazards. However, most of them remain susceptible to pesticide related dangers due to various factors notably; fate, perceived high cost of purchasing protective gear and lack of adequate training in the use and handling of pesticides. Further, although generally regarded as important, education had limited positive effect to safety knowledge and behaviour when handling pesticides. The challenge to policy and practice toward safe use of pesticides must address issues of farmers' economic survivability, perceptions and attitudes, along the whole chain from pesticide procurement, storage, farm application and disposal.

Keywords: *Environmental safety, occupational health, pesticides, small-scale farmers*

Gender Differentials in Adoption of Soil Nutrient Replenishment Technologies in Meru South District, Kenya

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Abstract

Understanding gender differentials in adoption of soil nutrient replenishment technologies is critical to their successful implementation. A survey was conducted to examine gender differentials in choices of technologies adopted in male and female headed households; socio-economic, institutional and demographic factors influencing adoption and gender differences in participation in project activities. Chi-square tests run at $p < 0.05$ revealed a significant relationship between gender and the choice of manure and fertilizer. Results of the logistic regression model revealed that adoption in male headed households was influenced by; farm size, area under food crops, area under cash crops, household size, number of adults, number of cattle, frequency of hiring labor, participation in project activities, access to credit and group membership. Factors that influenced adoption in female headed households were: area under cash crops, number of adults, perception of soil infertility, participation in project activities, access to credit and group membership. T-tests run at $p < 0.05$ revealed statistically significant gender differences in participation in field days, problem diagnosis meetings and village training workshops. There is a clear need for strategies and policy to address gender disparities in adoption of soil improvement technologies and to encourage women's participation in training activities.

Keywords: *Adoption, gender, participation, technologies*

Land Insecurity as a Limiting Factor of Soil Productivity

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Abstract

In Burkina Faso, agriculture is facing many constraints that limit seriously agricultural production and hinder to achieve food security. One of these constraints often evoked by farmers is land insecurity. This problem has been pointed out during a study of farming systems carried out in two rural localities around Bondoukuy village, in the province of Mouhoun. The methodology used to understand farming systems and the way to have access to agricultural lands, was investigations with land owners and migrants. The land holders are the Bwaba, the local ethnic group. The two rural localities are Mokouna and Bukuy, divided in three parts: top Bukuy, middle Bukuy and low Bukuy. The low Bukuy where soils are more fertile is exclusively reserved for Bwaba. The other rural localities are cultivated by migrants, mainly composed of Mossé coming from central zone of Burkina Faso because of recurrent droughts of 1970, 1973 and 1984. Soils are less fertile because of long cultivation. The results showed that land is rent to migrants for an undetermined time. In fact, the land owner can at any moment dispossess the user for no reason. Some activities like trees plantation are considered as an appropriation act of the land. Migrants have no sustainable right to the land. This situation does not encourage them to make investments in order to improve soil productivity and is a big handicap for achievement of food security in the region.

Keywords: *Burkina Faso, Bondoukuy, landed insecurity, migrants, food security*

Tracking Changes in Livelihoods and Natural Resource Management Impacts of Agricultural Innovations in Africa: *Lessons from Applying Participatory Monitoring and Evaluation Systems*

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Abstract

Participatory, monitoring and evaluation (PM&E) can be a vital component of an effective demand-driven R&D system by providing a systematic process for tracking changes in the livelihoods of agricultural innovations. PM&E provides a systematic process for self-reflection and learning; documenting experiences and lessons; and assessing long-term environmental, NRM and poverty impacts. This continuous process of learning and adjustment of strategies is central to enhancing the impacts from agricultural innovations, and is crucial in deciding on what strategies should be scaled up and how this might be achieved. This paper presents the lessons of an action-research project aimed to strengthen capacity of biophysical scientists and their development partners, farmers' organizations and other stakeholders to implement PM&E systems to track progress of their projects, and assess NRM and poverty impacts of integrated natural resources management innovations. The paper shares various lessons: (1) Challenges with developing the capacity of scientists and other stakeholders in PM&E; (2) Types of scientific and local indicators that should be used to track the various aspects: NRM changes and livelihood impacts; (3) Comparative analysis of local indicators across Eastern, Southern and Western Africa and factors that affect the differences; (4) A comparative analysis of scientific versus local indicators for tracking changes in livelihoods, NRM and agricultural innovations; (5) Impacts of the PM&E process on enhancing the involvement of local stakeholders in the execution of their projects, leading to better results; (6) Impacts of the PM&E process on enhancing the performance and relevance of R&D projects.

Keywords: *Local and technical indicators, tracking change*

Participatory Verification of Effect of Local Organic Materials on Yield and Profitability of New Bean Varieties by Katosi Women Farmer Group in Mukono District

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Abstract

Research has found that linking farmers to market is a motivating factor for encouraging farmers to invest in soil fertility improvement techniques to maintain the sustainability of their production. Organic sources of fertilizers are common for farmers that cannot afford, or access, inorganic fertilisers. Integrating good varietal performances with organic soil fertility amendment improve soil quality and crop yield. Initially, five “new” bean varieties (NABE 4, NABE 5, NABE 11, NABE 12C and Mani ga mulimi) were tested for yield performance and profitability. Yields were only significantly different ($P \leq 0.05$) across sites. Therefore, farmers based selection on other characteristics rather than yield for varieties to adopt. NABE 4, NABE 5 and NABE 12C were the most preferred due to their good qualities (colours, size, promising marketability). In the subsequent trial, compost and liquid manure were evaluated on yields of two selected varieties. Similarly, yields were significantly different only across soil types. Participatory farmer evaluation using scoring determined that compost was preferred because most farmers were able to make it themselves. NABE 4 was most preferred because it was highly tolerant to drought and diseases, had short cooking time and tasty thick soup. Based on cost benefit analysis, control was more profitable than compost and liquid manure, farmers concluded that there was no need to add more nutrients to the soils. This reinforces the fear that farmers linked to markets will continue to exploit their natural resources and will not invest in sustainable crop production due to constraints investment ability and labour.

Keywords: *Bean production, organic farming, yield, farmer evaluation, profitability.*

Application of soil quality indicators in semi-arid rangelands in South Africa: perspectives for degradation monitoring

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Abstract

Concerns were raised over the past decades on the degradation condition of arid and semi-arid rangelands in South Africa, mainly in areas under communal land management. Changes of vegetation components were often used to characterize degradation, whereas soil quality and degradation processes remain less understood. The integration of soil information in rangeland monitoring cannot be overemphasized. The aims of this study were to characterize and establish baseline indicators of soil quality/health, and to investigate the potential effects of grazing and exclusion management on soil quality indicators, that could be used for reporting on rangeland degradation in semi-arid South Africa. The soil characterization provided some valuable baseline indicators of soil quality (and fertility) at the sites surveyed. Notwithstanding the alarming plea about communal rangeland degradation, similar soil quality indicators were observed between the sites under communal management and surrounding commercial and/or game areas, considered well managed based on the attributed of their aboveground vegetation. This challenges the sole use of vegetation parameters in monitoring and assessing rangeland health. Furthermore, site-specific approach is cautioned when assessing degradation between different rangeland management systems. The results warrant the need to re-examine the “tacit” degradation in communal managed areas rangelands. This warrants the need to re-examine the “tacit” degradation in communal managed areas. The effects of grazing were divergent depending on the soil properties monitored and site-specific characteristics. Last, the integration of both science-experts and community knowledge and understanding is essential to empower local stakeholders in order to support management decisions for sustainable rangeland use.

Keywords: *Baseline indicators; communal rangeland management; grazing and exclusion effects; rangeland degradation; soil quality.*

Income, food security, nutrients and labour: a comparison of key aspects of African smallholder farming systems using IMPACT.

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Abstract

The livelihoods of African smallholders are largely dependent on appropriate natural resource management on their farms. Income, food security, soil fertility and labour availability are key aspects that are closely linked and that determine, and are determined by, livelihood strategies of rural families Africa. As part of the AfricaNuances project, we collected information on the dynamics of smallholder farming systems in selected locations of eight African countries (Kenya, Tanzania, Uganda, Zambia, Zimbabwe, Mali, Ghana and Cameroon), differing broadly in agroecology, markets and demography. Case studies representing farmers of different wealth status were selected in each location. This enabled us to have a wide variety of systems types to explore key aspects determining the productivity and sustainability of these systems. The information was collected using the IMPACT tool (Integrated Modelling Platform for Animal-Crop systems) and consisted of detailed monthly household-level information on land management, crop and livestock production, household composition and farm labour, input/output flows and market links. A comparative analysis of income and expenditures and their sources, household food security in relation to labour availability nutrient flows was performed across the case-studies, identifying trade-offs between these different dimensions of the systems. The role of key components in the farming system determining the well-being of smallholders was analysed and synthesised to identify potential development pathways required to promote sustainable development in rural Africa.

Keywords: *AfricaNuances, Food security, IMPACT, smallholder farming systems*

Optimization of Soil Fertility Management Across different Socio-Economic Gradients: A Case of Smallholder Maize-based Agro-ecosystems in Central Kenya

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Abstract

In the last two decades, risks and uncertainties have impeded possible increases in per capita food production by smallholders in central Kenyan Highlands. These include erratic weather, degraded soils, dilapidated road infrastructure and limited access to credit. However, soil fertility depletion is the most fundamental cause of declining per capita food production. The situation has been exacerbated by increase in costs of inorganic fertilizers occasioned by structural adjustment programmes (SAPs) over the same period. Resource-poor smallholders have therefore resorted to low-external input soil fertility management technologies. The major objective of this study was to carry out socio-economic analysis of smallholders' soil fertility technologies with a view to enhance their profit maximization and food self-sufficiency under different resources constraints for different farm typologies in Maragwa District. Participatory Learning and Action Research were used to delineate farmers into different bio-physical and socio-economic strata while Gross margin analysis was used to develop recommendations for optimal farm resource use across different farm gradients. Total gross margin in Class I was KES 20,818, KES 5,377 in Class II while in Class III it was KES -4,372. All smallholders' actual farm plans were found to be inefficient in resource allocation leading to low food production, farm incomes and poverty. About 100 % of farmers were living below USD 1 per person per day. Application of Manure (5 tons/ha) combined with inorganic fertilizers (20- 60 kg N/ha) was found to be most optimal integrated soil fertility management options for sustainable maize-based production systems across different socio-economic gradients.

Keywords: *Maize-based production systems, Millennium development goals (MDGs), Profit maximization, Resource-poor smallholders*

Agronomic and farmer assessment of new bean and soybean germplasm in selected regions in Rwanda and the Democratic Republic of Congo

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Abstract

Introducing resilient germplasm often presents a rapid approach to improve crop production. Evaluation trials were installed with 36 farmers' associations, aiming to simultaneously assess the agronomic performance, including the efficacy of particular traits, and to obtain feedback on the adoption potential and marketability of the germplasm. Farmer associations in Rwanda and DRC (4 sites in Bas-Congo, 4 sites in Sud-Kivu, 4 sites in Umutara, 2 sites in Bugesera and 2 sites in Kibungo) tested 27 bush bean and 9 climbing bean varieties. Measurements included scoring of susceptibility to pests and diseases, biomass production, biological nitrogen fixation, grain yield and grain micronutrient contents. The performance of the germplasm varied largely, principally due to differences in climatic conditions. Low soil fertility was the foremost constraint for crop growth and large responses to manure application were observed. In almost all associations, new varieties were found with favourable traits compared to the local variety. Performance of individual varieties, however, differed largely between sites. Results of participatory evaluation showed significant differences between male and female farmers, between producers and traders, and between sites, in the criteria used for evaluation, and in the varieties selected. This demonstrates the importance of providing a basket of options from which farmers can select their preferred varieties when introducing resilient germplasm. Some generally well-performing bean varieties were AND-10 and VCB81012 in Sud-Kivu, CODMLB003 and VCB81012 in Rwanda, and Lola and MLV06-90B in Bas-Congo. Farmers are currently multiplying their preferred varieties and producing seed for other smallholder farmers in the region.

Keywords: *Common bean, participatory evaluation, resilient germplasm*

Responding to farmer resource endowments in targeting ISFM on smallholder farmers

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Abstract

A two-year study was conducted between 2005-07 in Chinyika smallholder farming area of Zimbabwe under the Soil Fertility Consortium for Southern Africa (SOFECSA)'s integrated soil fertility management (ISFM) initiatives. The objective was to evaluate how deliberate targeting of ISFM options to farmers along social gradients could enhance farmer participation and crop yields. Maize, green manure and grain legumes were planted to fields belonging three farmer resource groups (RGs), namely Resource-endowed (RG1); Intermediate (RG2); and Resource-constrained (RG3). Organic and mineral fertilizer resources were allocated according to these RGs, which were otherwise used as Learning Centres (LCs). Based on farmer criteria, the same treatments were sequentially rotated the following season. In season 1, five LCs, with at least one from each RG were established. The number increased to 18 the following season: 8 in RG1; 6 in RG2 and 4 in RG3. Average maize yields were 0.3 t ha⁻¹ (RG3), 1.0 t ha⁻¹ (RG2) and 4.2 t ha⁻¹ (RG1) in season 1. Overall, highest maize yields were from manure + mineral fertilizer combinations. Legume yields followed the same trend with soyabean yielding ~50 kg ha⁻¹ (RG3), 600 kg ha⁻¹ (RG2) and 1.4 t ha⁻¹ (RG1). Significant yield increases of up to 400% for RG3 and 250% for RG2 were achieved in maize plots in season 2. Green-manured plots gave exceptionally high maize yields of 7 – 10 t ha⁻¹ for RG1. The LC approach apparently encouraged better participation of all farmer groups and could enhance the contribution ISFM within smallholder communities.

Keywords: *Learning Centre; maize yields; mineral fertilizer; resource endowment*

Optimizing the production under trees in parklands at Nobéré (Burkina Faso) using shade tolerant crops

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Abstract

Cereals production has been reported to be reduced under trees in parkland systems due to the shade indicating the need to replace them with shade tolerant crops. Thus, an experiment on the association of two fruit-trees, *Adansonia digitata* (Baobab) and *Parkia biglobosa* (Néré), with the millet (*Pennisetum glaucum*) and a shade tolerant crop called tabouchi (*Xanthosoma sagittifolium*), was conducted in Nobéré (Burkina Faso). The two crops were grown under 4 trees of each fruit-tree species. The influence zone of each tree was subdivided in 3 concentric zones: A= from tree trunk to half radius of the crown; B=from half radius to the edge of the crown and C=from the edge to 3 m away. A control plot was established for each tree in an area under no influence of any tree. The results revealed no significant difference in the height of millet plants under the two fruit species whereas the highest plants of the tabouchi were observed under néré tree. Trees shade increased the number of tillers but reduced the total leaves area of millet plants. In turn, the total leaves area of tabouchi plants was increased by shade. The photosynthetic energy conversion yield measurements revealed that the two crops were stressed during data recording period even though plants stress was lower in shaded zones. As a consequence of the above functioning parameters, the highest yields of millet were obtained in zone C ($1754.17 \pm 177 \text{ kg ha}^{-1}$) under baobab trees while tabouchi performed better in zones A ($4531.82 \pm 835 \text{ kg ha}^{-1}$) and B ($3470.92 \pm 955 \text{ kg ha}^{-1}$) under néré trees proving its shade tolerance. An economic evaluation of the option of replacing cereal by shade tolerant crop is going to be conducted.

Keywords: *Adansonia digitata*, *Parkia biglobosa*, *Pennisetum glaucum*, shade tolerance, *Xanthosoma sagittifolium*

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 Shistosome 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, 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*

The African Network for Soil Biology and Fertility (AfNet)

The African Network for Soil Biology and Fertility (AfNet) was established in 1988 as a pan-African Network of researchers in Sub-Saharan Africa. AfNet is the single most important implementing agency of Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT) in Africa. More recently, a Memorandum of Understanding (MOU) was signed between the Forum for Agricultural Research in Africa (FARA) and The International Centre for Tropical Agriculture (CIAT) for hosting AfNet under the umbrella of FARA. Since its inception, AfNet has grown steadily and the current membership stands at over 400 scientists. The Network aims at strengthening and sustaining stakeholder capacity to generate, share and apply soil fertility management knowledge and skills to contribute to the welfare of farming communities in the Africa. This is achieved through the adoption of the integrated soil fertility management (ISFM); a holistic approach to soil fertility that embraces the full range of driving factors and consequences namely biological, physical, chemical, social, economic and policy aspects of soil fertility.

The main activities of AfNet are:

- (i) **Research and development activities:** Network trials are scattered in more than 100 sites across the continent. The research is undertaken in collaboration with national agricultural research systems (NARS) scientists, farmers, non-governmental organizations (NGOs), local and foreign universities and advanced research institutes (AROs). Other partners include the CGIAR centres, system wide programmes (SWPs), Challenge Programmes (CPs) and other networks. The main research themes include: soil fertility management, nutrient use efficiency, conservation agriculture, targeting of recommendations to farmers and scaling-up success stories, among others
- (ii) **Capacity building:** AfNet's capacity building agenda is achieved through degree oriented training (MSc and PhD research) in the domain of ISFM as well as through short courses. Over the years AfNet offered several training courses on topics such as participatory research and scaling-up, decision support systems (DSSAT), proposal and scientific writing, presentation skills, soil erosion and carbon sequestration and nutrient monitoring (NUTMON) in agro-ecosystems, markets and agroenterprise development.
- (iii) **Information dissemination:** In an effort to facilitate exchange of information among all stakeholders, AfNet has published several books, newsletters, brochures and posters. AfNet has successfully organized 9 international symposia where researchers from across the continent were able to share their research experiences. AfNet has also established The Essential Electronic Agricultural Library (TEEAL) to facilitate information dissemination to researchers and students.

The AfNet Coordination Unit is comprised of The Coordinator, two research assistants and one administrative assistant. The AfNet Steering Committee consists of a multi-disciplinary and gender balanced team of African Scientists drawn from the Eastern, Southern, Central and Western Africa regions.

Soil Fertility Consortium for Southern Africa (SOFECSA)

The Soil Fertility Consortium for Southern Africa (SOFECSA) is a multi-institutional and interdisciplinary regional organization founded 2005 to develop and promote technical and institutional innovations that enhance contributions of integrated soil fertility research and development to sustainable food security and livelihood options in Southern Africa. SOFECSA is an impact-oriented consortium operationalised through a 15-member technical management/steering committee in collaboration with the host institution (CIMMYT-Southern Africa), a regional coordinator and support staff, and country-level teams drawn from diverse stakeholders.