Maize–bean systems: better practices mean better crops

RIU

Validated RNRRS Output.

Farmers in Kenya growing mixed maize–bean systems are using improved fertilisers, disease-tolerant maize varieties and early-maturing bean varieties to increase the productivity of their crops; herbicides are helping to protect crops, reduce women's labour (weeding) and conserve soil; and Farmer Field Schools are promoting the new methods. Farmers are also using an affordable, lightweight chisel plough to break up the hard soil ('soil pans') that results from years of shallow cultivation with hand implements or disc ploughs. Soil pans make it hard for crops to take root and for rainwater to penetrate the earth. Consequently, crops do not achieve their yield potential and are more susceptible to drought, and soils have high potential for erosion.

Project Ref: **CPP12:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Farm Input Promotions Africa, Kenya**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP12

Research into Use
NR International
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Geographical regions included:

Kenya,

Target Audiences for this content:

Crop farmers, Consumers,

A. Description of the research output(s)

1. Dissemination of improved crop varieties and crop management practices to improve food security amongst poor farmers in East Africa

2. The RNRSS Programme commissioning the research was the Crop Protection Programme. Funding has also been provided by the Rockefeller Foundation and USAID for further development and dissemination of the Research Outputs in other regions in Kenya.

3. Two projects were commissioned by the Crop Protection Programme:

R8219 - Improved access to appropriate farm inputs for integrated maize crop management by small-scale farmers in Embu and Kirinyaga districts, Kenya.

R8455 - Improved access to appropriate farm inputs for integrated maize crop management by small-scale farmers in Kenya and Tanzania

These projects were conducted in co-operation with Prof. J.M. Anderson (Univesity of Exeter), and Mr J. Muthamia of KARI-Embu.

FIPS-Africa was also involved as a co-operator in a project under the Crop Post-Harvest Programme in Tanzania, led by Mr L Nsemwa, and Dr N. Lyimo: R8422 – Market Information tools

4. The proposed cluster of outputs was developed over a 3 year period in projects funded by DfID's Crop Protection Programme to overcome specific constraints to improved productivity of maize and bean crops (see table below). The overall purpose of the projects was to ensure **food security** and **improved livelihoods** of poor, **small-holder farmers** through the development and dissemination of appropriate inputs, and development and demonstration of improved methodologies for management of crops and soils. This has been achieved by introducing small farmers to **appropriate fertilizers** including improved formulations (*Mavuno*, *Minjingu Mazao*) to increase crop productivity; **maize varieties** tolerant to **Maize Streak Virus (MSV);** and **herbicides** to enable **crop protection**, reduction in **womens' labour** and **soil conservation**. Methodologies included promotions through farmer Field Schools, targeting whole communities at village level (Village Extension Approach), and through stockists using small packs of inputs provided by the private sector. In the course of the projects, methodology was developed to promote other inputs such as **vegetables**, and early-maturing, **drought-tolerant bean varieties**, soil fertility-improving **soyabean** varieties, and **grain storage products**.

In another project in Western Kenya, funded by the Rockefeller Foundation, FIPS-Africa's approach has been further developed to include the promotion of **GRD-tolerant groundnut** varieties, **CMV-tolerant cassava varieties**, new varieties of **sweet potatoes**, and **indigenous vegetables**.

In a pilot project in Eastern Province, FIPS-Africa has developed, with the Rift Valley Institute of Science and Technology, a light-weight, **chisel plough** that is affordable and appropriate for the size of local tractors (unlike available commercial models). **Soil hard pans**, caused by years of shallow cultivation with hand implements or

disc ploughs, are a major constraint to crop production in many areas because they impede rooting depth and rainwater infiltration. Consequently, crops do not achieve the yield potential from the inputs, are more susceptible to drought and the soils have high potential for erosion. In addition to promotions aimed at mechanized farmers, there is considerable potential for contract ploughing of small-holder's plots with compacted soils because of the labour saved in planting along the rip lines and the large yield gains that more than offset costs. Breaking the hard-pan is an essential pre-requisite to achieve the potential from **conservation tillage practices** that FIPS-Africa is also promoting.

Cluster of research outputs currently promoted by FIPS-Africa to overcome specific constraints in maize/beans cropping systems

Target Poverty Grouping	Common Constraint	Research Output	Product	Dissemination tool	Dissemination approach	Notes
Moderate Poor/ Extreme Vulnerable Poor	Perennial Grass weeds	Glyphosate	Roundup Max	10 g promotion sachet	Village Extension Approach/ Stockist	100g sachet commercially available; appropriate where family labour is a constraint; component of conservation agriculture
	Hard/Plough Pan	Chisel Plough	RVIST Chisel Plough	Tractor Offering Contract Service	Village Extension Approach	Commercially-available; Restricted to farming systems where tractors are available for hire; component of conservation agriculture
	Soil Acidity	Rapid pH test	Lime Minjingu Mazao fertilizer	1 kg promotion pack	Village Extension Approach	Commercially available
	MSV Disease	MSV-tolerant varieties	WH403, WH502, WH505, WS202, WS103	100g promotion pack	Village Extension Approach/ Stockist	Donation by private sector; can be combined with planting fertilizer
	Soil P deficiency	Planting (High P) fertiizer	Mavuno Minjingu Mazao	1 kg promotion pack	Village Extension Approach/ Stockist	Commercially available
	Soil N deficiency	Topdressing fertilizer	Mavuno top fertilizer;	1 kg promotion pack;	Village Extension Approach/ Stockist	Commercially available; also contains S;

		Desmodium	Desmodium seed (ex Western Seed Co.)	50g packs		Grown between maize rows; particularly useful to increase quality of livestock feed, and where striga/ stalk borer also limit maize crop production
	Poor crop management		"Maxi-maize production" Planting String	"Maxi-maize production" Planting String	Village Extension Approach/ Stockist	Not yet commercially available but possible to commercialise
	Unreliable rainfall/early season drought	Early maturing maize and bean varieties	Bean: K-B1, K-B9, K-X56	30 seed mini-pack	Village Extension Approach	Not commercially available
	Grain Storage Pest (e.g. LGB)	Grain Storage Chemical	Spintor dust		Village Extension Approach/ Stockist	Commercially available
Extreme Vulnerable Poor/ e.g. Assetless Women-headed households	Extreme Poverty	Selected package to overcome constraints	Selected products to overcome constraints	Package of inputs for 0.5 acre	Farming Support Programme within Village Extension Approach	Time- and labour-consuming meaning relatively few people can be targeted with this approach

5.

Product	*Technology*	*Service*	*Process/Methodology*	*Policy*	*Other Please specify*
x	x	x	x		

6. Main commodities targeted are maize, and beans but FIPS-Africa has diversified its approach to include other crop species including vegetables (kale, cabbage, pumpkin, black nightshade, spider herb), groundnuts, sorghum, cowpeas, greengrams, pigeonpeas, soyabeans, sweet potatoes and cassava according to farmers' specific demands in different districts.

7.

Semi-Arid	*High Potential*	*Hillsides*	*Forest-Agriculture*	*Peri-Urban*	*Land water*	*Tropical moist forest*	*Cross-cutting*
x	x						

8.

Smallholder rainfed humid	*Irrigated*	*Wetland rice based*	*Smallholder rainfed highland*	*Smallholder rainfed dry/cold*	*Dualistic*	*Coastal artisanal fishing*
x			x			

9. FIPS-Africa's methodology can be easily adapted to include outputs from other RNRRS projects, or other research programmes, where those outputs are appropriate for targeted farming systems, and which alleviate the constraints to increased crop or livestock productivity.

The small pack methodology can be adapted to disseminate rosette-resistant groundnut varieties (R8104/R7445), quality kale seed (R8312), finger millet blast resistant varieties (R8445), improved pigeonpea varieties (R8481), improved beans (R8415), and disease-resistant maize cultivars (R8220/R8406) where germplasm is available for dissemination. Improved varieties of sweet potatoes (R8457/R8273), and cassava (R8405) can be disseminated from strategic bulking sites by FIPS-Africa field staff through FIPS-Africa's Village Extension Approach. The small pack methodology can also be adapted to promote seed of fodder crops (e.g. desmodium) as outputs of projects (R7955/R8445) to improve the feed quality of livestock, and/or control stalk borer/*striga* or increase soil fertility through N fixation. Technical information from other research programmes (e.g. seed priming (R6395)) can easily be passed to farmers by FIPS-Africa field staff where the technology is appropriate for overcoming constraints to productivity. Since in most of the farming systems where FIPS-Africa is working, farmers own livestock (primarily poultry, dairy cows), extension of information to increase chick survival or milk production through improved nutrition (outputs of R7431, R7855) could also be passed on to farmers by FIPS-Africa's field staff.

Farmers will only benefit from improved germplasm if soil physical and chemical constraints to crop growth are alleviated. FIPS-Africa has found that in many semi-arid areas in Kenya, a hard pan has developed below the soil surface that prevents infiltration of rainfall, and restricts rooting depth, resulting in poor crop yields. Soils are also severely depleted in soil nutrients (primarily phosphorus and nitrogen). Therefore, FIPS-Africa has developed an integrated soil and crop management approach whereby the appropriate varieties are promoted together with the appropriate fertilizers and soil management techniques (e.g. herbicides, chisel ploughing, and conservation tillage) to enable improved germplasm to achieve its potential.

FIPS-Africa's success has been achieved though increasing awareness of the need for improved inputs at farm level and developing private sector partnerships, and stockist networks, to supply this increased demand.

Validation

B. Validation of the Research Outputs

10. In Kenya, research outputs (*Mavuno* fertilizers, disease-tolerant maize varieties, early-maturing bean varieties) were validated by FIPS-Africa Field Workers in close co-operation with farmers, KARI, and the Ministry of Agriculture. Methodology developed included demonstrations at Farmer Field Schools, and Farmer Groups, and by farmers following small-pack promotions through farm input stockists, and following Field Days around

demonstrations, and through FIPS-Africa's *Village Extension Approach*.

In Western Kenya, the varieties of sweet potato and cassava promoted within FIPS-Africa's Village Extension Approach have been validated by KARI. The varieties of soyabean promoted have been validated by the Tropical Soil Biology and Fertility Programme (TSBF).

In the Rift Valley Province of Kenya, the reduced tillage technology facilitated by the Chisel Plough developed by FIPS-Africa has been validated by FIPS-Africa Field Workers in close co-operation with farmers. The reduced tillage technology is currently being validated with farmers in Makueni district where hard pans below the soil surface are a serious impediment to improved crop performance.

In Tanzania, the research output (*Mavuno, Minjingu Mazao* fertilizer) was validated with small farmers working closely with the Ministry of Agriculture (in the S.Highlands), and researchers (in the N. Highlands). Methodology used was mainly through demonstrations, but in the N. Highlands small pack promotions through stockists were also conducted.

The Small pack promotion methodology, developed by FIPS-Africa enables hundreds of thousands of farmers to validate research outputs on their own farms simultaneously. The real test of validation is whether these farmers continue to save their seed and bulk up new improved germplasm, or whether in the case of commercially-available research outputs, whether farmers return to their nearest stockist to purchase the outputs.

11. The outputs (Mavuno fertilizers, disease-tolerant maize varieties, herbicides, drought-tolerant bean varieties) were validated in the R8219 project which commenced in Embu and Kirinyaga districts in Kenya in January 2003, and lasted until March 2005.

In a project extension phase (R8455) from April 2005 to December 2005, outputs (Mavuno fertilizers, disease-tolerant maize varieties, drought-tolerant bean varieties, herbicides) were validated in Nyeri and Meru districts in Kenya. In Tanzania, research outputs (*Mavuno*, *Minjingu Mazao* fertilizers), were validated in co-operation with CPP projects supporting the dissemination of other research outputs i.e. disease-tolerant maize varieties (R8220) and improved bean varieties (R8414).

In Kenya, research outputs (*Mavuno* fertilizers, disease-tolerant varieties, and early-maturing bean varieties) have also been validated through other projects (Eastern and Western Provinces).

Outputs have been validated amongst the "Moderate Poor" and "Extreme vulnerable poor" poverty groups. The "Extreme Vulnerable Poor" group includes assetless male & female headed households in rural areas, and women headed households. In general, this group of people have been trying to subsist on limited farm sizes (< 1 ha), in Smallholder Rainfed Humid and Smallholder Rainfed Highland farming Systems, Semi-arid and High Potential Production Systems, which experience a bi-modal rainfall distribution.

Current Situation

C. Current Situation

12. In Kenya, two of the Outputs have been taken up by the Private Sector, and are being made available to small farmers through local farm input stockists. For example, Western Seed Co. is producing and marketing the disease-tolerant maize varieties (WH403, WH505, WH502), Athi River Mining is manufacturing and distributing *Mavuno* fertilizers and in Tanzania, manufacture of the output *(Minjingu Mazao* fertilizer) will commence in February 2007.

It is estimated that, as a consequence of FIPS-Africa's intervention, these maize varieties are being used over 30,000 acres of land, and used by 60,000 individual farmers assuming each farmer plants on average 0.5 acre. The number of farmers using *Mavuno* fertilizer is more difficult to calculate, but assuming that each farmer uses 50 kg, then 120,000 farmers could be using *Mavuno* fertilizer over 18 Districts of Kenya where FIPS-Africa is operating.

13. Mavuno fertilizers, disease-tolerant maize varieties and early-maturing bean varieties; these are being used by farmers in the mid-high altitude areas of Kenya (1200 – 1800 m). Eastern Province: Embu, Meru, Machakos, Makueni, and Kitui districts; Central Province: Kirinyaga, Nyeri, Murang'a, and Maragwa districts; Western Province: Vihiga, Kakamega, Butere-Mumias, and Bungoma districts. These areas are characterized by soils which are highly-depleted of nutrients, and a bi-modal rainfall distribution which permit the growing of two crops/ year, and where there is a threat of late-season drought.

Mavuno fertilizers have also been adopted by farmers in the Rift Valley Province which are primarily high-altitude areas characterised by 1 long growing season where late-maturing maize and bean varieties are grown, and where soils are primarily deficient in N, P, and S. *Mavuno* fertilizers have been adopted on crops other than maize and beans, and farmers are reporting successful application on high-value crops such as coffee, and horticultural crops such as passionfruit, and french beans and high value vegetable crops such as tomatoes, onions, cabbages, and kales.

14. Disease-tolerant maize varieties: Demand for varieties of Western Seed Co (WSC) is increasing rapidly throughout Kenya. In Embu and Kirinyaga districts demand for these varieties, following FIPS-Africa's promotions increased within 3 seasons from 0 tonnes in March 2003 to 50 tonnes in October 2004. In order to meet the rapidly increasing demand, WSC has just made a major investment in seed production and seed processing capacity, and is expecting to scale-up production from 500 T/year to 3000 T/year in 2007. WSC is also planning to market its varieties in Tanzania and Uganda.

Mavuno fertilizers. Demand for *Mavuno* fertilizers has increased from 0 tonnes in June 2003 to sales of 6,000 tonnes in 2006. Athi River Mining is planning to scale up production to 30,000 T/year over the next 3 years.

15. FIPS-Africa's success has been achieved through the implementation of a closely integrated methodology to increase awareness of the need for improved inputs or services at the farm level and developing private sector partnerships, and stockist networks, to supply this increased demand.

A major factor of success is the *Uptake* of *Research Outputs* by the *Private Sector*, and commitment by the Private Sector to develop markets for those Outputs amongst small farmers. Conventionally, the Private Sector

has ignored the market for small farmers in favour of the medium- to large-scale farmers who have a larger purchasing power and who are easier to reach. However, FIPS-Africa has demonstrated that demand for those inputs can be quickly generated if inputs are made available in small promotion packs. A key factor for success therefore is that the private sector packages its inputs in small packages which the majority of small farmers can afford and also for FIPS-Africa's market promotions. Experience has also shown that the inputs must be combined with information on how they should be used most effectively, and how soils should be best managed to ensure that the farmer obtains maximum economic benefits. Finally, promotion campaigns need to be carefully designed to create demand for those inputs amongst as many farmers as quickly and cost-effectively as possible. FIPS-Africa has found that hundreds of small plot demonstrations, and small pack promotions at the Village level that enable farmers to try different inputs on their own farms, empower farmers through "learning-by-doing". These extensive approaches have proved more effective in terms of stimulating farmer adoption of inputs than a few, larger plot demonstrations (e.g. in field schools).

Current Promotion

D. Current promotion/uptake pathways

16. Promotion is currently taking place in the following countries/districts:

Kenya
Western Province region (Vihiga, Kakamega, Butere-Mumias districts); promotion is currently taking place in this region within a framework of a project funded by the Rockefeller Foundation. Outputs promoted in this project include Mavuno fertilizers, and improved maize, beans, cowpea, soyabean, sweet potatoes, and cassava, and the growing of commercial and indigenous vegetables for income generation and household food security and nutrition.

Eastern Province region (Machakos, Makueni, Kitui districts); FIPS-Africa started a pilot project in February 2005 to show the potential of FIPS-Africa's methodology on improving farmers' livelihoods in this region. Activities are currently limited to the promotion of Western Seed Co. varieties through farm input stockists in the region, and promotion of the chisel plough, *Mavuno* fertilizer, Western Seed Co. varieties, and drought-tolerant bean varieties in selected villages in Makueni district.

Central Province region (Murang'a, Maragwa, Kirinyaga, Embu, Nyeri, and Meru North, Meru Central, and Meru South districts); Activities are currently limited to the promotion of Western Seed Co. varieties through farm input stockists in the region, and *Mavuno* fertilizer, Western Seed Co. varieties, and drought-tolerant bean varieties in selected villages in Kirinyaga district.

Tanzania
FIPS-Africa is currently co-operating with the Ministry of Agriculture in the S. Highlands (Iringa, Mbeya, Njombe, Mlowo, and Mbozi districts) to demonstrate the *Minjingu Mazao* fertilizer and the UH615 maize variety (output from R8220). FIPS-Africa is planning to continue with promotions of *Minjingu Mazao* and UH615 maize variety

with the assistance of inputs for demonstrations from the private sector in the 2006/7 growing season.

In the N. Highlands, FIPS-Africa facilitated CIAT with supply of *Minjingu Mazao* fertilizer (Hai, Monduli districts) for demonstrations to improve the productivity of improved bean varieties (output from R8414). Following cessation of support from DfID's Crop Protection Programme in December 2005, this work has now lapsed, although a Baseline Survey was conducted in August 2006 concerning input use and management by small farmers in these districts prior to the commencement of promotion of *Minjingu Mazao* and Western Seed Co. varieties in 2007.

Western Seed Co. has just donated 20 tonnes of seed for demonstration/promotion in the S. Highlands of Tanzania, and FIPS-Africa has agreed to assist with distribution to Ministry of Agriculture staff for demonstrations, and farm input stockists for promotions in advance of the 2006/7 growing season.

17. Current barriers slowing the adoption of outputs are:

(a) *insufficient funds to employ more field workers* for village promotions.and to scale-up activities into other regions (e.g. Eastern, Coast, South Nyanza, Western Provinces) and other countries is the major constraint to adoption of outputs.
(b) *lack of availability of germplasm for promotion* because there is little private sector interest in sweet potatoes, cassava, groundnuts, beans). KARI's improved varieties of sweet potato and cassava are not widely available and here is limited availability of GRD-tolerant groundnut varieties in Kenya.
(c) *erratic availability of inputs from private sector*; The success of FIPS-Africa's promotions has sometimes resulted in an imbalance of demand over supply. Participating private sector companies need time to adjust to increase the availability of their inputs such as seed and fertilizer .
(d) *Low purchasing power of farmers;* FIPS-Africa's small pack promotion methodology is working well for the more innovative and informed farmers, but there are many poorest farmers who are risk-averse, unable to afford even 1 kg of fertilizer and hire out their labor to neighboring farmers. Consequently, they are unable to cultivate and plant their own farms on time. A new strategy is required to lift these farmers out of the poverty trap (see 'Farming Support Programme' below).

18. The following changes are required to reduce the barriers to adoption:

(a) Increased and long-term funding; an increased donor funding which needs to be sustained for approximately 10 rainy seasons to enable all farmers in a particular district to access improved planting material and information on improved crop/soil management. This requires 2-3 graduate-level Field Workers/district each assisted by 5 village-based field assistants;
(b) Establishment of local bulking sites for dissemination of improved germplasm; for crops with perishable planting material such as cassava and sweet potatoes;
(c) The development of a sustainable 'Farming Support Programme' (FSP) with the marginalized poor that will not only achieve household food security but also includes an innovative approach to 'inventory credit' to enable these farmers to purchase further inputs. This new method to introduce inputs to the poorest and marginalized farmers in a sustainable way is currently being piloted in Western Kenya.

19. FIPS-Africa has developed methodology to successfully disseminate research outputs to large numbers of poor farmers as quickly and cost effectively as possible. Lessons learned are as follows:

(a) “affordable technology” - for research outputs adopted by the private sector, the technology must be affordable. Technology must be packaged in quantities that farmers can afford to experiment with at low-risk. For fertilizers, FIPS-Africa has found that even poor farmers will readily experiment with packages up to 1 kg (ca. US $0.5). Having seen significant yield gains from the inputs, farmers invariably return to their nearest stockist to purchase inputs in larger quantities to improve their food security;
(b) “small seeds, many farmers” - for improved OPVs which have little commercial interest, FIPS-Africa has found that small packs of seed containing from 30-60 seeds can have a huge impact on adoption. For example, from a 30 seed mini-pack of an improved bean variety, farmers can bulk up to 10 kg within 2 seasons
(c) “nothing for free” – FIPS-Africa’s’ widespread experience, over many years, is that farmers who receive inputs for free attach little value to them, and they may not be used properly - or even used at all. Free inputs also encourage dependency and distort the market value of inputs. By attaching a value on the inputs that FIPS-Africa promotes, farmers are encouraged to learn “farming as a business”.
(d) “village approach” - conventional dissemination approaches through Farmer Field Schools often have limited success because of the limited diffusion of information from the Field School members to other groups in the community and even to neighbours. Through FIPS-Africa’s all-inclusive “Village Extension Approach”, all community members are empowered to experiment with improved inputs and crop management practices simultaneously.

Impacts On Poverty

E. Impacts on poverty to date

20. An Impact Assessment was conducted amongst farmers in Embu and Kirinyaga districts in August 2005. A report entitled “Participatory Impact Assessment of improved access to appropriate farm inputs by small farmers in Eastern and Central Kenya” is available as one of the outputs of this project.

A further study was conducted in the month of December 2005 by FIPS-Africa field workers in Kirinyaga and Nyeri districts to determine the effect of the 150g mini-packs of hybrid seed provided by Western Seed Co on adoption of new maize varieties.

A similar survey was conducted in Butere-Mumias district in Western Kenya on a project funded by the Rockefeller Foundation, where 31 farmers who received the promotion package were selected at random and interviewed.

21. The Impact Assessment study confirmed that farmers adopting inputs promoted by FIPS-Africa were more food secure than non-adopters. The study also found that up to the end of the project in December 2005, that the number of adopters was approximately 75,000 out of a target of 300,000 farmers. A further study of 100 farmers who received a 150g mini-pack of a Western Seed Co. variety revealed that before advice from FIPS-Africa farmers would harvest on average 3.8 x 90 kg bags/0.81 acre (equivalent to 5.4 bags/acre). After trying out the mini-pack, 98% reported that they had subsequently purchased Western Seed Co. varieties. In the 2005 long

rainy season, mean yield of farmers had increased to 9.4 bags/0.69 acre (equivalent to 16.1 bags/acre). Extra quantity of maize produced per farmer was 5.7 bags equivalent to KSh 6780 (GBP 52) (5 bags/year is the minimum for food security for an average household – assuming minimal post-harvest losses in storage).

In terms of food security, only 30% of farmers produced 5 bags or more before the receipt of the mini-pack. After receipt of the mini-pack, 80% of those farmers produced 5 bags or more of maize on their farms. Assuming families on average need to produce 5 bags per season, it can be concluded that through FIPS-Africa's interventions, the number of food secure families increased from 30 to 80% of households.

Interestingly, farmers reduced their acreage under maize from 0.81 to 0.69 acres. Benefits are therefore likely to be underestimated as farmers could have benefited from growing higher value crops on the land taken out of maize production.

In Nyeri district, 73 farmers who had received a 150g mini-pack of a Western Seed Co. variety were interviewed. 97% of farmers said that they had used Western Seed Co. varieties in the 2005 long rainy season. Before receiving instruction from FIPS-Africa, farmers said that they had on average produced 3.9 bags/0.86 acres (5.7 bags / acre). After receipt of mini-pack and instruction on improved maize crop management, yields increased on average to 9.1 bags/0.77 acres (14.4 bags / acre). Extra yield produced/farmer was on average 5.2 bags equivalent to KSh 6,224 (GBP 48). Interestingly, whilst maize yields increased by a factor of 2.33, mean land area under maize cultivation declined by 10% presumably as farmers realised they could produce enough for their needs from a smaller land area. Most importantly the number of farmers who attained the food security target of at least 5 bags / season increased from 32% before FIPS-Africa's intervention to 73% in the 2005 long rains season.

The survey in Butere-Mumias district revealed that farmers increased their yields from on average 4.5 (90 kg) bags/0.56 acre (equivalent to 8 bags/acre) before advice from FIPS-Africa to 29.7 bags/1.54 acres (equivalent to 19.3 bags/acre). Farmers produced on average an extra 25.2 bags equivalent to KSh 25,200 (GBP 194), assuming a conservative value of KSh 1000/90 kg bag.

Interestingly, whilst maize yields increased by a factor of 2.41, mean land area under maize cultivation increased by a factor of 2.75, as farmers realised that they could make money from growing maize using improved seeds and improved crop management methods.

The survey also showed that before receiving advice from FIPS-Africa, only 39% farmers purchased improved seed (H614), and only 42% purchased planting fertilizer (DAP). Following the promotions, all farmers purchased seed (58% Western Seed Co. varieties, and 32% *Dekalb* varieties), and 94% purchased planting fertilizer of which 80% purchased *Mavuno* fertilizer. Before FIPS-Africa, only 55% used to buy topdressing fertilizer. Following the promotions 97% purchased topdressing fertilizer (*Mavuno* topdressing).

Environmental Impact

H. Environmental Impact

24. The direct environmental impact of the outcomes are sustainable soil management supporting a resident population in areas with constraints on land availability. Meeting household food requirements from small plots frees other areas of the small holding for forage or wood production and alleviating pressures on communal lands. Improving water infiltration reduces runoff, soil erosion, siltation of local water courses and regeneration of ground water. The widespread occurrence of plough pans in high potential areas is a major constraint to achieving the yield potential from inputs and increases drought susceptibility of the crop. This problem is recognized by the government NARS in Kenya but has not been addressed in extension – particularly the issue that small-scale mechanized farmers do not have the traction power to use commercial chisel ploughs. The use of herbicides to enable the adoption of reduced tillage technologies (RTT) has considerable development potential that is not yet mainstream. The use of herbicides for weed control have major impacts in reducing women' labour for cultivation and weeding, particularly in families debilitated by HIV/AIDS and other diseases. The widespread promotion of RTT by governments would have considerable on-farm social and environmental benefits, and offsite impacts on hydrology and erosion. However, FIPS-Africa has found that the poor adoption of RTT as a package, promoted by some private sector organizations, is because farmers do not understand the components of the package and how they can be modified to fit their particular circumstances. The adoption of RTT has additional benefits in increasing the soil organic matter content that is largely lost by oxidation under conventional tillage in semi-arid regions. Building the soil carbon capital has on-site benefits for soil heath and off-site benefits in carbon sequestration. Soil biodiversity also increases under RTT.

25. Increasing sustainable soil/nutrient and water management have no adverse environmental benefits. Widespread use of glyphosphate for weed control has no adverse off-site impacts and on-farm effects on biodiversity are limited compared to normal weeding practices. Extensive use of some pre-emergence herbicides, e.g. atrazine, could have adverse environmental effects (as in EU/USA) and may require monitoring and impact assessment in the longer term.

26. Excepting total failure of rainfall, the principal risk from climate change to food security and livelihoods of rural poor is the variability in rainfall patterns and late season drought. The key elements of mitigation are optimal crop management, choice of crop varieties and soil/water management. The maize demonstrations set up by FIPS-Africa using correct spacing and fertilizer placement often show much better survival under late season drought than the conventional farmers' practice. Promoting the planting of short and long maturing maize varieties spreads risk from crop failure due to late season droughts. The widespread promotion of water harvesting methods, such as ridging, improved infiltration and reducing soil compaction would have immediate benefits in semi-arid areas and establish good practices that will pre-empt some impacts of climate variability.