

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*