Output 4
Improved rural livelihoods through sustainable, profitable, diverse and intensive agricultural production systems

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Rationale

Intensification and diversification of smallholder agricultural production is needed to meet the food and income needs of the poor and cannot occur without investment in natural resource management, especially soil fertility. Investing in soil fertility management is necessary to help households mitigate many of the characteristics of poverty, for example, by improving the quantity and quality of food, increasing income, and resilience of soil productive capacity. Access to multiple stress-adapted and improved crop varieties and multi-purpose legume species, improved soil and water conservation practices and improved targeting to different categories of farmers, are a few examples of existing interventions.

Investment in improving soil fertility is not constrained by a lack of technical solutions *per se* but is more linked to lack of access to: information for improved decision making and analyzing trade-offs; inputs (e.g. fertilizers, credit and improved germplasm) and profitable markets.

Technical innovation to improve poor people's agricultural productivity can link the goals of improving small farm competitiveness, increasing assets, nutrition and income to the sustainable management of the natural resource base.

Key research questions

1. Which ISFM options are appropriate, where (farm//landscape), and for which farmers (typologies/social capital) to create profitable and resilient agricultural production systems?
2. What are the component and system thresholds for improving resilience of target farming systems?
3. Where and under what conditions does market orientation lead to increased investment in integrated natural resource management (INRM) and improved livelihoods?
4. What information, resources and knowledge do farmers need for improved decision making?

Highlights

- In a set of demonstration trials in 4 districts in western Kenya, aiming at suppressing *Striga hermonthica,* herbicide-resistant maize (IR-maize) reduced the emergence of *Striga*, although its productivity was observed to be lower than that of the hybrid varieties. The push-pull *Desmodium*-maize intercropping system substantially reduced *Striga* emergence but only after 2 seasons. *Mucuna*-maize rotations led to a substantial reduction in *Striga* emergence and increase in maize grain yield while this was not true for the soybean-maize rotation. In the latter case, however, the production of grains for food or sale is certainly going to result in better economic returns in the latter treatment. *Striga* emergence reduced substantially between season 1 and season 4 in all treatments, indicating that consistent uprooting of *Striga* seedlings before flowering can gradually decrease its seed-bank. Both male and female farmers appreciated the *Striga* tolerant properties of the IR-maize but less its productivity. Fertilizer application was also appreciated, even in terms of *Striga* tolerance, probably due to better maize growth after fertilizer application, even in presence of *Striga*.
- In response to the need for a high-value cash crop that could be grown and marketed by large numbers of small farmers and which could drive their investment in improved soil fertility, the exposure of rural households to soybean has been broadened in ways that now enables them to participate in the crop's development in western Kenya.

- A three-tier-approach comprising of household-level tier, community-level tier, and the tier on linking producers with large-scale feed and food processing companies has been used to sustainably promote soybean in the farming systems of Kenya. A simple adaptation is what is required to use it to promote any other agricultural enterprise.
- Although the number of agro-input dealers in Kenya is still small relative to the rural population, there has been a steady increase ranging from 2% for seed treatment chemicals to 22% for mineral fertilizers with a mean of about 16% from 2003 to 2005.
- Results from a survey of grain traders in western Kenya showed that altogether, 16 different grains were found across the markets, the most common (in terms of number of traders selling it) being millet (31% traders), sorghum and rice (27% each) among the cereals and common beans (22%), soybean (18%) and groundnut (17%) among the grain legumes.
- Various studies in east and southern Africa have shown that linking farmers to markets can lead to increase investments in natural resource management, if innovative agricultural technologies that meet the specific needs and constraints of different wealth and gender groups are developed.
- Active involvement of stakeholders in the design of the NRM system points to ways of tightening the nutrient cycle, for example, in relation to women's management of small livestock, and the use of multipurpose legumes and dual purpose barriers as sources of biomass for soil fertility, livestock feed, fuel and fencing.
- In Zimbabwe, increases in crop yields, %N fixation and, N balance and residual fertility in cotton-cowpea intercropping systems showed that this could be a potentially productive system that can easily fit into the current smallholder farming systems under rain-fed conditions.
- Results from a household nutrition and health situation in Mbita division, Suba district, Kenya with the aim of developing a comprehensive program for intervention using soybean-enriched diets in the management of HIV/AIDS, indicated that the diets of the children were inadequate for the majority of the households. Vital statistics from Suba district indicate high mortality rates of 147/1000 and 247/1000 for infants and children under the age of five, respectively. Also, there was a high prevalence of diseases among the children and in the households in general.
- Household socioeconomic and demographic characteristics in Mbita division, Suba district, Kenya showed that over 30% of the study population was children under-five, followed by those in the 16-25 age-ranges (23%). The average household size was confirmed to be 4.8. Overall, the study area has young population with 92% falling between 0-36 years, an indication of low life expectancy and females (53.9%) constituted more than half of the total household members (n=1278), while males constituted 46.1%. The study also revealed high level of unemployment rate in the study area, with 17.1% involved in unpaid employment. Finally the majority of the households fall within the low SES with deepening poverty background depicted by low educational achievement, occupational status and small land holding acreage.
- The food situation and nutritional status of children aged 6-9 years old from HIV/AIDS affected areas of Suba District, Kenya showed that in Sindo primary school 98.1% were female while 1.9% were male. The guardians/parents of children in Sindo primary school are engaged in small businesses (56.6%) and 13.2% are in temporary employment. Those that were unemployed comprised of 26.4% and the self employed 1.9%. These results are different in Ongayo primary school where a big number of parents (73.2%) are unemployed, 8.9% are in temporary employment while 17.9% run small businesses.
- The issues of HIV prevalence, household food/nutrition security, and quantity and quality food supplies led to land use practices that degrade the soil fertility in the areas of catchment. But it was shown that intercropping amaranth and soybeans improved it, thus increasing plant nutrition.

- Farm-level analysis of trade-offs between soil fertility management alternatives is required to improve understanding of complex biophysical and socio-economic factors influencing decision making in smallholder farming systems and to identify opportunities for improving resource use efficiency.
- Models for analyzing farm-level trade-offs and scenario analysis has shown that decision support tools can be used to analyze impacts of changes in production on labor requirements, income investments and impacts on food and nutrition security.

Output target 2007

ü ***Crop-livestock systems with triple benefits tested and adapted to farmer circumstances in hillsides***

Published work

Delve, R.J[1], Chitsike, C[2], Kaaria, S[3], Kaganzi, E[3], Muzira, R[3]. and Sanginga, P[3]. (2006). Smallholder farmer-market linkages increase adoption of improved technological options and NRM strategies. In: Amede, T[4], German, L[5], Opondo, C[6], Rao, S[7]. and Stroud[5] (eds). 2006. Integrated natural resource management in practice: Enabling communities to improve mountain livelihoods and landscapes. Proceedings of a conference held on October 12-15, 2004 at ICRAF-Headquarters, Nairobi, Kenya. Kampala, Uganda: African Highlands Initiative

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Abstract: The paradigm of involving farmers in research is based on strong evidence that enhancing farmers technical skills and research capabilities, and involving them as decision-makers in the technology development process results in innovations that are more responsive to their priorities, needs and constraints. Linking the technology development process to market opportunities has the potential to promote links between investment in natural resources, markets, and adoption of technologies. Market orientated agriculture for reducing poverty and environmental degradation needs to centre on three related paradigms; strengthening biological processes in agriculture (to optimise nutrient cycling, minimize external inputs and maximize the efficiency of their use); building farmer's capacities (to learn and innovate focused on improving livelihoods and the management of natural resources); and developing forward and backward linkages (between natural resources, production and markets). Starting with identification of market opportunities, natural resource management (NRM) issues are often raised during the process, for example, investment in soil fertility, leading to an iterative cycle of participatory action research with communities. In a multi-stakeholder coalition, CIAT and its partners are working in Malawi, Mozambique, Tanzania and Uganda to explore and understand how market orientation leads to improved NRM at the farm level. This paper uses case studies from Kabale in south western Uganda to highlight and discuss examples where identifying potential markets for existing and new products has led to increased investment in NRM and how developing innovative agricultural technologies that meet the specific needs and constraints of different wealth and gender groups leads to improved livelihoods. This active involvement of stakeholders in the design of the NRM system points to ways of tightening the nutrient cycle, for example, in relation to women's management of small livestock, and the use of multipurpose legumes and dual purpose barriers as sources of biomass for soil fertility, livestock feed, fuel and fencing.

Rusinamhodzi, L[1], Murwira, H.K[1], and Nyamangara, J[2]. 2006. Cotton-cowpea intercropping and its N_2 fixation capacity improves yield of a subsequent maize crop under Zimbabwean rain-fed conditions. Plant and Soil 287: 327-336

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Abstract: Intercropping cotton (*Gossypium hirsutum* L.) and cowpea (*Vigna unguiculata* (L.) Walp) is one of the ways to improve food security and soil fertility whilst generating cash income of the rural poor. A study was carried out to find out the effect of cotton-cowpea intercropping on cowpea N_2-fixation capacity, nitrogen balance and yield of a subsequent maize crop. Results showed that cowpea suppressed cotton yields but the reduction in yield was compensated for by cowpea grain yield. Cowpea grain yield was significantly different across treatments and the yields were as follows, sole cowpea (1.6 Mg ha^{-1}), 1:1 intercrop (1.1 Mg ha^{-1}), and 2:1 intercrop (0.7 Mg ha^{-1}). Cotton lint yield was also significantly different across treatments and was sole cotton (2.5 Mg ha^{-1}), 1:1 intercrop (0.9 Mg ha^{-1}) and 2:1 intercrop (1.5 Mg ha^{-1}).

Intercropping cotton and cowpea increased the productivity with land equivalence ratios (LER) of 1.4 and 1.3 for 1:1 and 2:1 intercrop treatments respectively. There was an increase in percentage of N fixation (%Ndfa) by cowpea in intercrops as compared to sole crops though the absolute amount fixed (Ndfa) was lower due to reduced plant population. Sole cowpea had %Ndfa of 73%, 1:1 intercrop had 85% and 2:1 intercrop had 77% while Ndfa was 138 kg ha^{-1} for sole cowpea , 128 kg $ha^{-1}$for 1:1 intercrop and 68 kg ha^{-1} for 2:1 intercrop and these were significantly different . Sole cowpea and the intercrops all showed positive N balances of 92 kg ha^{-1} for sole cowpea and 1:1 intercrop, and 48 kg ha^{-1} for 2:1 intercrop. Cowpea fixed N transferred to the companion cotton crop was very low with 1:1 intercrop recording 3.5 kg N ha^{-1} and 2:1 intercrop recording 0.5 kg N ha^{-1}. Crop residues from intercrops and sole cowpea increased maize yields more than residues from sole cotton. Maize grain yield was, after sole cotton (1.4 Mg ha^{-1}), sole cowpea (4.6 Mg ha^{-1}), 1:1 intercrops (4.4 Mg ha^{-1}) and 2:1 intercrops (3.9 Mg ha^{-1}) and these were significantly different from each other. The LER, crop yields, %N fixation and, N balance and residual fertility showed that cotton-cowpea intercropping could be a potentially productive system that can easily fit into the current smallholder farming systems under rain-fed conditions. The fertilizer equivalency values show that substantial benefits do accrue and effort should be directed at maximizing the dry matter yield of the legume in the intercrop system while maintaining or improving the economic yield of the companion cash crop.

Delve, R.J[1], Gonzalez-Estrada, E[2], Dimes, J[3], Amede, T[4], Wickama, J[5], Zingore, S[1] and Herrero, M[2]. (2006). Evaluation of a farm-level decision support tool for trade-off and scenario analysis for addressing food security, income generation and NRM. In: Amede, T[4], German, L[6], Opondo, C[7], Rao, S[8]. and Stroud[5] (eds). 2006. Integrated natural resource management in practice: Enabling communities to improve mountain livelihoods and landscapes. Proceedings of a conference held on October 12-15, 2004 at ICRAF-Headquarters, Nairobi, Kenya. Kampala, Uganda: African Highlands Initiative.

[1]TSBF-CIAT, Zimbabwe; [2]ILRI, Kenya; [3]ICRISAT, Zimbabwe; [4]TSBF-CIAT, c/o ILRI, Addis Ababa; [5]ARI, Zimbabwe; [6]AHI, Kenya;[7]Dominion Farm, Kenya [8]ICRAF, Kenya

Abstract: Resource-poor farmers face difficult decisions over the use of scarce nutrient sources in crop-livestock production systems. A better understanding of the comparative values and trade-offs in the use of land, labour, manures and other locally available resources is required in order to increase the production and efficiency of mixed crop-livestock systems. While efforts are required to expand our knowledge of the biophysical aspects of alternative uses of organic nutrient sources, similar efforts are also required on the socio-economic driving forces behind farmers' decision making. The approach uses trade-off analysis, partial budgeting and multiple goal linear programming to identify management options to address farmers production criteria and overcome their constraints. This evaluation includes both the short and longer-term economic and environmental benefits. From the social and economic viewpoint, organic resources can be identified that could substitute for mineral fertilizers in areas where fertilizers are not affordable. From an environmental aspect, management practices could be identified that results in fewer nutrient losses and could rebuild or maintain the soil resource base.

A multi-stakeholder coalition has been working in Ethiopia, Tanzania, Zimbabwe and Uganda and has successfully developed a decision support tool (DST) to explore these different trade-offs and scenarios based on smallholder farmers existing practices and opportunities. This paper uses case studies from AHI benchmark sites in Lushoto, Tanzania and Areka, Ethiopia to discuss the potential of the DST for improving farmers and development partners decision making to achieve food security, increase farm income, increase returns to land and labour and maintaining sustainable production.

Examples to be presented will investigate scenarios and trade-offs for three different wealth categories per site and for different areas of the farm with varying soil fertility levels, for example:

- Land allocation – which crops to which land
- Efficiency of fertilizer use – when to apply, where to apply it in the rotation, how much

- ∉ Labour constraints – when to weed, when to apply manures
- ∉ Investment options: capital allocation - livestock versus crop enterprises, labour allocation - farm and non-farm
- ∉ Appropriate use of crop residues in mixed systems
- ∉ Integration of legumes into the system

Completed work

Farmers' participatory evaluation of a community-based learning process: "Strengthening Folk Ecology" for integrated soil fertility management in Western Kenya

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Farmers and researchers in western Kenya have used community based learning approaches to jointly develop a "dynamic expertise" of integrated soil fertility management (ISFM). This approach builds on farmers' "folk ecology" and outsiders' knowledge, taking action research on natural resource management beyond methods that are descriptive (ethnopedology) or curriculum-driven (farmer field schools). The paper presents and analyses experiences from the on-going participatory monitoring and evaluation of the Strengthening "Folk Ecology" project to document and critique the community-based learning process and its sustainability. Issues include the trade-offs and tensions between science and action-oriented research as well as the true potential of participatory methods for "leveling" power relations between different actors.

Three categories of learning outputs are addressed: a) farmers and researchers learning from experimental results themselves, b) farmers' learning from the experimentation process, and c) researchers' learning from the experimentation process.

a) Evaluating research results. Activities have been conducted every season (long and short rains) from 2002-2005. Topics addressed in collective experiments included organic resources, inorganic inputs, cereal – legume rotations, indigenous vegetables. The diversity of follow-up activities at collective and individual levels

Observations on farmers' experiments: In many cases, the over-simplified experimental design initially preferred by the project undermined the scientific rigor of findings without actually improving clarity for farmers. This allowed for many conflicting interpretations of results, which (for example) confounded local characteristics and land-use history with treatment effects. Farmers and researchers both felt that there was a need to include more farms as replicates in collective experiments to improve the chances that findings could be compared across sites. In all the study sites, farmers' data collection abilities were quite strong; when these quantitative skills were combined with participatory evaluations it proved to be a powerful learning tool. Individual experiments were carried out in three different modes: Verifying / validating the findings of collective experiments, modifying technologies to fit new uses, and adapting the technologies to become more convenient or easier to operationalise in the local context. Farmers reported increased confidence in the dynamic expertise that emerged from their collective and individual experiments (which included the use of organic and inorganic inputs, cereal-legume rotation, the role of different soil nutrients and deficiencies, and ISFM for indigenous vegetables). Many technologies outside of ISFM were considered by farmers as part of the "Folk Ecology" project, including Striga control, soil and water conservation, and aspects of crop husbandry or agronomy such as row planting beans (formerly only broadcast). Finally, some farmers had developed erroneous assumptions from their participation, treating experimentation as a "demonstration" of good options (e.g. Stover as a beneficial soil input when it had been included in experiments as a low quality material against which to test high quality ones).

b) Farmers evaluating research process. At the participatory evaluation session held in June 2005, farmers' groups made comments on the following topics: Communication and feedback, Incentives to participate, Group politics, and Scaling up impacts. Most groups are also now re-baptizing "Folk Ecology" project with local names. To facilitate better learning from experimental results farmers insisted that there be a much faster feedback of data, test results (i.e. of soil and biomass), and of the photos and certificates that were promised by researchers. Other farmers were also faulted for lagging in the sharing of knowledge they gained from study tours, as well as the results of their individual experiments. Among the incentives to participate, many mentioned the idea of setting targets and goals (through organised competitions and prizes). Other problems included the failure of participants to honour their commitments (e.g. times and dates of activities), the need to "cost share" on onerous tasks (with payment or at least provision of lunches or sodas). Participants were also angered that researcher-designed trials employed outsiders as the day labourers when local labour could have been used. Some commentators also wanted the farmers' evaluations of the researchers to be included in the commendation (or sanctioning!) of researchers by CIAT (e.g. included in our Annual Assessments).

Other comments expressed strong desires for test crops to be broadened beyond maize to include other local staples (millet, sorghum, cassava) as well as local vegetables. Insistence on the importance of local soil types also means extending test sites (and replication) to include this variable. Seed bulking remains a priority activity for farmer groups (and individual experimenters).

c) Researchers evaluating research process. All the project activities are now linked explicitly to a phasing out of activity (end date = 30 June, 2008). This guides everything from building capacity for experimentation to establishing seed supply, group financing strategies, and links with support personnel. Self-organization and funding is being promoted with proposals to local NGOs, marketing and credit activities. It was observed that despite its complexity, soil fertility management is actually a good "entry point" for participatory research and has promoted a wide range of learning and empowerment. The group-based approach does seem to use (and reinforce?) selective pathways of communication and learning, and may not adequately address the most vulnerable community members. The top-down extension model is deeply entrenched both in farmers' and researchers' attitudes (and follows the flow of resources in this and most other TSBF projects); "scientized" language remains a marker of status in many of the interactions. More attention needs to be paid to learning from the group members who have "opted out" of formal involvement.

The potential of *Ipomoea stenosiphon* as a soil fertility ameliorant in Zimbabwe

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There is potential for smallholder farmers in Zimbabwe to use locally available plant resources. The challenge is to identify those with high nutrient concentrations and large amounts of above ground biomass. *Ipomoea stenosiphon* (Hall) A. Meeuse, a plant species indigenous to Zimbabwe, is currently being used by farmers in Ngundu (semi-arid) and this study builds on farmers' current knowledge. The aim of this study was to determine its variation in shoot nutrient concentrations with respect to soil type, its mineralisation potential and effect on maize productivity. *Ipomoea stenosiphon* growing on clayey soils had significantly higher shoot N concentration of 43 g N kg^{-1} compared to 11 g N kg^{-1} on sandy soils ($P<0.001$). The highest shoot P concentration of 4.6 g kg^{-1} was recorded in plants growing on clayey soils and was significantly higher than a concentration of 2.5 kg P kg^{-1} measured on a sandy soil ($P<0.05$). Shoot K concentration ranged from 1.5% in sandy soil to 4% in clayey soil, with significant differences among different soil types ($P<0.05$). Above ground biomass production from all the three soil types was significantly different ($P<0.05$) with clay having the highest biomass production of 12.3 t ha^{-1} and least amount was from sandy soils (2.6 t ha^{-1}) in natural stands. Laboratory incubation of *I. stenosiphon* shoot biomass showed its superior N mineralisation over several agroforestry species that included *Cajanus cajan, Lablab purpureus, Macroptilium atropurpureum* and *Leucaena diversifolia* ($P < 0.05$) but was

inferior to *Leucaena leucocephala* and *Acacia angustissima* because of their higher N content of 3.23% and 3.03% respectively, compared to 2.27% for *I. stenosiphon*. Field evaluation in Ngundu and Shurugwi showed average maize yield increases of 3 and 4 t ha^{-1} respectively after application of *I. stenosiphon* biomass at 75 kg N ha^{-1}. These yields showed N fertilizer equivalences of 81% and 86% in Ngundu and Shurugwi respectively. Corresponding P fertilizer equivalence values ranged from 85% to 107% when 15 kg P ha^{-1} of *I stenosiphon* biomass was used. The study showed the high capacity for acquisition and accumulation of soil nutrients in *I. stenosiphon* biomass. The plant could be used as a soil ameliorant in biomass transfer systems but there is a danger of long term nutrient mining that requires further research.

Evaluation of resource management options for smallholder farms using an integrated modelling approach

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Farm-level analysis of trade-offs between soil fertility management alternatives is required to improve understanding of complex biophysical and socio-economic factors influencing decision making in smallholder farming systems and to identify opportunities for improving resource use efficiency. A farm characterization (IMPACT) tool linked to a generic (Household) optimisation model was used to evaluate resource use on farms in contrasting wealth categories in Zimbabwe for the 2002/2003 cropping year. The Household model optimised farm's gross margins taking into account productivity of crops and livestock, off-farm activities and food sufficiency. Alternatives for management of nutrient resource were simulated using APSIM for the crop production and RUMINANT for the livestock component. The output from the simulation models was fed into the Household model and evaluated within the biophysical and socio-economic boundaries of the farms. Analysis of the performance a poor farm by IMPACT produced a yearly negative net cash balance of US$ -7, mainly due to negative returns from the cropping system.

The farmer relied on donated food and fertilizers. The cash balance was negative, even though she also sold labour to generate income. The net income balance on the poor farm would be increased to US$81 and N balance from 7 kg ha^{-1} to 10 kg ha^{-1} by expanding the area allocated to groundnut from the current 5% to 31%. This would, however, generate a huge demand in labour (46-man days more) and reduce the P balance from 0 to -1 kg ha^{-1}. Maize would be managed more efficiently on the poor farm by cultivating a smaller, well-managed area. A wealthy farm under a maize-dominated cropping system had a net cash balance of US$210, mainly from sell of crop products. Under current resource management, the net cash balance would be increased to US$290 by optimisation of diet. The net cash balance for the wealthy farm would be further increased to US$448, and nutrient balances by 271 kg N ha^{-1} and 30 kg P ha^{-1} by expanding the management strategy where maize was grown with a combination of cattle manure and ammonium nitrate. To do this, the farmer would need to source more manure (or improve capture and the efficiency with which nutrients are cycled through manure) and invest in 110 man-days extra labour. Expansion of the area grown to groundnut without fertilizer inputs to a third of the farm reduced net cash balance by US$11 compared to the current crop allocation due to poor groundnut yield. This also increased labour demand by 155 man-days. Groundnut intensification on the wealthy would be more economical and labour-effective if a small area is grown with basal fertilizer. Despite reducing nutrient balances for the arable plots, feeding groundnut residues to lactating cows increased net cash balance for the current year through increased milk production.

Promoting the adoption of conservation agriculture approaches in smallholder farming areas of Zimbabwe (Madziwa and Wedza projects)

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Conservation agriculture (CA) is a way to improve the livelihoods of millions of people and achieve sustainable agriculture over a wide area. It has shown promise in Africa where farming communities are perennially faced with problems of low yields, low fertility, lack of capital and labour shortages mainly attributed to the AIDS scourge. Soil fertility depletion, land degradation and drought, exacerbated by soil tillage and tillage-induced soil erosion, are major threats to food security and the sustainable intensification of agro-ecosystems. The principles of CA are minimum soil disturbances, crop residue retention and either crop rotation or intercropping. These principles are thought to improve soil fertility, production of more food, using less labour at a lower cost. Farmer managed demonstration plots on CA approaches were established starting 2006-07 seasons in the target communities. In Madziwa, three approaches are being compared and these are; mulch ripping, direct seeding with residue retention and conventional ploughing with no residue retention in maize and soyabean based systems. Maize is the staple food of most of people in East and Southern Africa while soyabean is becoming a very important cash crop. These approaches will be adapted each season based on experiences and feedback from farmers. We hope that resource poor farmers who are the ultimate beneficiaries, will benefit from more stable and productive systems that help conserve the resource base, and that are less costly, allowing the family to engage in additional economic activities. Women are likely to benefit from reduced labor requirements for the production of staple grains. Government scientists and extension workers, and other research and development specialists will broaden their knowledge base of experience on impact-oriented research on conservation agriculture and natural resource management. We also hope to define farmer recommendation domains based on land types, agro-climatic regions, livestock ownership or other criteria.

Output target 2007

ü ***Strategies of BGBD management for crop yield enhancement, disease control, and other environmental services demonstrated in seven tropical countries participating in the BGBD project***

Progress towards this output target will be reported next year.

Output target 2008

ü ***Improved production systems having multiple benefits of food security, income, human health and environmental services identified***

Published work

Chianu[1], J., Vanlauwe[1], B., Mukalama[1], J., Adesina[2], A., Sanginga[1], N. (2006) Farmer evaluation of improved soybean varieties being screened in five locations in Kenya: Implications for research and development. African Journal of Agricultural Research Vol. 1 (5): 143–150.

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Abstract: In order to determine the improved soybean varieties that if recommended to the farmers would have a high probability of adoption, a farmer participatory approach was used to evaluate 12 soybean varieties at full podding in five locations (*Oyani*, *Riana*, *Kasewe*, *Akiites*, and *Mabole*) in western Kenya. These comprise of 11 improved varieties (TGx1871-12E, TGx1895-4F, TGx1895-33F, TGx1895-49F, TGX1878-7E, TGx1893-7F, TGx1893-10F, TGx1740-2F, TGx1448-2E, NAMSOY 4m, and MAKSOY 1n) and one local variety (*Nyala*). Farmers generate all the 17 criteria for use in the evaluation, with researchers only facilitating. One hundred and two farmers (52% females) participated in the evaluation. A scoring matrix was employed to articulate the results. Data analysis was done using Microsoft Excel. This paper shows that of the seven dual-purpose varieties tested in all the five locations, only TGx1740-2F was acceptable in all. Some varieties were acceptable in specific locations: TGx1895-49F in *Oyani*, *Nyala* in *Kasewe*, TGx1448-2E *Akiites*, and TGx1893-7F in *Mabole*. This result shows that to avoid low adoption, a blanket recommendation of varieties that were accepted only in selected locations must be avoided. TGx1740-2F was the only variety that could be recommended across locations and that was clearly better than the existing farmers' own variety, *Nyala*.

Mbanasor Jude, A. and Chianu, J.N. (2006). Efficiency of indigenous poultry feed production enterprises in Abia State, Nigeria. International Journal of Poultry Science 5 (5): xx-xx.

[1]Federal University of Agriculture, Umudike, Nigeria; [2]TSBF-CIAT, Kenya

The determination of efficient production levels for indigenous poultry feed production enterprises, given the existing technology is necessary to examine alternative options to increase productivity. If producers are not making efficient use of existing technologies improving their efficiency is usually more cost-effective than introducing new technology. This paper examines the technical efficiency of the indigenous poultry feed production enterprises in Abia State, Nigeria. A stochastic Trans-log production frontier with technical inefficiency effect model is specified and estimated. The estimated mean technical efficiency of the 120 enterprises in the sample is 78%. Also the test of full technical efficiency for the enterprises is rejected; hence there is presence of inefficiency in the production activities of the enterprises in the study area. The outstanding variable affecting technical efficiency of the enterprise is experience. However, as indigenous poultry feed producers in Abia State, Nigeria have attained a high level of technical efficiency under existing technology; the introduction of new technology is a key to raising the productivity of the enterprise. The modernization of processes involved provides a promising new technology to raise the productivity of the enterprise.

Completed work

Soybean: a new role in western Kenya. Highlights – CIAT in Africa, No. 35 June 2006.

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Soybean (*Glycine max*) is an annual legume crop grown in Kenya. It was introduced from Uganda as early as 1904 and although it has been promoted by various national and international organizations over

the years, it still remains a minor crop in the farming systems throughout the country. This initiative, recently catalyzed by TSBF-CIAT, aims to broaden the exposure of rural households to soybean in ways that enable them to participate in the crop's development in western Kenya. This was a response to the need for a high-value cash crop that could be grown and marketed by large numbers of small farmers and which could drive their investment in improved soil fertility. Project partners are the Kenya Agricultural Research Institute, Kenyatta University, the Lake Basin Development Authority, the Kenya Forestry Research Institute, the International Maize and Wheat Improvement Centre (CIMMYT), and the International Institute for Tropical Agriculture (IITA).

The new initiative aims to: (i) capture and hold the interest of farmers in soybean through an information campaign (to dispel unfounded myths and emphasize its benefits), and (ii) create a desire amongst farmers to process and consume soybean in different forms through training in processing. Underlying this approach is the need to promote and encourage sustainability in the soybean industry in the region through encouraging community-based seed production, improving links with the private seed sector, and providing training in seed storage and marketing.

A model for promoting a versatile crop that has remained minor: the case of soybean in Kenya. 1 Prize Award Winning poster. GFAR-2006 Poster Competition. *Evidence-based contributions of ARD to the Millennium Development Goals (MDGs)*, New Delhi, India.

Chianu, J. N[1], Ohiokpehai, O[1], Vanlauwe, B[1], Okoth, P[1], Roing K[1], Adesina, A[2], Naidoo, P[3], Opondo, J[4], and N. Sanginga[1]

[1]TSBF-CIAT, Kenya; [2]Rockefeller Foundation, Kenya; [3]Kenyatta University, Kenya; [4]Dominion Farm, Kenya

Soybean is an important food, feed, oil and cash crop in the world. As a legume, it also fixes atmospheric nitrogen, thereby helping to improve soil fertility saving on farmer investment in mineral fertilizers. Efforts to promote it in sub-Saharan Africa led to mixed results with successes in Nigeria and Zimbabwe and failures in Kenya due to several reasons including (i) lack of awareness on processing/utilization, (ii) low yield, (iii) lack of market and policy support, and (iv) low prices. This paper uses the understanding of reasons for successes in Nigeria and Zimbabwe and for failures in Kenya to create a model called 'three-tier-approach' for sustainable soybean promotion in Kenya. This model is about intervening at household level, community level, and linking soybean producers with large-scale feed and food industries that use soybean for manufacturing but presently import large quantities of soybean used for manufacturing. Results show that the model has increased the confidence of farmers to produce soybean for home consumption and the market. Thousands of farmers' groups, their networks, and individual farmers are presently benefiting from this approach and are beginning to take advantage of all the benefits (food, feed, oil, cash crop, soil fertility improvement, etc.) of soybean. The organization of all stakeholders in a strategic alliance to strengthen the model is yielding numerous benefits (e.g., increase in income, availability of credit for farm inputs, availability of farm inputs, assurance of market at mutually agreed prices, ready availability of market information, public private partnership). The paper concluded by recommending the three-tier model supported by appropriate institutions, policies and strategic alliances for sustainable promotion of important crops such also soybean in Kenya and similar environments.

Feeding Patterns and Practices among Households With Children Aged 6-59 Months In Mbita Division, Suba District, Kenya

O. Ohiokpehai[1], J. Kimiywe[2], P. Naidoo formerty of Rockefeller[3], A. Adesina[4] and N. Sanginga[1]

[1]TSBF-CIAT, Kenya; [3 4]Kenyatta University; [4]Rockefeller Foundation

The growth patterns of children are reflective of community nutritional status and food security, which is measured in terms of food consumption patterns and practices, availability and accessibility. Vital statistics from Suba district indicate high mortality rates of 146.9/1000 and 247/1000 for infants and

under fives respectively. The expected HIV cases are also estimated at 41% of the reproductive population. The purpose of this study therefore was to conduct a baseline survey on the nutrition and health situation in Mbita division, Suba district, with the aim of developing a comprehensive programme for intervention using soybean-enriched diets in the management of HIV/AIDS. To achieve this, the following objectives were formulated; to establish the food consumption and utilization practices in the households; determine food production patterns and practices; determine food accessibility and availability, and to investigate the morbidity patterns of households and children. The survey was conducted in three locations namely Gembe West, Gembe east and Rusinga West. 265 households, 162 from township, 50 from Kayanja and 53 from Kaswanga were interviewed. Food frequency and 24-hour recall were used to collect data on household and children's food consumption patterns and practices. A structured questionnaire was used to collect data on feeding and childcare practices and household morbidity patterns. To access food availability and accessibility, respondents were asked questions on methods of food acquisition and production patterns. The study findings were verified by information from key informant focus group discussions and from observational checklist. Results indicated that the diets were inadequate for the majority of the households. Most households depended on fishing and very few practiced subsistence farming, most of the foods consumed were therefore purchased. Some families resorted to food for work and donations because of insufficient incomes.

There was also a high prevalence of diseases among the children and in the households in general. The common illnesses reported were malaria, upper respiratory tract infections, stomach-ache and diarrhea/typhoid among others. An in-depth study should be conducted in Suba District in order to determine the magnitude of malnutrition and rate of morbidity and its relationship to the prevalence of HIV/AIDS, and the causes and consequences of these on the socio economic status of the individuals in the community. This will facilitate in the planning of viable intervention programmes, which should involve all the relevant stakeholders

Socioeconomic and Demographic Profiles of Households with Children Aged 6-59 Months, Mbita Division, Suba District

O. Omo[1] ,J. Kimiywe[2] ,J. Chianu[1] , D. Mbithe[1] , N. Sanginga[1] .

[1]TSBF-CIAT,Kenya; [2]Kenyatta University, Kenya

Household socioeconomic and demographic characteristics have been shown to have significant influence on nutrition and health status outcome. Their role in nutrition and health status of individuals infected or in households affected by HIV cannot therefore be ignored. Several studies and scientific literature have identified socioeconomic status (SES) as powerful determinant of health status. In fact today, health disparities as a result of SES have become important issues of public health concern worldwide. Higher morbidity and mortality among people with lower SES has been extensively reported. Moreover, household SES has been shown to have great influence on the nutritional quality of children's diet in turn affecting their nutrition status. The survey was carried out to establish the socioeconomic and demographic characteristics of households with children aged 6-59 months in Mbita Division Suba District. A Descriptive Cross-sectional survey study was conducted in three sub locations. Also a pre-tested structured questionnaire was administered in 265 households with a child aged 6-59 months inclusive. Verbal consent was sought before the questionnaire was administered. Data obtained was coded, edited and statistically analyzed using SPSS software. Over 30% of the study population was children under-five, followed by those in the 16-25 age-ranges (23%). The average household size was 4.8. Overall, the study area has young population with 92% falling between 0-36 years, an indication of low life expectancy. Females (53.9%) constituted more than half of the total household members (n=1278), while males constituted 46.1%. A large proportion of the households were male headed (87.2%) compared to 12.8% headed by females. Thirty nine percent of the households belong to the protestant religion, followed by Seventh Day Adventists (36.1%). Literacy level in the study population was relatively low, 56% has primary education, < 18% and 5% secondary and tertiary education respectively. The study also revealed high level of unemployment rate in the study area, with 17.1%

involved in unpaid employment. Finally the majority of the households fall within the low SES with deepening poverty background depicted by low educational achievement, occupational status and small land holding acreage. Attention to education and poverty alleviation programs might assist in curbing the possible negative effects associated with low SES on the nutrition and health status of members of such households.

Work in progress

Collaborative Experiment on INPUT cost and LABOUR Reduction for Soybean Production

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[1]KULeuven, Belgium, TSBF-CIAT; [2]KULeuven, Belgium; [1]TSBF-CIAT, Kenya

Through collaboration between farmers and researchers an experiment was designed to look at different methods to reduce input cost and labour for soybean production. The experiments were conducted in 4 "zones" of Migori/Rongo district in the south of Nyanza Province in Kenya. The aim of this research was to identify alternative methods of soybean production that could better fit different types of farmers, depending on their availability of cash and labour forces.

The experiments were conducted in 17 fields, chosen by farmers to be spread as much as possible to reach more farmers. A split-plot design was used (with factors 'labour' and 'input') of 19-24 plots of 8x8m to 10x10m depending on the available space. Soybean was planted in all but two plots (maize for future rotation references) at 45cm x 5cm distance. Treatments chosen for labour were point-placing (L), drilling at correct distance in a trench (T), and broadcasting (BC) with one (1) and two (2) times weeding. The input treatments included in all fields DAP, ½ DAP and ½ manure, full manure, no input and were complemented with different alternative inputs as Tithonia, ashes, ½ ashes ½ manure. The inputs were applied at a rate of 20kg P ha^{-1}. Farmers agreed to provide land and labour while researchers would provide seeds and inputs. The harvest remained with the farmers. The soybean variety NAMSOY (short maturing) was used, planted in September and harvested in December-January due to the delayed rains. Analysis included soil, hours worked, cost, N-fixation, biomass production and yield. Throughout the season the farmer's preferences were assessed during field days to be compared with the agronomic output.

At present, agronomic data are not yet available. Interesting results available are those of the farmers' votes during field days. Two types of voting were done. In the first, farmers were given graduation of votes (from "very much" to "very little"), then a score was calculated by weighting those votes. The farmers voted for the harvest predictions, for the easiness to find the inputs and the labour requirement of the treatments (Figure 58). In the second type of voting, farmers were given two votes: one for the best treatment and one for the worse treatment. This shows their preference while combining the two elements (cost/ability vs. harvest) (Figure 59).

INPUTS: The graphs show that the highest harvest is expected for DAP and for ½ DAP + ½ manure. Nevertheless, the difficulty to get DAP makes it less advantageous. The harvest expectation of farmers in manure was also high, and it's easiness to get makes that many farmers in Kakmasia and Central voted it for best. Farmers mentioned it improves the moisture in the soil and it improves the soil at longer term than DAP.

DAP is known as bringing a lot of nutrients for remaining for a short time. The expectations for the alternatives, ashes and Tithonia + DAP were lower, mainly because unknown. Ashes are used only for pest control on maize. Therefore, ashes did not receive "best" votes nor "worse" votes. Tithonia was voted as best in Rayudhi, where farmers earlier heard about it's benefits but had not tried it.

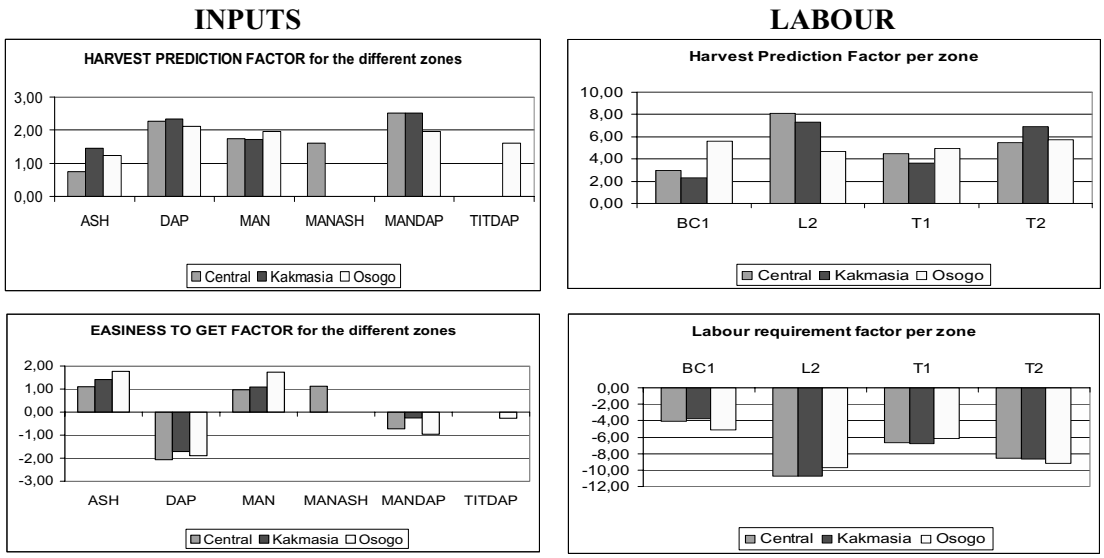

Figure 58. Harvest Prediction of farmers during the growing season, compared with the labour requirement /input availability (done after germination, Oct 06). The "factors" were calculated by giving a weight to the different votes (eg: 1 bag harvest = 1, very easy to find = +2, very difficult = -2, 3 farmer needed for the work = -3) .

LEGEND: ASH = full ashes, DAP = full DAP, MAN = full manure, MANASH = ½ manure + ½ ashes, MANDAP = ½ manure + ½ DAP, TITDAP = ½ Tithonia + ½ DAP; BC1 = Broadcasting, 1 Weeding, L2 = point-placing in lines, 2 times weeding, T1= drilling in trenches at good distance, 1 weeding, T2 = drilling in trenches at good distance, 2 times weeding.

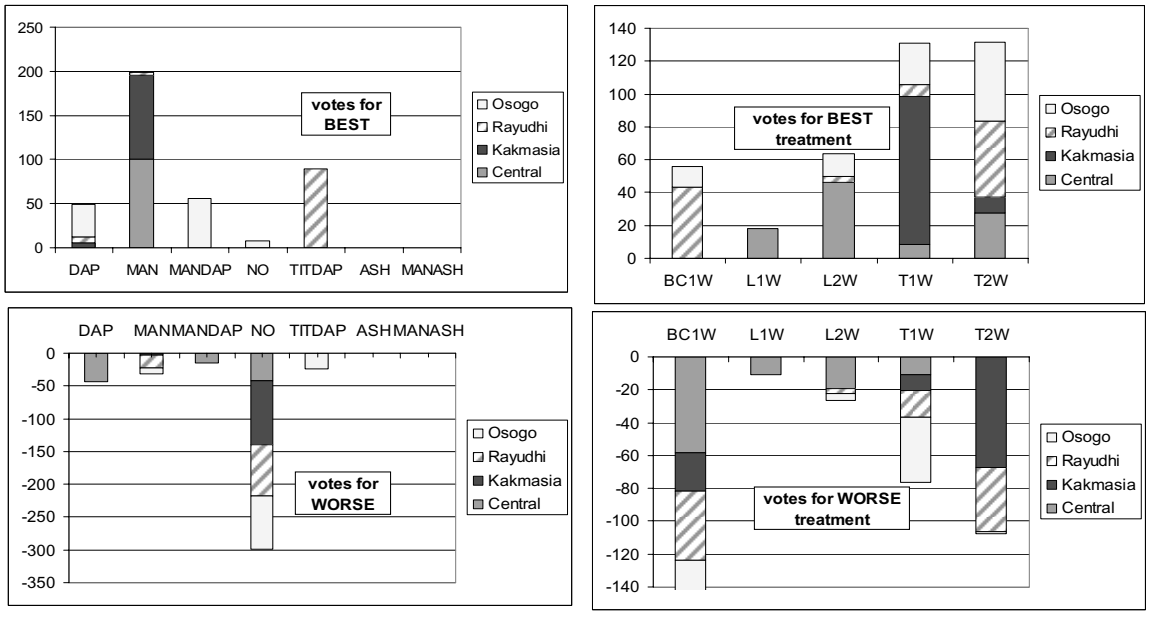

Figure 59. Votes for the best and the worse treatments (in % per group (elder/young/women) and zone). Done at mid-podding stage (Nov 06).

LABOUR: The harvest predictions for the different labour treatments varied from zone to zone. Most farmers agreed on the better harvest with 2 times weeding than 1 time weeding, and with the better harvest from organised planting in lines (L2, T2 and T1) than broadcasting. The votes for broadcasting strongly depended on the farmers' availability of labour at home. Although most farmers voted it as worse treatment, mainly people living alone voted it as best option. Some people had also experienced good soybean harvests with broadcasting. The labour requirement of point-placing seeds was seen as very high. Farmers even laughed with this method during planting and said that no farmer would be crazy enough to do this in his field. Planting in trenches with one weeding was preferred in Kakmasia above the 2 times weeding, while most other zones preferred the trench planting with two weedings. This resulted from the observation that the plants did not seem to suffer that much from the weeds. With this small difference in harvest farmers then preferred to reduce labour.

This experiment showed that intense collaboration with farmers and field days allow better understanding the adoptability of treatments tested on-farm. Both farmers and researchers understood through the voting exercises the large variation in preferences between different farmers, depending on their availability of funds and labour forces. The collaboration also built a trust relationship that allowed to speak more openly about how to improve the treatments even further. Once available, the harvest results will be compared with the votings above and then discussed with farmers during a post-harvest field day. The farmers participating to the experiments were also given documents in which they are guided in the calculation of cost-benefits and in the choice of "better treatments". This experience builds the capacity of the farmers to create, conduct and analyze their own experiments in future.

Participatory evaluation of best-bet options for control of Striga hermonthica and declining soil fertility

B. Vanlauwe, L. Nyambega, V. Manyong, many farmer groups
TSBF-CIAT, Kenya; IITA Tanzania

In the context of the project 'Striga control in western Kenya: Raising awareness, containing and reducing the infestation and developing strategies for eradication', supported by the African Appropriate Technology Foundation (AATF), the mandate of TSBF-CIAT is to investigate the containment and eradication of striga infestation through the fusion of different technical approaches. Impact on the soil fertility status and striga seed bank will be quantified. Feedback from active farmer research groups will be obtained through group learning activities on farmer-led testing and evaluation activities with a selected set of technologies.

Fourteen farmer groups were selected in Bondo, Busia, Teso, Siaya, and Vihiga districts, using level of activity, interest in farming, and presence of striga as main criteria. In each of the target sites, the farmer research group selected fields with very high striga occurrence, the latter being validated by field visits during the previous growing season. A set of best-bet interventions, consisting of the components Desmodium intercopping, fertilizer application, IR maize, striga tolerant maize, and herbaceous/grain legume rotation, was exposed to the farmer groups and agreements were made on how to manage the trials and their produce (Table 53). No financial support was provided for implementation and management of the demonstration trials. A set of group learning activities was developed and is being implemented during the current growing season. During the season, interested at the Teso sites was minimal so these groups were dropped from the project, leaving 11 active demonstration sites.

During each growing season, the various treatments with maize were evaluated by a substantial number of male and female farmers at all sites. Criteria for ranking were identified in a participatory way and farmers were facilitated to visit the different treatments and score these individually (1 being worst, 5 being best).

Response to fertilizer of the WH varieties was poor during the first 2 seasons, due to substantial *Striga* parasitism. In the push-pull system, application of fertilizer increased maize yield from the first season onwards, although yields in the unfertilized push-pull system were lower than those in the maize mono-cropped systems, probably caused by drought stress. IR-maize was observed to yield less than WH varieties in presence of fertilizer. In the *Mucuna*-maize and soybean-maize rotations, response to fertilizer was observed for the last season only. Soybean yields were around 1200 kg ha^{-1}, except for the SR2005 season that was characterized by drought, especially in Bondo district (Figure 60).

Cumulative maize yields were highest for treatments with WH varieties in presence of fertilizer application (Figure 61). Cumulative IR-maize yields were substantially lower than those of WH maize in presence of fertilizer while in absence of fertilizer, yields were similar. The Push-pull system did not increase cumulative maize grain yield compared with the mono-cropped WH maize. Inclusion of 1 or 2 soybean crops resulted in cumulative maize yields similar to those in the fertilized mono-cropping systems, while cumulative maize yields in the *Mucuna*-maize rotations were as high as in the mono-cropped systems, notwithstanding the loss of 2 maize growing seasons. In the soybean-maize rotations, cumulative soybean yields were just slightly lower than cumulative maize yields. Taking into account both maize and soybean yields, total productivity was highest in the mono-cropped maize and soybean-maize rotations after addition of fertilizer (Figure 61).

Table 53. Treatment structure of the demonstration trails.

Treatment	Long rainy season 2005	Short rainy season 2005	Long rainy season 2006	Short rainy season 2006
1	WH502 without fertilizer	WH502 without fertilizer	WH502 without fertilizer	WH502 without fertilizer
2	WH502 with DAP/Urea	WH502 with DAP/Urea	WH502 with DAP/Urea	WH502 with DAP/Urea
3	IR maize without fert	IR maize without fert	IR maize without fert	IR maize without fert
4	IR maize with DAP/urea	IR maize with DAP/urea	IR maize with DAP/urea	IR maize with DAP/urea
5	*Mucuna* without fert	WH502 without fertilizer	*Mucuna* without fert	WH502 without fertilizer
6	*Mucuna* with DAP	WH502 with DAP/Urea	*Mucuna* with DAP	WH502 with DAP/Urea
7	*Mucuna* with DAP	IR maize with DAP/urea	*Mucuna* with DAP	IR maize with DAP/urea
8	Sobyean without fert	WH502 without fertilizer	Sobyean without fert	WH502 without fertilizer
9	Soybean with DAP	WH502 with DAP/Urea	Soybean with DAP	WH502 with DAP/Urea
10	Soybean with DAP	IR maize with DAP/urea	Soybean with DAP	IR maize with DAP/urea
11	Push pull WH502 without fert	Push pull WH502 without fert	Push pull WH502 without fert	Push pull WH502 without fert
12	Push pull WH502 with DAP/urea	Push pull WH502 with DAP/urea	Push pull WH502 with DAP/urea	Push pull WH502 with DAP/urea
13	Soybean/beans intercrop with DAP	WH502 with DAP/Urea	WH502 with DAP/Urea	WH502 with DAP/Urea
14	Soybean/beans intercrop with DAP	Soybean/beans intercrop with DAP	WH502 with DAP/Urea	WH502 with DAP/Urea
15	Soybean/beans intercrop with DAP	Soybean/beans intercrop with DAP	Soybean/beans intercrop with DAP	WH502 with DAP/Urea

In the treatments which contained maize every season (first 6 treatments), application of fertilizer substantially increased maize grain yield, but only for the last 2 seasons in the treatments with WH maize (Figure 60).

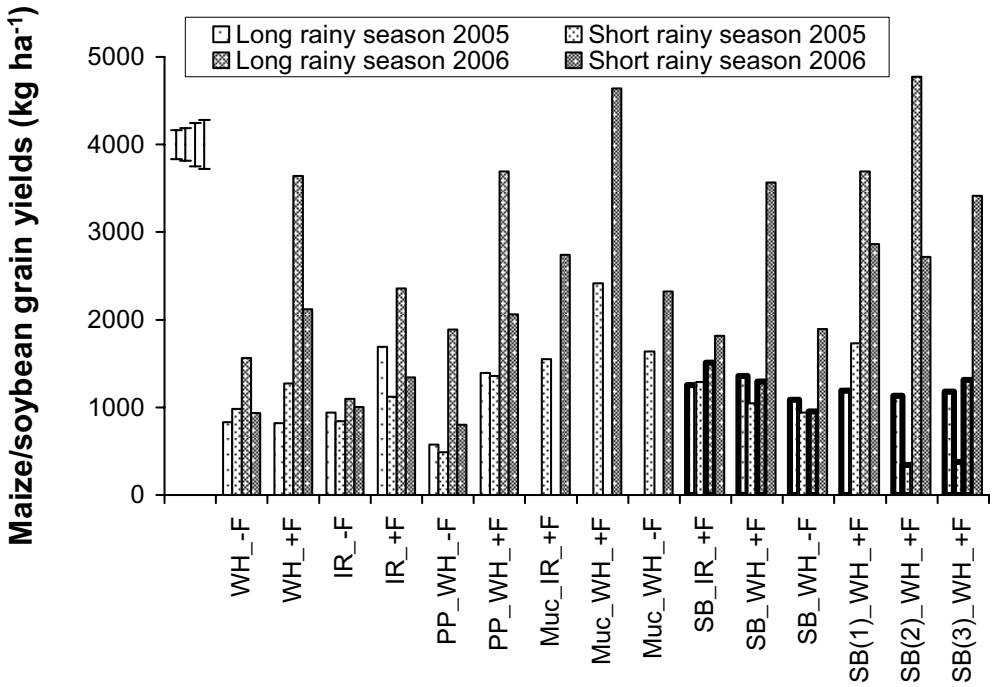

Figure 60. Maize and soybean grain yield during the four seasons considered in this project. 'F' refers to 'fertilizers', 'PP' to 'push-pull', 'IR' to herbicide-resistant maize, 'WH' to the non-herbicide-resistant maize variety WH403/WH502 used, 'Muc' to '*Mucuna'*, and 'SB' to 'soybean'. The figure between brackets for the last 3 bars indicates the numbers of subsequent soybean seasons. Bars with bold borders are soybean yields, other bars are maize yields. In Bondo district, maize yields were nil due to drought. Error bars are Standard Errors of the Difference for each season (n=11).

Obviously, since the current price of soybean grains is quite higher than those of maize grains, economically, the systems with inclusion of a soybean phase are likely outperforming the mono-cropped maize systems.

The initial *Striga* seedbank was 25,485 ± 33,477 seeds m^{-2}. *Striga* emergence was substantially reduced in the treatments with mono-cropped IR-maize and in the push-pull systems after the first season (Figure 62). *Striga* emergence was also substantially reduced after 1 season of *Mucuna* in contrast with the soybean-maize rotations where *Striga* emergence was similar as that in the mono-cropped plots with WH maize. Increasing the number of soybean crops before maize from 1 to 3 did not reduce *Striga* emergence, compared with the WH mono-cropped plots. *Striga* emergence in the demonstration trials was observed to decline substantially from the first to the last season, even in the mono-cropped treatments with WH varieties, probably because all emerged *Striga* plants were consistently removed from the plots after taking *Striga* emergence data (Figure 62).

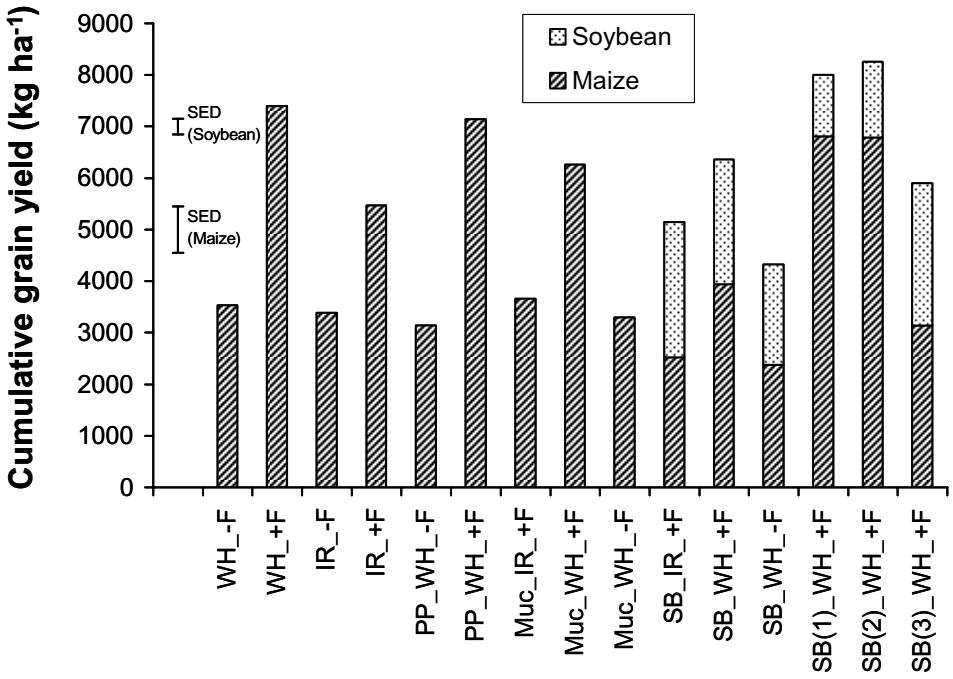

Figure 61. Cumulative maize and soybean grain yield during the four seasons considered in this project. 'F' refers to 'fertilizers', 'PP' to 'push-pull', 'IR' to herbicide-resistant maize, 'WH' to the non-herbicide-resistant maize variety WH403/WH502 used, 'Muc' to 'Mucuna', and 'SB' to 'soybean'. The figure between brackets for the last 3 bars indicates the numbers of subsequent soybean seasons. Error bars are Standard Errors of the Difference for each season (n=11).

Although IR-maize certainly reduces *Striga* emergence, its productivity was observed to be lower than that of the WH hybrid varieties in presence of fertilizer. This was not true in absence of fertilizer. The push-pull system substantially reduced *Striga* emergence but only after 2 seasons. In absence of fertilizer, maize yields in the push-pull system are less than those in the mono-cropped system, likely caused by competition for water between the *Desmodium* and maize during seasons with erratic rainfall. *Mucuna*-maize rotations led to a substantial reduction in *Striga* emergence and increase in maize grain yield while this was not true for the soybean-maize rotation. In the latter case, however, the production of grains for food or sale is certainly going to result in better economic returns in the latter treatment. *Striga* emergence reduced substantially between season 1 and season 4 in all treatments, indicating that consistent uprooting *Striga* seedlings before flowering can gradually decrease its seed-bank. Both male and female farmers appreciated the *Striga* tolerant properties of the IR-maize but less its productivity. Fertilizer application was also appreciated, even in terms of *Striga* tolerance, probably due to better maize growth after fertilizer application, even in presence of *Striga*.

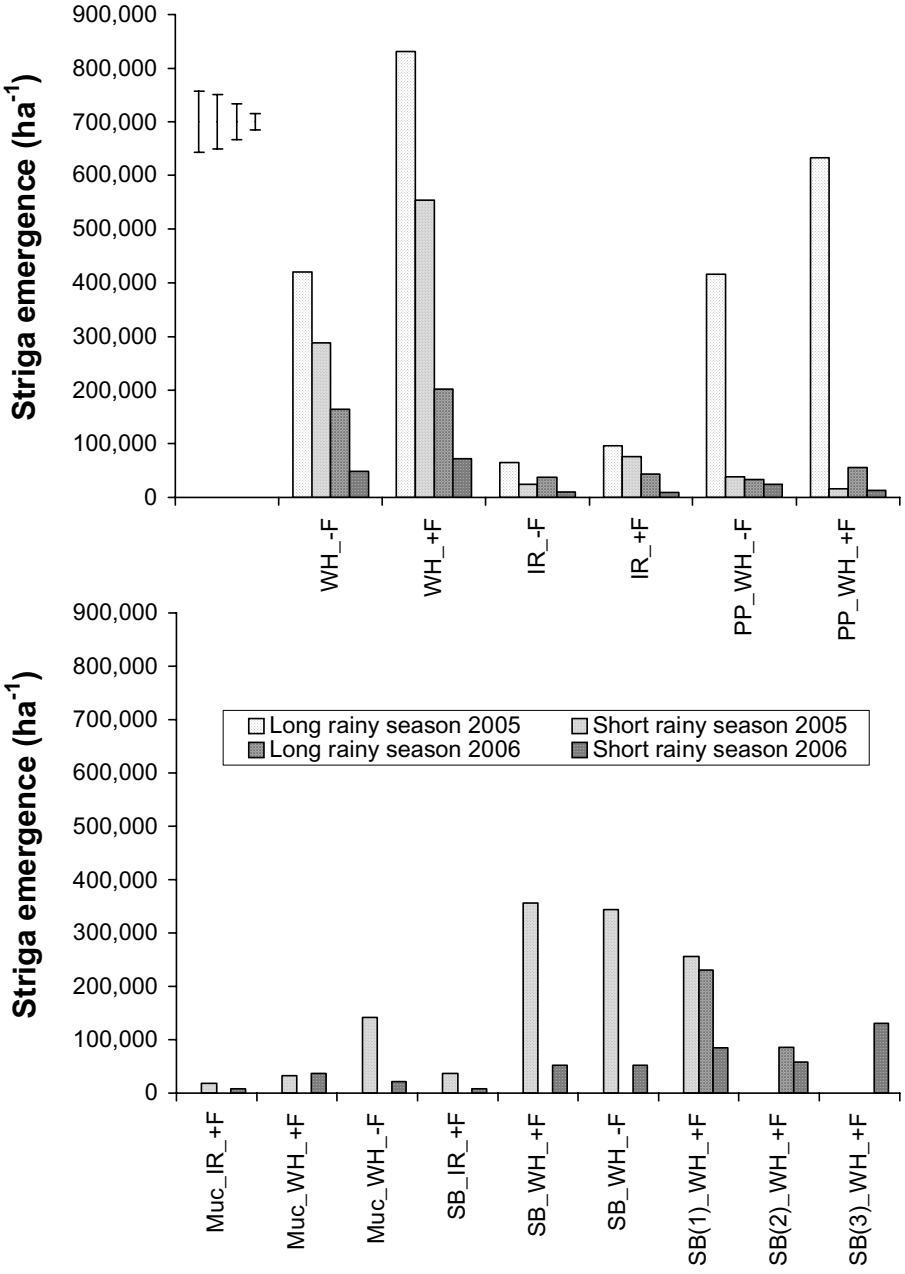

Figure 62. *Striga* emergence (sum of emergence at 6, 8, and 10 weeks after maize planting) during the four seasons considered in this project. 'F' refers to 'fertilizers', 'PP' to 'push-pull', 'IR' to herbicide-resistant maize, 'WH' to the non-herbicide-resistant maize variety WH403/WH502 used, 'Muc' to '*Mucuna'*, and 'SB' to 'soybean'. The figure between brackets for the last 3 bars indicates the numbers of subsequent soybean seasons. Error bars are Standard Errors of the Difference for each season (*n*=11).

During the participatory evaluation exercise, both male and female farmers ranked the treatments with fertilizer inputs and previous soybean as best, both in terms of *Striga* tolerance as in terms of maize grain yield (Figure 63). Although the IR-maize scored relatively high for *Striga* tolerance, its yield potential was less well appreciated by both male and female farmers (Figure 63).

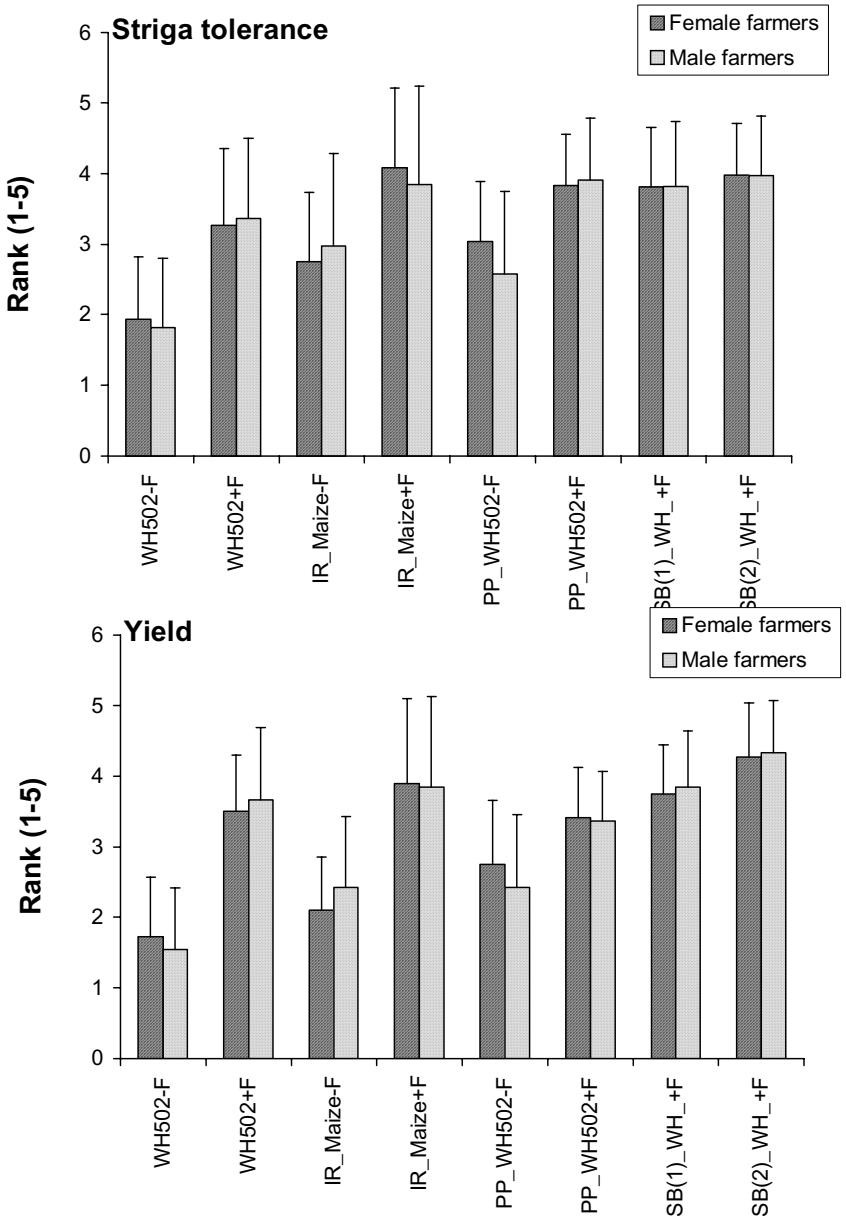

Figure 63. Ranking of the various treatments with maize during the LR 2006 season in terms of Striga tolerance and yield. Rank 5 is best, 1 is worst. 'F' refers to 'fertilizers', 'PP' to 'push-pull', 'IR' to herbicide-resistant maize, 'WH502' to the non-herbicide-resistant maize variety WH502 used, and 'SB' to 'soybean'. The figure between brackets for the last 2 bars indicates the numbers of subsequent soybean seasons. Error bars are Standard Deviations (n=48 for female farmers and 33 for male farmers).

Baseline study on soybeans (production, processing, utilization and marketing) in the farming systems of East Africa (Kenya, Uganda, and Tanzania)

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[1]TSBF-CIAT,Kenya; [2]NARO, Uganda; [3]CIMMYT, Kenya; [4]Rockefeller Foundation, Kenya; [5]Ilonga Research Institute, Tanzania; [6]Dominion Farms, Siaya District, Kenya

Soybean was introduced in the farming systems of Kenya, Uganda, and Tanzania many decades ago. However, the crop has remained a minor crop despite its great potentials for improving household food and nutrition security (through quality food supply), household cash income (through the sales of soybean and soybean products), household health (through the provision of high quality protein-rich food), and soil fertility improvement (through its atmospheric nitrogen-fixing ability). Literature indicates that low yield, lack of knowledge on its utilization, and lack of market are among the key factors that have contributed to lack of adoption of soybeans in the farming systems of East Africa. A recent effort based on improved dual-purpose promiscuous soybeans varieties sourced from IITA, Ibadan, Nigeria has been commenced by TSBF-CIAT.

This study aims at documenting the baseline data (on production, processing, utilization, and marketing) in order to have sufficient information to assess the impact of the improved dual-purpose promiscuous soybeans varieties on the soybean sub-sector in East Africa in future.

This study is being carried out in selected districts in the three countries. Data for the attainment of the objective of this study are being collected from primary sources (household-level and community-level surveys using questionnaires), secondary sources (reports, published articles, books, etc.) and key informant interviews. Data processing is being executed using many computer applications including Microsoft Excel, SPSS, and SAS.

Data collection for both the Kenya and the Uganda arms of the study has been completed. The data have also been entered into the computer and are currently being processed (including validation and cleaning, and analysis). The implementation of the baseline community-level and household-level socioeconomic data collection in Tanzania has commenced with the listing of the male and female farmers who grow or do not grow soybean in two villages (*Kidegembye* and *Image*) selected from *Njombe* district. The distribution of household with respect to soybean growing status and gender of household head is as in Table 54 below.

Table 54. Summary of households (number) listed in two villages in *Njombe* district of Tanzania

Village	Soybean growing status	Gender of household head		Total
		Male-headed	Female-headed	
Kidegembye	Soybean growing	30	26	56
	Non-soybean growing	322	218	540
Image	Soybean growing	42	0	42
	Non-soybean growing	467	200	667
Total across soybean growing status		861	444	1305

Source: Summarized from household listing data, 2006/2007

Using these frames, the baseline community-and household-level surveys are planned for the second half of 2007.

Identification and development of options for sustainable soybean demand and marketing in the farming systems of Kenya

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[1]TSBF-CIAT, Kenya; [2]Institute of Development Studies, UON, Kenya; [3]Rockefeller Foundation, Kenya

Soybean was introduced in the farming systems of Kenya many decades ago. However, the crop has remained a minor crop despite its great potentials for improving household food and nutrition security (through quality food supply), household cash income (through the sales of soybean and soybean products), household health (through the provision of high quality protein-rich food), and soil fertility improvement (through its atmospheric nitrogen-fixing ability). Lack of market for the output is one of the key reasons given by farmers for not giving much attention to soybean production. This is compounded by the lack of knowledge on soybean utilization by many farm households. These imply that without proper market development, all efforts towards soybean development and promotion in Kenya will amount to nothing.

This study aims at identifying various ways of developing soybean market at three different levels (household-level, community-level, and industrial level by linking farmers with industries that use soybean) in the farming systems of Kenya.

Data from many studies currently being carried out will contribute to this. These include (i) the baseline household-level survey of soybean in the farming systems of western Kenya, (ii) the baseline community-level survey of soybean in the farming systems of western Kenya, (iii) survey of selected food (including supermarkets) and feed industries in Kenya, and (iv) key informant interviews, among others. All these surveys are being executed using structured questionnaire. Secondary data will be derived from reports, published articles, books, etc.

Apart from the above, the processes that we are using to develop the soybean market development at household-level include (i) awareness creation on the various attributes of soybean, (ii) effective promotion through participatory training and development on the processing of easy-to-prepare soybean products and the associated recipes, etc.). At the community-level, our efforts are centered on the *VitaGoat* and or *VitaCow* System (machines used in soymilk production and the production of soybean residues that are handy in the production of high protein soy bread, soy biscuit, soy cake, livestock feed, etc.). At the industrial level, our activity is on linking farmers and producer groups to large-scale food and feed industries (to ensure the existence of market opportunities that can mop up production levels that are beyond the absorptive capacities of the household- and community-level demand and help in import substitution that can save the huge foreign exchange often spent by these industries to import soybean for their operations in Kenya

The awareness creation has led and is currently continuing to lead to widespread adoption of soybean production among the communities in TSBF-CIAT action sites in *Butere-Mumias* and *Migori* and numerous other districts that have joined the soybean promotion work. Two *VitaGoats* and one *VitaCow* have been imported from Canada, especially for community-level soymilk processing and the generation of soybean residues for use in the production of other soybean products. Installation of these (*VitaCow* in *Mumias*, one *VitaGoat* each *Eldoret* and *Migori*) is planned for April 2007, starting with *Eldoret*. For sustainability, the associated trainings will be extended to representatives from the Ministry of Agriculture and farmers' groups from some of the districts where our project presently operates. Many industrial processors of soybean in Kenya, including *Bidco* and NUTRO EPZ have agreed to import substitution and to clear the market for whatever soybean that the Kenyan farmers produce and at KShs. 26 per kg. They have kept this promise and have been purchasing soybean from farmers and farmers' groups. They encourage farmers and farmers' groups to bulk as from 5 tons before arranging to supply them. This will also assist in enabling the farmers to tap some of the advantages associated with the economies of large scale, especially those related to cheap transport per unit of sales.

Evaluation of key agricultural production input supply and network in the farming systems of western Kenya

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Widespread and increasing rural poverty in sub-Saharan Africa has been of great concern to the development community. Compared to other developing regions of the world, low factor (land, labor, capital, management) productivity and low use of farm inputs by smallholder farmers is one of the factors often responsible for the gap between potential farmers' yields and actual crop yields. These are also common features of the farming systems of western Kenya. In addition, market constraints reduce profitability in the use of inputs, increasing production risks. These negatively affect livelihoods by impacting negatively on household food and nutrition security. Among the other reasons, lack of access to key agricultural production inputs (inorganic fertilizers, organic inputs, seeds, etc.) by the smallholder farmers has been blamed for the low factor productivity that characterize western Kenya agriculture. The situation is further compounded by the HIV/AIDS pandemic that is most widespread in western Kenya compared to other regions of Kenya.

The objective of this study is to (i) assess the availability farm input supply centers in selected districts in western Kenya, (ii) to evaluate the types and suitability of agricultural inputs stocked, (iii) to assess the types and qualities of other services that farm input suppliers offer to the smallholder farmers, and (iv) to make recommendations on how to improve the access of smallholder farmers to agricultural production inputs in the farming systems of western Kenya and similar environments.

This study was carried out in eight districts from three provinces (Western, Nyanza, and Rift Valley) in western Kenya. These districts were randomly selected from the list of all the districts in the three provinces. In each selected district, a list of all the agricultural production input dealers was compiled. From this list, a random sample of 130 agro-input dealers was selected for interview using structured questionnaire. Secondary data sources include reports, published journal articles, proceedings of conferences, books, etc. Data processing is ongoing and is being carried out mostly using Microsoft Excel and SPSS.

Preliminary results indicate that although the number of agro-dealers is still small relative to rural population, there has been a steady annual increase (from 2% for seed treatment chemicals to 22% for fertilizers with mean of 16% across inputs) in their number from 2003 to 2005. Di-ammonium Phosphate (DAP) fertilizer (stocked by 92% of respondents) was the most frequently occurring input, followed by Calcium Ammonium Nitrate (CAN) fertilizer (84%), Urea (78%), and NPK (40%). The other services provided to smallholder farmers by agro-input dealers were input information (75% of respondents), credit (13%), bulk breaking (8%), spraying (4%). The most important constraints faced by agro-dealers were transportation (53%), lack of market (30%), limited market information (21%), storage (13%), and inadequate business knowledge and skill (12%). The study preliminarily concludes with suggestions on how to enhance the efficiency of agro-dealers in input delivery to smallholder farmers - timely since SSA governments are presently creating policy and institutional structures to enhance farm input use.

The place of soybean among the grains (grain legumes and cereals) traded in selected marketed markets in East Africa (Western Kenya and Central and Northern Uganda)

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Cereals and legumes are the most common crops cultivated by smallholder farmers in Kenya. Farm households, especially food self-sufficient ones, must market these grains at profit as an incentive for future production increases, poverty reduction and improved livelihoods. Middlemen who normally perform agricultural marketing functions are often reported to earn abnormal margins – explaining the

surge and promotion of farmer associations to encourage farmers' effective participation in agricultural marketing. Besides, literature, interactions with farmers and key informants have revealed that lack of market (and low prices) has been a major reason for the low presence of soybeans in the farming systems of western Kenya. This is compounded by lack of knowledge on simple methods of processing soybeans for food, making marketing the product the only option left for the producers.

The objective of this study is to (i) assess the characteristics (diversity of commodities sold, gender, scale of operations, marketing infrastructure, age, educational level, etc.) of grains market actors, (ii) examine the issue of margin based on soybean, a relatively new crop with high and expanding domestic demand because it is a cash, food, fodder, and soil fertility improving crop- characteristics that confer a high adoption potential, (iii) assess the degree of availability of soybean in the selected markets, (iv) determine the types and sources of different soybean varieties found in the markets, (v) evaluate the stock and market shares of soybeans relative to the other grains traded in the markets, (vi) evaluate the marketing margins associated with soybean marketing in the markets, and (v) make recommendations on how to increase both the marketing margin associated with soybean marketing and the market share of soybeans compared with the other grains.

This study was carried out in eight districts from three provinces (Western, *Nyanza*, and Rift Valley) in western Kenya and two district hubs (*Lira* and *Luwero*) in Uganda. These districts were randomly (stratified in the case of Uganda) selected from the list of all the districts. In each selected district, a list of all the markets where grains (including soybean) are traded was compiled. From this list, a random sample of markets was selected. At the market, the traders selling grains are listed and a random sample is taken and interviewed using structured questionnaire. Effort is made to include large and small stock traders in the sample. Secondary data sources include reports, published journal articles, proceedings of conferences, books, etc. Data processing (entry, validation, cleaning, and analysis) is ongoing and the software being includes Microsoft Excel and SPSS.

Results based on data from western Kenya show that altogether 16 different grains were found across the surveyed markets, the most common (in terms of number of traders selling it) being millet (31% traders), sorghum and rice (27% each) among cereals and common beans (22%), soybean (18%) and groundnut (17%) among legumes. For maize traders (27% of traders), maize accounted for 37% of total stock found in the surveyed markets. While about 80% of all the traders were women, 90% were small-scaled (grains stock ranging from 0.01 to 18t with a mean of 1.8 t month^{-1}), 60% operating in open shops. Soybean traders earned a marketing margin of 15%. The paper preliminarily cautioned on the view that middlemen make excessive profits at the expense of farmers.

Economic Evaluation of the Contribution of Below Ground Biodiversity: Case Study of Biological Nitrogen Fixation by Rhizobia

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Although it is a common knowledge that soil microorganisms form an important constituent of below ground biodiversity and provide key ecosystem services, such knowledge is often not leading to the formulation of favorable policies to conserve the soil microorganisms. Applying the knowledge gained from several experiment station and on-farm research (supplemented with necessary assumptions) on FAO-sourced secondary data on soybean (*Glycine Max*) from 19 countries in Africa, this study attempted to increase the visibility of the important activities of microorganisms by quantifying the economic value of nitrogen fixation often associated with the activities of legume nodulating bacteria (LNB). The computation of economic value of nitrogen fixation was mostly based on the method of cost replacement or cost savings of the fixed nitrogen compared with the mineral nitrogen fertilizer required to attain the level of nitrogen fixed. Result shows that the economic value of the nitrogen-fixing attribute of soybean

in Africa, especially the promiscuous varieties, is quite high and in total ranges from about US$ 197 million in 2002 to about US$ 203 million in 2004 with a mean of about US$ 199 million across the years (2002, 2003 and 2004). The study preliminarily concludes with recommendations on the various ways of increasing the chances of smallholder farmers benefiting from the nitrogen-fixing attribute of LNB, especially since many of them cannot afford adequate quantities of inorganic fertilizers required for increased crop productivity.

Food situation and nutritional status of children 6-9 years old in HIV/AIDS affected areas of Suba District. A comparative study

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The HIV/aids pandemic has continued to claim more lives in Africa leading to an increase in the number of orphaned and vulnerable children. Research conducted by Case and Ableindiger (2004), shows that ten countries in Southern Africa have orphan rates higher than 15%. Orphans are likely to be susceptible to HIV, more food insecure, more malnourished, and less healthy than non orphans. (Lundberg *et al,* 2001). It has been found that there is reduced quality and quantity of dietary intake, child survival and nutrition in households affected by HIV/AIDS. A study by Njeru and Kioko, (2004), shows that the number of orphans rose from 43,359 in 1990 to 965,975 in 2000 in primary schools in Kenya. This number is projected to rise to 2,189,593 by 2010. GOK/MOH (2006), reports that Kenya has an estimated 1 million orphans and vulnerable children as a result of HIV/AIDS. Besides HIV/AIDS, hunger and malnutrition are rampant amongst the poor in the world. According to FAO/WHO (1992), one out of five persons in developing world is chronically undernourished while 192 million children suffer from protein energy malnutrition (PEM) and other micronutrient deficiencies. Approximately 780 million in developing countries do not have access to adequate food. In Africa, where there is a growth rate of 3%, the number of people affected by hunger has grown drastically. Reports by GOK/MOH (2006) indicate that about 47% of Kenyans lack adequate food to meet their nutritional requirements. About 31% of children under 5 years are stunted and 20% are underweight. The rates are higher in rural areas than urban areas. The School age children need food that satisfies the high demands for rapid growth, mental development and physical activity.

This study was carried out in Suba district in three schools .The results presented here are based on two schools namely Sindo primary school and Ongayo primary school. Sindo primary school is currently on the school feeding project where porridge made of corn soy blend is being provided at mid morning. Ongayo primary school is acting as a control and receiving Nutrition Education among other services such as deworming,

Vitamin A supplementation and a long lasting insecticide treated mosquito net. Suba District had a HIV/AIDS prevalence of 41% in 2005 but went down to 32% in 2006. (NASCOP/MOH. 2006). The children in the feeding trial were chosen based on the fact that they are either partial or total orphans. Some children are affected by HIV/AIDS in view of the fact that they live with ailing parents and relatives. The objective of this study is to investigate the food situation and nutritional status of children aged 6-9 years old from HIV/AIDS affected areas of Suba District.

Study Area

Suba district has been selected for the study due to the prevailing conditions that have lead to HIV/AIDS prevalence of 31% (NASCOP, 2006) that is increasing at an alarming rate due to a number of factors including inadequate health services and facilities. For instance, the poverty index in Suba is 64%, there is food insecurity due to low agricultural activity despite rich soils, high unemployment rate, and poor infrastructure-only 4.3% have access to piped water while access to electricity is 1%. (Masambu, 2005). The study was a cross sectional descriptive survey to obtain baseline data prior to the school feeding trial.

Kaksingri division where Sindo and Ongayo schools are situated has 877 orphans while Mbita division has 51 primary schools with 13,660 pupils with a total of 1,396 orphans. Random methods were used to select 53 children from Sindo primary school and 56 from Ong'ayo primary school. The parents/guardians of the children were interviewed using a standard interview schedule to obtain information on demographic characteristics, socio-economic status and household dietary patterns. Informed consent was obtained from the parents/guardians verbally. All the children were dewormed and supplemented with Vitamin A. They were also given an insecticide treated mosquito net to guard them against malaria, an endemic disease in the area. Anthropometric assessment of the children was also done. A standard height metre /stadiometer was used to take the heights of the children and a Seca weighing scale was used to take the weights of the children. In addition, a non stretchable MUAC tape was used to take the mid upper arm circumference. Using the Nutrisurvey programme for windows, these were converted into Z scores for HA, WH, WA. A SD of -2 showed moderate stunting, underweight and wasting while -3 meant severe stunting, underweight and stunting according to NCHS-WHO references (1977). The rest of the data was analyzed using SPSS for windows version 11.5.

Sex of Respondent, Age of Caregiver, and Marital Status

In Sindo primary school 98.1% were female while 1.9% were male. This number represented the households headed by men. Majority of the respondents (parents) were in the age group of 19-25 years (37.7%). This was followed by the age group of 26-30 years old (24.5%), 31-35 years (13.3%), 36-40 (5.7%) while 41 years and above represented 9.5%. Majority of the respondents (71.7%) were married, 24.5% were widowed while 3.8% were single.

The parents/guardians from Ongayo who were interviewed comprised of 96.4% females and 3.6% male. The age group of the respondents varied slightly from the Sindo parents whereby many of them (35.8%) were aged between 36 to 40 years old. The 19-25 age group comprised of 12.6%, 26-30 years, 34%, 31-35 age group 10.1% and 41 and above 18%. Just like in Sindo, majority (69.6%) were married, 26.8% widowed and 3.6% separated.

Occupation and Household Income

The study showed that many guardians /parents of children in Sindo primary school are engaged in small businesses (56.6%) and 13.2% are in temporary employment. Those that were unemployed comprised of 26.4% and the self employed 1.9%. The total household incomes ranged from nil to ksh.25, 000 per month with majority (30.3%) earning between ksh.500-2,000 per month.

A further 28.4% earned between ksh. 2,001 -4,000, 17% earned ksh.4, 001-6,000 and 7.6% earned between 6,001-10,000. 13.3% brought home more than ksh.10, 000. These results are different in Ongayo primary school parents where a big number of them (73.2%) are unemployed, 8.9% are in temporary employment while 17.9% run small businesses. The highest earners (35.8%) got between ksh.2,000 to 4,000 and a further 32.2% earning between ksh. 500 and 2,000. In addition, 10.4% earned between ksh. 4,000-6,000 while 7.2% earned ksh.15,000 and above.

Food Production, Land Size and Soybean Utilization

Some parents in Sindo primary school cultivate land (56.6%). The rest (43.4%) do not cultivate any land. Those who cultivate (39.7%) use between 0.5 and 2 acres of land to grow food crops. 22.7% grow food crops on 1.5 to 4 acres of land. The highest acreage per person is 1 acre (20.8%). Of all the respondents in Sindo, only 3.8% grow soybean, 96.2% do not grow them at all. Of those who grow soybean, 1.9% grew it on 0.25 acres of land and another 1.9% on .50 acres of land. A further 39.6% reported to buy soybean for use in the household. The open air market is where they bought the soybean from. For utilization of soybean, 13.3% boil and eat, 13.3% grind and make porridge from it and 13.3% boil then fry or stew. For preparation of the land, many people (20.8) use oxen, 17% till the land by hand while another 17% use both oxen and hand. In order to obtain food in the household, 47.2% purchase from the shops and open

air market and 49.1% purchase and use food from their farms. About 1.9% obtains food from their farms and another 1.9% gets assistance. The main staple is maize (79.2%) followed by millet (11.3%) then sorghum at 3.8%. In order to obtain additional food for the household, 86.8% purchase the food, 9.4% participate in food for work and 3.8% get assistance. A high number of parents in Ongayo primary school cultivate land (91.9%) with only 8.9% not cultivating. Among those who cultivate land, the amount of land under cultivation ranges from 0.5 to 2 acres 44.7%, 2.5-5.0 acres 42.9% and 6-10 acres 7.2%. Majority of the people (33.9%) cultivate 2 acres followed by 5 acres (14.3%) and 3 acres (16.1%). The acreage allocated to food crop ranges between 0.5 -2 acres (19.6%), 1.5-4 acres (64.3%), and 5-6 acres (7.2%). The people in Ongayo mostly use oxen (39.3%) to plough their land and a combination of oxen and hand (35.7%). A smaller number (16.1%) use their hand to till the land. As far as soybean growing and utilization is concerned, only 7.1% grow soybeans on their land while 92.9% do not grow soybean at all. The acreage under soybean comprises of 0.25 acres (3.6%), 0.50 acres (1.8%), and 1 acre (1.8%). 92.9% admitted that they don't buy soybeans for use at home but 7.1% reported to buy soybean for home consumption. All the 7.1% buy them from the open air market.

For soybean processing and utilization, 1.8% boil them and eat, 3.6% use them as beverage and 9% boil then stew or fry as serve as accompaniments to other dishes such as rice. To obtain food for the household, 83.9% purchase and get it from their farms, 10.7% purchase all the food required for the household and 1.8% get food through assistance. A further 3.6% obtain food through assistance, purchase and from their farms. The main staple in this area is maize (100%). When there is shortage of food in the household, 98.2% purchase food while 1.8% got food through assistance.

Livestock Production and Use

From the Table (55) below, many people in Sindo do not rear livestock, for example, only 18.9% keep cows, 15.2% keep sheep and 26.5% rear goats. More people rear poultry which they use at home as a source of food 30.2% while 26.4% use them for food and sale. The highest number of cows owned is 2-7.5%, sheep 7.6%, goats 13.2% and poultry 10. On the contrary, more people in Ongayo keep cows (57.2%), Sheep 16.2%, goats (62.5%) and poultry (84.2%). More than 44.6% of the cows are for use at home, usually for milk production while 10.7% is for home use and sale. 14% of the sheep are for home use, 35.7% of the goats.10. More than 30.4% of the poultry is for home use while 3.6% is kept for sale.

Table 55. Livestock ownership in Sindo and Ongayo.

Sindo	**Number**	**Cows%**	**Sheep%**	**Goats%**	**Poultry%**
	0	79.2	84.9	73.6	41.5
	1-3	15.1	5.7	13.2	18.9
	4-10	3.8	9.5	11.4	26.4
	11-15	0	0	1.9	9.5
	16 and above	0	0	0	3.8
Total		**100**	**100**	**100**	**100**
Ongayo	0	42.9	83.9	37.5	16.1
	1-5	46.4	9.0	35.6	32.2
	6-10	0	7.2	19.7	21.5
	11 -15	10.8	0	7.2	9.0
	16 and above	0	0	0	21.5
Total		**100**	**100**	**100**	**100**

Table 56. Childcare and child health practices.

Sindo	Mother alive%	Father alive%
Alive and lives with child	81.8	66
Alive but does not live with child	5.7	0
Not alive	13.2	32.1
Does not know	0	1.9
Total	100	100
Ongayo		
Alive and lives with child	75	55.4
Alive but does not live with child	12.5	23.2
Not alive	12.5	19.6
Does not know	0	1.8
Total	**100**	**100**

From the Table (56) above, majority of the children in Sindo live with their parents. However, paternal orphan hood (32.1%) is noticeably higher than maternal orphan-hood, 13.2%.

A few mothers 5.7% are alive but don't live with the index child. One parent (1.9%) did not know the father of her child. This trend is also noted in Ongayo whereby slightly more than half (55.4%) live with their fathers. Paternal orphan-hood is lower at 19.6% and maternal orphan-hood lower at 12.5%. Among the children in the study in Sindo primary school, 37.7% are male while 62.3% are female. In Ongayo primary school, 46.4% are males while 53.6% are females. As regards feeding practices, 94.3% of children in Sindo feed from the family pot whereas 5.7% have their food cooked separately. 69.8% feed 3 times a day, 18.9% feed 4 times a day and 9.4% feed 2 times a day. All the children in Ongayo (100%) feed from the family pot with majority (82.1%) feeding three times a day, 14.3% four times a day and 3.6% feeding once a day.

Baseline Nutritional Status

Anthropometric assessment of the children showed the following at baseline level (Table 57) as the nutrition status.

Table 57. Baseline nutritional status of children in Sindo and Ongayo.

Sindo	Nutrition situation	Underweight (%)	Stunting%	Wasting%
	Normal	88.7	79.2	98.1
	Moderate	9.4	15.1	1.9
	Severe	1.9	5.7	0
	Total	**100**	**100**	**100**
Ongayo	Normal	92.9	85.7	82.1
	Moderate	3.6	8.9	12.5
	Severe	0	1.8	1.8
	Total	**100**	**100**	**100**

More children in Ongayo had normal nutritional status with regard to underweight, stunting and wasting (92.9%), 85.7% and 82.1% as compared to Sindo 88.7%, 79.2% and 98.1%. The underweight children in Sindo were 9.4% moderate and 1.9% severe. There was more stunting 15.1% moderate and 5.7% severe stunting. Only 1.9% was moderately wasted in Sindo. In Ongayo, 3.6% were moderately underweight,

8.9% moderately stunted, 1.8% severely stunted and 12.5% moderately wasted.1.8% were severely wasted

The above findings indicate that there are younger mothers in Sindo compared to Ongayo. This could contribute to the disparities in the nutritional status of children in the two areas. Fewer children in Ongayo are underweight and stunted but a slightly higher number is stunted. It is apparent that parents in Sindo are more economically able compared to those in Ongayo. Most of them are employed and earn higher wages/salaries but this does not translate to better nutritional status of their children. Food production is also higher in Ongayo compared to Sindo as well as livestock rearing. This may explain why children in Ongayo are better nourished than those in Sindo. However, food production is not adequate in the households in both areas as it is apparent that a lot of people buy food more than they produce from their farms. Since the rate of unemployment is high in Ongayo, the mothers and caregivers may be spending more time with the children at home thus taking better care of them. Soybean growing and utilization is minimal in both areas. For those that grow soybean, the acreage allocated to the crop is too little to produce the quantity that can be used to improve and maintain higher nutritional status of the children and the household in general. The Nutrition Education being offered in schools will help to enlighten people on the benefits of consuming soy products and the need to increase production.

The rate of orphan hood among school children is a concern and should be addressed. This is especially so when the family breadwinner is deceased and the family cannot obtain adequate food. Some children come to school hungry and look forward to the porridge provided at mid morning break. For some, this is the only food till the evening meal. Food supplementation in schools will go a long way in improving the health and nutrition of school children.

Effect of intercropping on nutritional value of grain amaranth and soybean among HIV/AIDS affected rural households of Western Kenya.

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In Sub-Saharan Africa, food insecurity and the HIV/AIDS crisis represent priority issues for agricultural and rural development (Gari J. 2000). In addition, the HIV/AIDS epidemic is undermining the labor and economic foundations of poor rural households, therefore aggravating their food insecurity, deepening their poverty, and limiting their coping capacities. However, according to AMPATH-Kenya (2007), nutrition is essential for people living with HIV/AIDS, and plays a major role in boosting the body's immune system hence the importance of promoting foods high in nutritional content.

According to Doreen M. (2007) soybean could help combat HIV/AIDS. Because protein requirements of HIV-infected persons jump 50 to 100 percent higher than normal levels, soy is apparently well suited to meet many of the food and nutrition challenges faced by people with the disease. Similarly, many published literature have documented the relative importance of amaranth in Kenya and the rest of the world. Its dietary composition stimulates the body defense mechanism to retard the progression of HIV/AIDS virus, and as such it one of the food crops that hold the key to fighting the HIV/AIDS scourge. However, soybean has been used in many parts of world but was introduced recently in Kenya. This therefore means that very little research has been conducted to evaluate its importance in agronomy, and yield under intercrops with other plants as well as its role in the HIV/AIDS management in the country. The grain amaranth too is indigenous to Kenya and many communities are ignorant of its role in health hence the need to promote it amongst rural households suffering from food insecurity and nutritional deficiencies.

Soybean-amaranth intercrop system may therefore help the small-scale farmers to boost their food security and replenish their farms, which are low in soil fertility while raising income levels as well as reducing the progress of HIV/AIDS among the affected. The objective of this study was therefore to

determine the effect of using a best-bet agronomic practice on the protein content of soybean and amaranth grains and amaranth leaves and Vitamin A content of Amaranth leaves.

Site Description

The experiment was carried out from two sites in Teso district for two seasons from March 2006 to November 2007.

Site 1- Soils on Bottomlands

Soils developed on infill mainly from undifferentiated Basement system Rocks. Very deep, very dark grey to brown , mottled friable to firm, Sandy clay to clay, often abruptly underlying a topsoil of friable sandy clay loam. (Dystric PLANOSLS; with pellic VERTISOLS, vertic and humic GLEYSOLS and Plinthic ACRISOLS).

Site 2- Soils on Hills and Minor scarps

This has a complex of excessively drained, shallow stony or rocky soils of varying color, consistence and texture) dystric REGOSOLS; with ferralic CAMBISOLS, lithic phase and Rock outcrops). Soils are developed on granites.

Field operations

The crops varieties planted were the dual purpose soybean variety SB20 and *A. hybridus* for soybean and amaranth crops obtained from TSBF-CIAT and Simlaw seeds respectively. During both seasons, the crops were sown at a distance of 50 cm between soybean rows and 33.5cm between amaranth rows in double rows intercrops. Planting was done at an interval of 33cm between soybean and amaranth rows in single rows intercrops. For pure stands, amaranth was planted at an interval of 30 cm and soybean at 45 cm between rows. Intra-row spacing was 5cm and 10cm for soybean and amaranth crops respectively in all planting methods. The individual plot area was 3m×3m. Prior to planting, all plots were given a basal application of 100 kg N ha^{-1} and 60Kg P ha^{-1} as C.A.N and TSP respectively. All P and N fertilizers were evenly broadcast and incorporated into the top 20 cm of the soil prior to sowing. Weeding was carried out only twice during each cropping season.

Data collection

Harvesting of amaranth and soybean grains was carried at maturity at two months and three months respectively in both seasons on both sites. Amaranth leaves were harvested six times at one week interval 14 days after germination. The grains were dried at 13% moisture content prior to analysis while 100g of fresh amaranth leaves were sampled for either protein or vitamin A analysis. Protein content analysis was carried out using micro-kjedhal method while vitamin A analysis was determined using a procedure from AOAC.

Preliminary results

This was high in soybeans harvested from site 1 compared to those harvested in site 2 probably because the soils in site 1 were very fertile and high in Nitrogen content. The protein content was also highest in double row intercrops since there was no competition unlike in single rows or sole crops where competition was very high. However, there was no significant difference in protein content of soybeans in sole stand compared to the soybean crop planted in double rows (Figures 64, 65, 66 and 67).

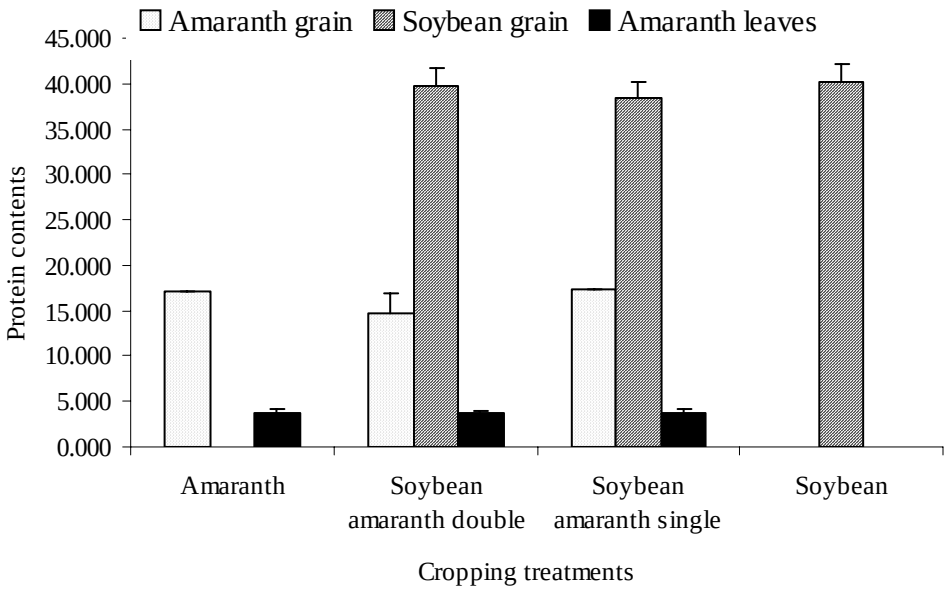

Figure 64. Protein content of amaranth and soybean in site 1 during the first planting season

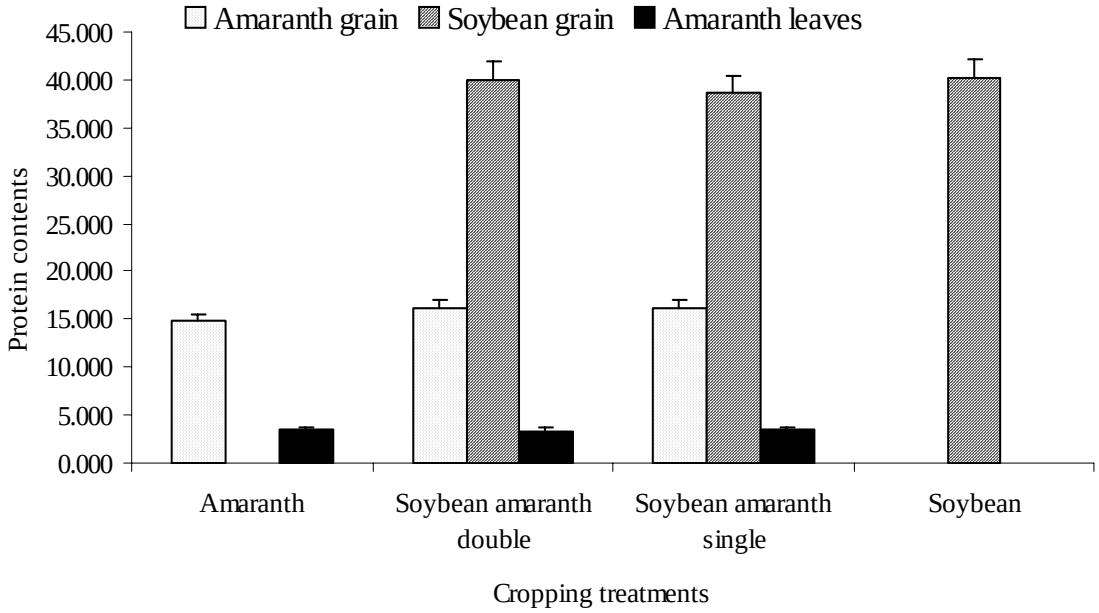

Figure 65. Protein content of amaranth and soybean in site 2 during the first planting season

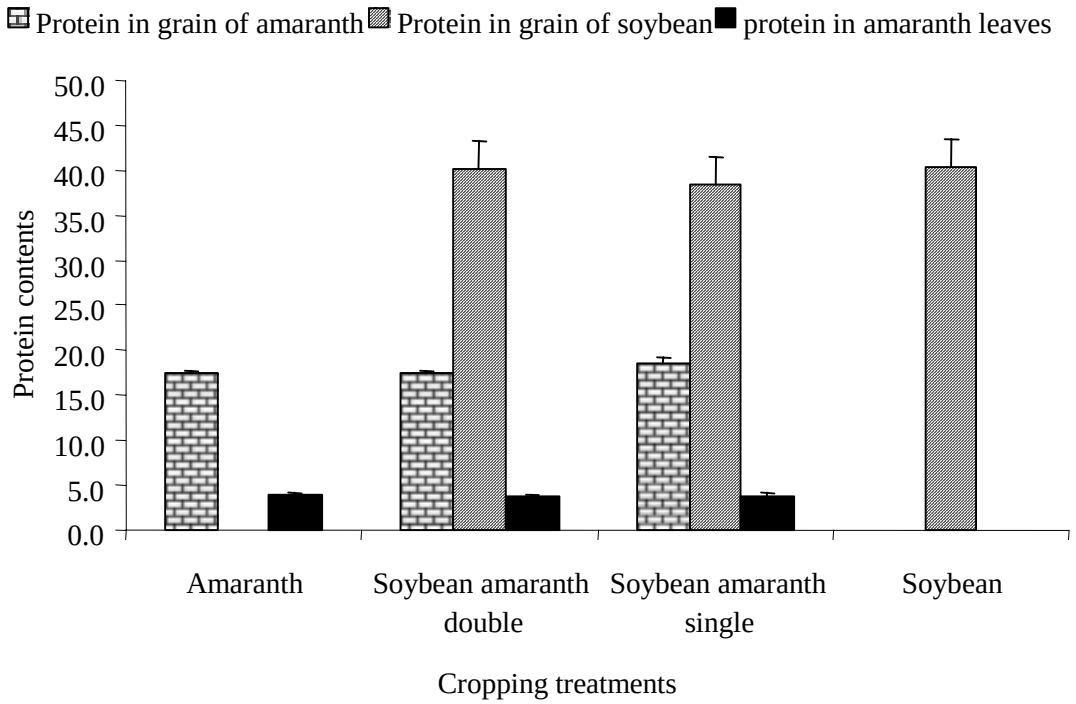

Figure 66. Protein content of amaranth and soybean in site 1 during the second planting season

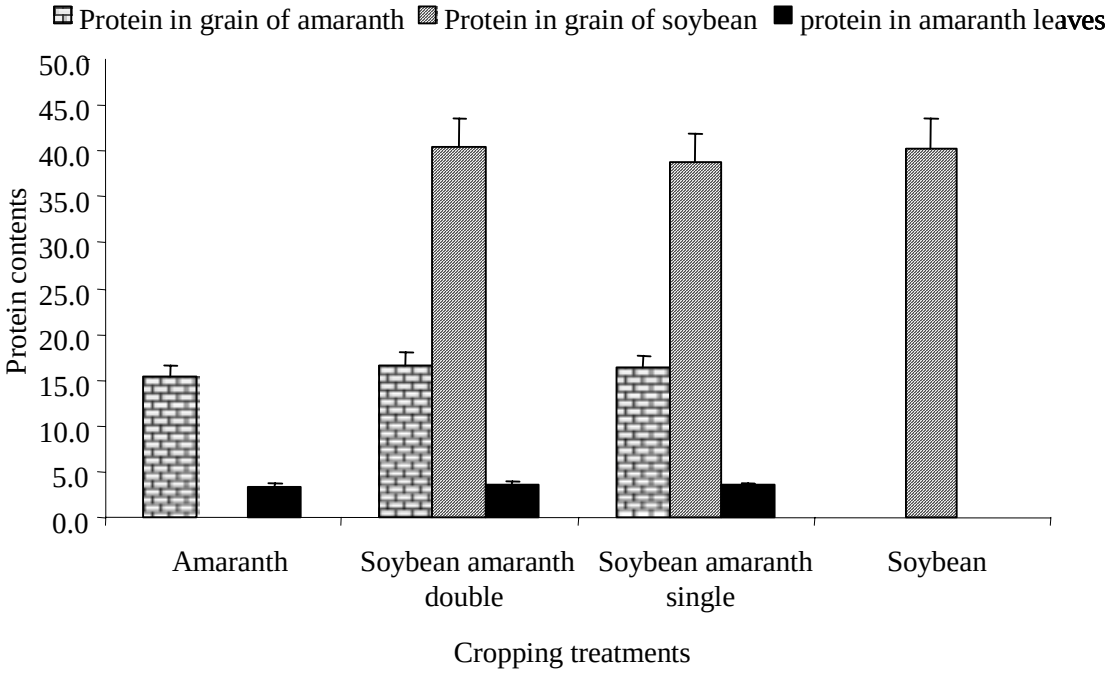

Figure 67. Protein content of amaranth and soybean in site 2 during the second planting season

Amaranth grain protein content
This was higher in grains harvested in site 1 since the soils were very fertile compared to soils in site 2. The protein content also increased during the second season although the difference was not significant. Protein content of amaranth grains planted using single rows was slightly higher than of those planted using double rows although the difference was not significant. However there was a significant difference of amaranth planted in single or double rows compared to sole amaranth (Figures 64, 65, 66 and 67).

Amaranth leaf protein content
This was higher in site 1 where soils were of high fertility levels than in site 2. Amaranth planted in single rows had slightly higher protein content although it was not significantly different from amaranth planted in double rows. Amaranth planted in single rows had a significant difference in protein content compared to sole crops (Figures 64, 65, 66 and 67).

Vitamin A content of amaranth leaves.
This increased significantly in the second season especially in site 2. There was a significant difference of levels of vitamin content in site 1 compared to site 2 in both seasons (Fig 68).

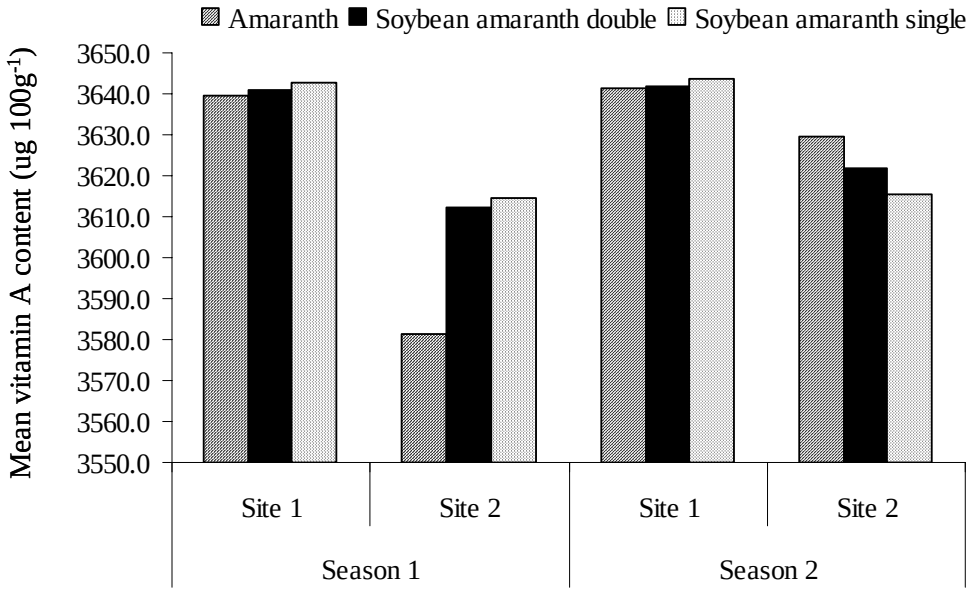

Figure 68. The effect of intercropping on the vitamin A content of the amaranth leaves

Preliminary conclusions

Protein content of both grains was greatly influenced by the amount of nitrogen available in the soils. This means that, for production of quality grains, the soils must be very fertile therefore confirming the importance of using double rows intercropping system as a best bet method in increasing food security high in nutritional value. Similarly, the levels of vitamin A content of amaranth leaves also depended on soil fertility as it was significantly higher in site 1 than site 2 and increased during the second season in site 2 probably due to residual effect of the soybean crop**.**

Effect of soybean (*Glycine max*) supplementation on the nutritional status of HIV affected children aged 6-9 in selected schools in Suba District, Kenya

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[1]TSBF-CIAT, [2]Moi University, [3]Kenyatta University

The HIV epidemic has become a serious health and development problem in sub-Saharan Africa (SSA). Estimates indicate that over 40 million people are currently living with HIV/AIDS worldwide, more than 70% of whom are in SSA (UNAIDS 2005). The toll HIV/AIDS has taken on women and children is particularly acute.

The World Health Organization reported that approximately 8 million children had acquired the AIDS causing virus globally by the year 2000 since the epidemic begun and 3.6 million had already died (WHO 2002). The HIV prevalence rate in Kenya is 6.7%. Suba district has the highest prevalence in Kenya at 41% (KDHS, 2003). It is estimated that there are 12 million AIDS orphans in SSA with 1.1 million in Kenya alone (MOH 2001). Statistics indicate that the number of AIDS orphans increased in primary schools in Kenya from 43,359 in 1990 to 965,975 in the year 2000. The number of HIV/AIDS orphans in Suba district is estimated to be 5,072 (KDHS 2003). These children are vulnerable to malnutrition, poor health, impaired learning and early school dropout. Yet despite these difficulties, there are no school feeding programs in Suba district. Soybeans provide food of choice for the nutrition of malnourished individuals. Besides being a cheap source of protein locally produced, they contain high protein and fat content and the micronutrient level is higher than other locally produced legumes.
This paper presents preliminary findings of a study in which HIV affected children aged 6-9 attending primary school and enrolled in classes 1, 2 and 3 in selected schools in Suba district were served with porridge made from corn-soy blend as a mid-morning snack for three months. The children were monitored every month for 6 months.

Subjects

The experimental research design was employed in this study. Three schools were selected for the study namely; Sindo, Lambwe and Ong'ayo primary schools. A sample frame of HIV orphaned children and other vulnerable children enrolled in class 1, 2 and 3 were prepared with the assistance of the head teachers. The non-probability sampling strategy was used to identify 50 children from each school. Sindo and Lambwe primary schools formed the study group and were on the feeding program while Ong'ayo primary school formed the control and was not on the feeding program. Therefore a total of 150 children from both farming and fishing communities in Suba district formed the study sample.

Methods and materials

Structured questionnaires administered to mothers/caretakers of the children were used to collect data on the socio-economic, demographic food consumption patterns and prevalence of morbidity. Biochemical tests were done on the index child at baseline to determine their haemoglobin levels, serum albumin, zinc and serum retinol. (This will be repeated at 3 months and at 6 months). Anthropometric measurements height and weight were carried out on the children using standard anthropometric procedures. Body weight was taken with minimum clothing using an electronic scale (SECA) to the nearest 0.1kg. Height was taken while the child was standing using a stadiometer to the nearest 0.1cm. A non-stretchable arm circumference tape was used to take mid-upper-arm circumference (MUAC). These measurements were taken at baseline and will be repeated every month for 6 months.

Data was edited and entered into a computer software program. Data from the questionnaire was analyzed using the Statistical Package for Social Scientists (SPSS) for Windows (version 11.5). A p-value of <0.05 was considered significant. Anthropometric data and food consumption data was analyzed using the Nutri-Survey computer software program. Biochemical analyses were done at KEMRI laboratories Nairobi.

Cut off points

Anthropometric measurements were computed for nutritional status indicators WA, HA & HW according to the guidelines by the National Centre for Health Statistics (NCHS-WHO) growth curves. Children with WA, HA & HW values <-2 std deviations of the reference population were considered malnourished. Values <-3 STD deviations of the reference population were considered severely malnourished. MUAC values >13.5 were considered normal, 12.5-13.5 mildly malnourished while values <12.5 severely malnourished.

Expected results

1. Both the study groups, Lambwe and Sindo primary schools are likely to show a steady increase in growth of the children during the monthly evaluations compared to the control at Ong'ayo primary school mainly due to the feeding.
2. There will be an overall reduction in prevalence in morbidity in both the study schools, Lambwe and Sindo primary schools. This will be attributed to the feeding on corn-soy blend. However, general reduction may be observed among all the study subjects because of the vitamin A supplements and mosquito nets that were given to all of them.
3. There will be a notable reduction in school absenteeism and dropout rate and an increase in attention span among the children in the feeding program.
4. Children in farming communities are likely to have a higher increase in growth due to a wider variety of foods available from the farms in comparison to children in fishing communities this could be due to insufficient fish available to individuals at the house hold level, a common observation among fishing communities.

Preliminary conclusions

1. Soybean supplementation enhances the nutritional status and overall growth of children. This is due to the protein and caloric content.
2. Micronutrients present in the soybeans boost immunity and reduce prevalence of morbidity.
3. Presence of school feeding program increases attention span, reduces dropout rate absenteeism and improves academic performance. The community should therefore work towards the sustainability of the feeding program after the project comes to an end.

Effect of soybean (*Glycine max*) supplementation on the nutritional status of HIV + children 6-59 months in Suba District, Kenya

O. Ohiokpehai, G. Were, J. Kimiywe, J. Okeyo, G. Mbagaya, N. Sanginga

TSBF-CIAT, Kenya; Kenyatta University, Kenya; Moi University, Kenya

Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome (HIV/AIDS) has emerged as one of the most serious health situations facing the developing world with consequences that reach far beyond the health sector. Modest estimates indicate that over 40 million people are currently living with HIV/AIDS worldwide, more than 70% of whom are in sub-Saharan Africa (UNAIDS, 2005). The toll HIV and AIDS has taken on women and children, is particularly acute. According to the World Health Organization (WHO) approximately 8 million children had acquired the AIDS causing virus globally by the year 2000 since the epidemic begun and 3.6 million had already died (WHO, 2002). In Kenya, it is estimated that 25,000 children acquire HIV every year and about 100,000 are currently living with HIV/AIDS.

Mother to child transmission (MTCT) contributes 90% of all paediatric HIV infection globally, while the remaining 10% is caused by sexual abuse, blood transfusion and exposure to infected blood (Piwoz & Preble, 2000; FANTA, 2001). Effect of AIDS related morbidity and mortality on HIV infected children is particularly acute. These children have a weak immune system and are thus likely to be more susceptible

to infection. One of the most critical health and welfare problems among infants and young children living with HIV/AIDS in the world today and playing a significant role in their death is malnutrition. Even if the child is mildly malnourished, the mortality risk is increased in event of infection (Piwoz et al., 2000). High rates of malnutrition have been reported as one of the factors responsible for the rapid disease progression in children. Prevention of malnutrition among HIV positive children is therefore likely to have a positive impact to their life.

This paper discusses the preliminary findings from the study in which HIV + children aged 6-59 months were fed on porridge made from corn-soy blend for 3 months and their nutritional status monitored every month for 3 months during the feeding period.

The two research sites were at Suba District Hospital (SDH) and Mbita health centre (MHC) because they have a successful prevention-of-mother-to-child infection (PMTCT) and patient support care (PSC) programs. The study targeted HIV positive children aged 6-59 months attending antenatal clinic at SDH and MHC. A sample frame of 100 children registered at the PMTCT and PSC clinic at each site was used. Simple random sampling procedure was used to select 50 children 25 from each hospital who formed the study sample.

Structured questionnaires administered to mothers/caretakers of the children were used to collect data on socio-economic, demographic, food consumption and prevalence of morbidity. Biochemical tests were done on the index child at baseline (and after 3 months) to determine their haemoglobin levels, serum albumin, full blood count and CD 4 percentage. Anthropometric measurements height and weight were carried out on the index child using standard anthropometric procedures. Body weight was taken with minimum clothing using a salter scale calibrated to the nearest 0.1kg height was taken using a length board calibrated to the nearest 0.1cm. A non-stretchable arm circumference tape was used to take mid-upper-arm-circumference measurement (MUAC).

Data was edited and entered into computer software for analysis. Data from the questionnaires was analyzed using the Statistical Package of Social Scientists (SPSS) version 11.5. While anthropometric and dietary intake data was analyzed using the Nutri-Survey computer software. Biochemical analyses were done at KEMRI laboratories in Nairobi.

Expected results

1. The children in the study sample will show a steady increase in the nutritional status as seen in the WA, HA and WH values. This will be attributed to the feeding.
2. There will be an overall reduction in morbidity patterns and infection rate among the children. This will be attributed to the micronutrients in the corn-soy which boost immunity.

Preliminary conclusions

1. Soybean supplementation enhances the nutritional status and health of HIV positive children.
2. The micronutrient content in the corn-soy blend boosts immunity therefore reduces infection rate among HIV positive individuals.

The use of training in soybean processing and utilisation as vehicle of knowledge dissemination and scale-up

O. Ohiokpehai, B. King'olla and N. Sanginga
TSBF-CIAT, Kenya

The proven and tested technologies through the project was shared with partners, patients and farmers. This sharing of knowledge was used as a method of scaling up and strengthening alliances.
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Training was carried out in Eldoret, Butere, Mumias, Migori and at Suba District (Figure 69) by introducing soybean processing and utilization (Figure 70). For all the sites, we used different training techniques, depending on the community's practices and preferences. Soybean introduction vis-à-vis processing was combined with hygiene and sanitation and processing of food products. The following topics were included: HIV/AIDS and Nutrition awareness, basic business management, and Money issues.

However the following topics were covered during the ToT to improve on finished product quality: (i) Hygiene and sanitation, (ii) Basic business management, (iii) Nutritional education, (iv) Nutrition as it relates to HIV, (v) Entrepreneurial awareness, (vi) Gender issues, (vii) Money matters, and (viii) Packaging and labeling. As shown in Figure 70 – In **Eldoret** for HIV patients the training adopted training of every two weeks for one full day (Table 58). The patients would come in to the farm and they would be taken through a training session for a whole day. This method was adopted as the patients could not be saddled with a heavy training schedule. At the end of four or five trainings, the patients were issued with certificates of attendance. This was a form of motivation to the patients to increase their interest in soybeans. The utensils used were supplied by TSBF. The number of training undertaken are shown below (Table 58), and training is continuing in AMPATH focusing on hygiene, sanitation and infant feeding with children whose mothers are HIV positive.

Table 58. Number of Patients Trained in Eldoret – AMPATH

Location/Groups	Dates	Number of men patients	Number of women patients	Total Number of patients
Eldoret (ToT)	16–20 January 2006	3	12	15
Mosoriot Rural Health Clinic (ToP)	21 Feb 2006	3	13	16
Mosoriot Rural Health Clinic (ToP)	7 March 2006	3	13	16
Mosoriot Rural Health Clinic (ToP)	21 March 2006	3	13	16
Mosoriot Rural Health Clinic (ToP)	4 April 2006	3	13	16
Mosoriot Rural Health Clinic (ToP)	18 April 2006	3	10	13
Total Number of Patients Trained		**18**	**74**	**92**

ToT –Training of Trainers **ToP** – Training of Patients

Butere/Mumias – In Butere/Mumias (see Figure 70) the farmers met prior to the training days and planned for the activities facilitated by a trainer. The training was carried out for two days (Table 59). The farmers supplied the utensils used as per our advice. The topics covered during the training sessions included: (i) Food safety and Hygiene, (ii) Soybean and vegetable processing and utilization, (iii) Nutritional education, (iv) Basic business, (v) Packaging, and (vi) Labeling.

Migori District – In Migori (see Table 59) we identified seven groups of farmers' cooperatives. Training commenced with four cooperative societies, with 60 or more farmers trained on soybean processing and utilization. TSBF worked with facilitators trained previously in Butere/Mumias. Also, farmers were chosen as trainers to demonstrate to their fellow farmers that they had been trained in processing and

utilization of soybeans, as they had adopted consumption of soybeans, and it was possible to process soybean.

The farmers from Migori were identified through a sister project "Exploring multiple potential of soybeans in enhancing rural livelihood and small industry in East Africa." These farmers had already planted and harvested soybeans, and were waiting to be trained on soybean processing. Before such ToF took place, participatory planning was carried out. For each training session the facilitators went into the villages and met with some of the participants and officers of the cooperative groups who participated in one or two-day planning. Decisions on venue, budget, utensils needs for the training, and other logistic issues were discussed during the planning.

Ninety two patients were trained in Eldoret (Table 58). In Butere/Mumias and Migori the total number of farmers trained was 484 (Table 59).

Table 59. Number of Farmers Trained in Butere/Mumias and Migori

Location/Groups	Dates	Number of men farmers	Number of women farmers	Total Number of farmers Trained
Butere/Mumias District (ToT)	24–28 October 2005	1	10	11
Nabogo Panga Self Help Group – Mumias District (ToF)	3 December 2005	9	16	25
Khwisero Location – Butere/ Mumias (ToF)	14 & 15 February 2006	7	16	23
South Wanga Location – Butere/Mumias (ToF)	21 & 22 February 2006	6	14	20
Meting Location –Butere/ Mumias (ToF)	28 February & 1 March 2006	5	15	20
Emabole Soya Farmers Group – Butere/Mumias (ToF)	19 & 20 April 2006	7	23	30
Jitolee Women's Group – Butere/Mumias (ToF)	3 & 4 May 2006	5	25	30
Stella Rayudth Soya Group – Uriri Farmer's Co-operative Migori District (ToF)	19–20 June 2006	7	70	77
Kakamasia Suna Farmers Cooperative, Migori District (ToF)	21–22 June 2006	7	70	77
Osogo Ronga Farmers Cooperative, Migori District (ToF)	23– 4 June 2006	18	66	84
Amoso Soya Bean Project	26–27 June 2006	4	83	87
Total Number of Farmers Trained		**76**	**408**	**484**

ToT – Training of Trainers **ToF** – Training of Farmers

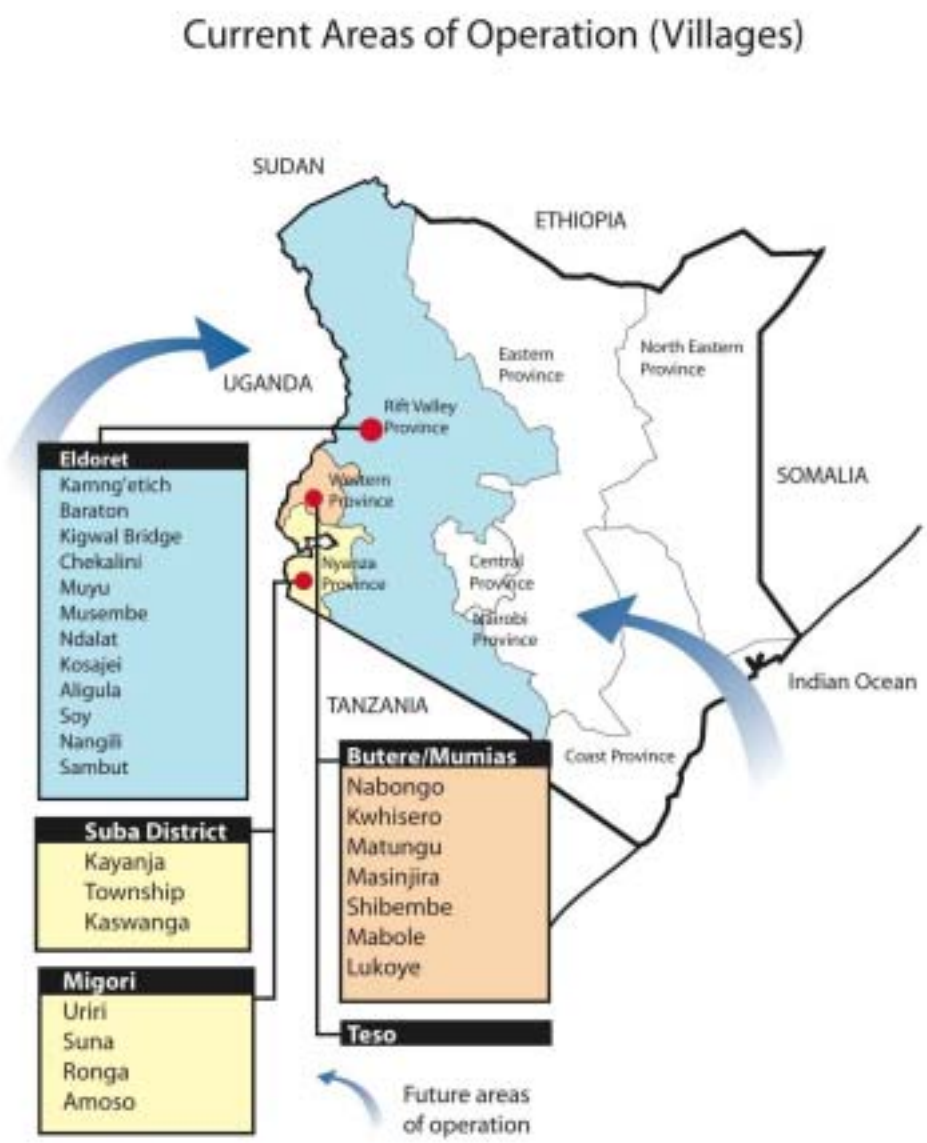

Figure 69. Target villages for training

Figure 70. Farmers / patients processing soybean products

Improving cereal productivity and farmers' income using a strategic application of fertilizers in West Africa

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In the past two years, ICRISAT, in collaboration with other International Agricultural Research Centres, National Agricultural Research and Extension Systems) has been evaluating and promoting point or hill application of fertilizer along with "Warrantage" in three West African countries, namely, Burkina Faso, Mali and Niger. The hill application of fertilizers consists of applying small doses of fertilizer in the planting hills of millet and sorghum. The combination of strategic hill application of fertilizer with complementary institutional and market linkages, through an inventory credit system (known as "Warrantage") offers a good opportunity to improve crop productivity and farmers' incomes. Results from the two year on-farm trials showed that, on average, in all the three countries, grain yields of millet and sorghum were greater by 44 to 120 % while incomes of farmers increased by 52 to 134 % when using hill application of fertilizer than with the earlier recommended fertilizer broadcasting methods and farmers' practice. Substantial net profits were obtained by farmers using "Warrantage". Farmers' access to credit and inputs was improved substantially through the "warrantage" system. The technology has reached up to 12650 farm households in the three countries and efforts are in progress to further scale-up and out the technology to wider geographical areas.

Responses of Maize-Bean Intercrops to Minjingu Phosphate Rock and Lime in Terms of Nutrient Use Efficiency and Economic Benefits on Acid Soils of Western Kenya

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Low inherent soil fertility in the highly weathered and leached soils largely accounts for low and unsustained crop yields in most African countries. But in particular, the major nutrients, nitrogen (N) and phosphorus (P), are commonly deficient in these soils. This scenario of nutrient depletion is reflected in food deficits and hence the food aid received continuously, specifically in sub-Saharan Africa. Undoubtedly, substantial efforts have been made in the continent to replenish the fertility of degraded soils in attempts to raise crop yields, towards self-sufficiency and export. Such efforts consist of applications of both organic and inorganic resources to improve the nutrient status of soils and enhanced nutrient uptake by crops, provided that soil moisture is adequate. Overall, positive crop responses to these materials have been obtained. Thus in the East African region, maize (staple) yields have been raised in one growing season from below 0.5 t ha^{-1} without nutrient inputs, to 3–5 t ha^{-1} from various nutrient amendments at the smallhold farm level. However, in spite of the positive crop responses to nutrient inputs, farmers are generally slow to adopt the soil fertility management technologies. In this paper we review the impact of some technologies, focussing the use of nutrient resources of different characteristics (qualities) in relation to improved crop yields, with an overall goal to enhance technology adoption. Thus, inorganic resources or fertilizers often give immediate crop responses, but their use or adoption is rather restricted to large-scale farmers who can afford to buy these materials. Organic resources, which include crop residues, water hyacinth and agroforestry shrubs and trees, are widely distributed, but they are generally of low quality, reflecting the need to apply large quantities to meet crop nutrient demands. Moreover, most organics will add N mainly to soils. On the other hand, phosphate rocks of varying reactivity are found widely in Africa and are refined elsewhere to supply soluble P sources. The recently developed soil fertility management options in East Africa have targeted the efficient use of N and P by crops and the integrated nutrient management approach. Some people have also felt that the repackaging of inputs in small, affordable quantities, such as the PREP-PAC described in this paper, may be an avenue to attract smallhold farmers to use nutrient inputs. Nonetheless, crop responses to nutrient inputs vary widely within and across agroecozones (AEZs), suggesting specificity in recommendations. We highlight this observation in a case study whereby eight soil fertility management options, developed independently, are being tested side-by-side at on-farm level. Farmers will be empowered to identify technologies from their own choices that are agronomically effective and economically friendly. This approach of technology testing and subsequent adoption is recommended for technology development in future.

An Approach for promoting a versatile crop that has remained minor: Case of soybean in the farming systems of Kenya

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Soybean is an important food, feed oil and cash crop in the world. Efforts to promote it in sub-Saharan Africa led to mixed results with success in Nigeria and Zimbabwe and failures in Kenya because of (i) lack of awareness on processing/utilization, (ii) low yield and (iii) lack of market. This paper aims at using the understanding of the reasons for success in Nigeria and Zimbabwe and the missing links that led to failure in Kenya to create a model for sustainable soybean promotion in Kenya. Results show how the model increased the confidence of farmers to produce soybeans for home consumption and the market since industrial food/feed processors have guaranteed import substitution at a mutual beneficial price. Other partners in the strategic alliance for sustainable soybean promotion in Kenya provide credit, mineral fertilizer and know-how on other aspects of value addition all of which enhance soybean yield.

Output target 2009

ü ***Validated intensive and profitable systems are being demonstrated, promoted by partners and adopted by farmers in 10 countries***

Published work

Maithya, J. M., Kimenye, L. N., Mugivane, F. I. and Ramisch, J. J. (2006). Profitability of agro-forestry based soil fertility management technologies: the case of small holder food production in Western Kenya. Nutrient Cycling Agroecosystem 76: 355–367

Abstract: Persistent food insecurity accompanied by low and declining farm household incomes are a common feature of many small holder maize and bean producers in western Kenya. This has been largely attributed to soil nutrient depletion, among other factors. One way of addressing soil fertility problems in many maize-based cropping systems is the use of agro-forestry based technologies. We carried out a survey in western Kenya (Vihiga and Siaya districts) aimed at analyzing the financial and social profitability of use of agroforestry based (improved tree fallows) and other soil fertility management technologies among small-holder farmers. The Policy Analysis Matrix (PAM) was used to determine the financial and social profitability of different production systems, which were categorized on the basis of the technology used to address soil fertility. Farm budgets were first prepared and in turn used to construct the PAMs for six production systems namely: maize–bean intercrop without any soil fertility management inputs; maize–bean inter-crop with chemical fertilizers only; maize–bean intercrop with a combination of chemical fertilizers and improved fallows; maize–bean intercrop with improved fallows only; maize–bean intercrop with a combination of improved fallows and rock phosphate; and maize–bean intercrop with Farm Yard Manure (FYM) only. Results revealed that use of chemical fertilizers with improved fallows was the most profitable technology and thus the study recommended that farmers be encouraged to intensify the use of chemical fertilizers. To make chemical fertilizers more accessible to farmers, the study also recommended that good linkages be made between farmers and micro credit institutions so that small-scale farmers are not actually biased against due to lack of collateral when credit is being advanced to clients.

Odendo[1], M., Ojiem[1], J., Bationo[2], A. and Mudeheri[1], M. (2006) On-farm evaluation and scaling-up of soil fertility management technologies in western Kenya. Nutrient Cycling Agroecosystem 76: 369–381

[1]KARI, Kenya; [2]TSBF-CIAT, Kenya

Abstract: Low soil fertility is a fundamental constraint to crop production in western Kenya. Although researchers have developed many soil fertility-improving technologies, the adoption of these technologies is low due to inadequate awareness of the technologies, poor access to requisite resources and unsuitability of the technologies to the farmers' conditions. On-farm experiments were conducted during the 2002/2003 long rain cropping seasons in two village clusters in Vihiga and Kakamega Districts in order to: (1) introduce farmers to selected soil fertility-improving options and elicit farmers' evaluation of the options; (2) assess the economics of the selected soil fertility management options under standard farming conditions; (3) compare the farmers' evaluations with the results of an economic assessment. Five treatments were suggested to the farmers and through consensus, they ultimately chose to test three: (1) 5 tons ha^{-1} FYM (Farm Yard Manure); (2) 60 kg P ha^{-1} plus 60 kg N ha^{-1} (chemical fertilizers); (3) 2.5 tons ha^{-1} FYM plus 30 kg P ha^{-1} (chemical fertilizers). These were assessed concurrently with farmers' accepted practice, using maize as a test crop. Farmers were involved in the routine management, monitoring and evaluation of the experiments, and field days were held to introduce more farmers to the technologies. The results of this investigation show that the application of 30 kg P plus 2.5 tons FYM ha^{-1} gave economically viable returns that remained viable even under a projected decline in maize yield and an increase in the price of fertilizers. This treatment was also the most preferred option of the farmers.

The results of this study should be used for validation of the promising options and planning of future experiments.

Completed work

Participatory Diagnosis in the Eastern Drylands of Kenya: Are Farmers aware of Their Soil Fertility Status?

J.M. Kimiti[1], A.O. Esilaba[2], B. Vanlauwe[3] and A. Bationo[3]

[1,3]TSBF-CIAT, Nairobi, Kenya; [1]KARI, Nairobi, Kenya

A participatory diagnosis (PD) was carried out in Makueni District, eastern Kenya, with a view of identifying farmer awareness on soil fertility status so as to identify gaps for research on soil fertility improvement. The results indicate that farmers are aware of soil types, soil characteristics soil, soil fertility status and soil distribution of different soil types in their villages. In addition, the farmers are aware of declining soil fertility, which they attributed to soil erosion, continuous cropping, poor methods of cultivation, and inadequate farm inputs. The farmers use farmyard manure to improve soil fertility and are aware of the quality of different manures used in their farms. The types of farmyard manures as ranked by famers in decreasing quality are poultry manure>goat manure>cattle manure. However it was revealed that cattle manure is commonly used because it is readily available though not adequate. Crop residues, especially those of grain legumes, are also used for soil fertility improvement. In this paper the results of farmer participation research meetings with emphasis on soil fertility management in eastern Kenya are discussed.

Output targets 2009

ü **The contribution of multiple stress adapted germplasm in driving overall system resilience is understood for the conditions occurring in all mandate areas**

Progress towards this output target will be reported next year.

Output target 2009

ü ***Products of the trade-off analysis are guiding the introduction and evaluation of alternative NRM options, better suited to the farmer production objectives and the environment of the actions sites***

Progress towards this output target will be reported next year.

Progress towards achieving output level outcome

- *Partners promoting resilient production systems with multiple benefits (food security, income, human health and environmental services)*

Farmers in Africa and Latin America are evaluating actively crop components and management technologies having benefits on food security, income generation and soil fertility. Improved lines of Cowpea and L*ablab purpureus* have been selected by farmer groups in Kenya and Uganda for their contribution to human consumption, increased fodder availability and improved soil fertility. Small farmers in the Cerrados of Brazil are increasing milk production by introducing drought-tolerant forage legumes in their pastures. Market-led crop options such as soybean and vegetables will play a major role in generating income for small farmers in Africa, provided that sustainable markets are developed and alternative uses explored. Preliminary results are promising. The combination of resistant maize varieties and improved soil fertility is showing potential to reduce Striga emergence in maize fields in western Kenya.

Progress towards achieving output level impact

- *Improved resilience of production systems contribute to food security, income generation and health of farmers*

The new production systems under development by the TSBF team and their collaborators in Africa and Latin America will have a positive impact on crop productivity and profitability in the short term. This will be translated into improved food availability at the household level and greater chances to link agricultural production of smallholder production systems with market demands. Soybean crop will become an important component of production systems if production, processing and marketing bottlenecks are solved.