

## **CROP PROTECTION PROGRAMME**

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

**R No R8219 (ZA No ZA0534)**

## **FINAL TECHNICAL REPORT**

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## Executive Summary

There are three major bio-physical constraints to improved maize crop production by small farmers in Embu and Kirinyaga districts in Kenya: poor soil fertility, prevalence of the maize streak virus (MSV) and weeds. Use of appropriate farm inputs (fertilizers, disease-tolerant varieties and herbicides) is essential to increase yields. However, inputs are conventionally packaged in large bag sizes that are too expensive for most small farmers. In addition, blanket recommendations for fertiliser, that date back a decade or more, can result in the current use of inappropriate nutrient applications to crops. The overall project purpose is to increase yields of small farmers through the development and implementation of innovative methodologies to introduce small farmers to appropriate farm inputs and crop management. Methodologies included dissemination through Farmer Field Schools (FFS), small plot demonstrations (maize varieties, fertilisers and herbicides) and promotions using small packs of inputs provided by the private sector. Demonstrations through the FFS, showed large yield increases due to fertilizer (44 -179%), and through the use of a MSV tolerant variety (WH403) compared to conventionally-used hybrid (H513) (41 - 53%). Maize yields under conservation tillage were approximately 40% greater than under conventional tillage. In addition, the use of herbicides (glyphosate and lasso-atrazine) in a no-till system reduced the cost of production by 50% compared to conventional tillage (digging and hand weeding). A total of 500 farmers were trained by KARI-Embu staff in use of herbicides, conservation tillage, fertilizer use, and MSV-tolerant varieties through 12 FFS. In addition FIPS-Africa conducted a total of 1,500 small plot demonstrations on small-scale farmers' fields in 6 districts over four seasons. Project outputs were promoted through a network of 120 farm input stockists who were trained in the identification and control of MSV. Private sector co-operated in the provision of inputs in small quantities to empower farmers to experiment with their use. Athi River Mining developed two new fertilizers (*Mavuno* and *Mavuno Top*), and packaged them in branded 1 kg bags. Western Seed Co. supplied over 60,000 small 150g packs of seed of MSV-tolerant varieties, free-of-charge, which were distributed to farmers through stockists, farmer groups, and during market promotions. Monsanto packaged its Roundup Max (glyphosate) product in 100g quantities. 500 posters advertising *Mavuno* fertilizers, MSV-tolerant maize varieties and symptoms of nutrient deficiency and MSV were produced and distributed to co-operating stockists. With support from the private sector, the geographical range of the project was extended into Nyeri, Meru, Kiambu, Thika, Murang'a and Maragwa districts. The project succeeded in quickly raising demand for 60 Tonnes of seed of new maize varieties amongst small farmers sold through stockists within the 4<sup>th</sup> season of the project. The majority of farmers purchased a 2 kg bag (the smallest bag size available). In addition, over 200 Tonnes of *Mavuno* fertilizers were sold in the project areas. Assuming that the 60 tonnes of seed was used effectively with fertilizer to yield an extra 1.3 T maize grain/acre, and it was used by 12000 farmers each growing 0.5 acres of maize, then each farmer would harvest an extra yield equivalent to 7 (90 kg) bags. An impact assessment, scheduled for August 2005, is required to determine the relative effectiveness of the different promotion pathways (FFS, demonstrations, small pack promotions) on adoption. Data will be used to fine-tune the promotion approach for future promotion campaigns in neighbouring regions/countries. Methodology is continuing to be developed for the widespread dissemination of the use of herbicides that is more complex considering higher demands for training in terms of product knowledge, and application methods.

## Background

Production of maize by small farmers in Embu and Kirinyaga districts is well below crop potential. Maize varieties with a yield potential of 5 -10 t ha<sup>-1</sup> are available on the market, but yields in these districts are in the range of 0.5 - 1.0 t ha<sup>-1</sup>. The

increasing pressure on land resulting from a rapidly increasing population means there is an urgent need not only to increase yields per hectare of cultivated maize.

There are three major bio-physical constraints to improved crop production. Firstly, soil fertility is very low, with nitrogen and phosphorus deficiencies widespread. Low use of fertilizers also results in the depletion of other nutrients such as potassium and sulphur. Secondly, the maize streak virus (MSV) is prevalent resulting in up to 80% loss of yield in non-tolerant varieties. Thirdly, crops suffer from competition from weeds due to ineffective and late weeding often caused by lack of availability of labour.

Use of appropriate farm inputs to increase yields is essential to increase yields. Appropriate fertilizers, containing the right blend of plant nutrients, are required to alleviate the nutrient deficiency constraints, disease-tolerant high-yielding maize varieties are required to maximise crop response to nutrient inputs, and herbicides are required to control weeds whilst saving labour. However, inputs are conventionally packaged in large bag sizes which are beyond the financial means of the vast majority of small farmers who survive on an income of the equivalent of about 1 US\$/day. For example fertilizers are conventionally packaged in 50 kg bags which cost the equivalent of US\$ 25.

Previous research from Western Kenya has shown that small farmers are keen to purchase small quantities of appropriate fertilizers, and improved seeds, in mini-packs costing as little as 3 Ksh (3 pence). Farmers try these out on their own plots of land and, having 'learnt by doing', return to their nearest stockist to purchase progressively larger packs as they see the returns on soil fertility, food security and marketable surplus. Use of this methodology has dramatically increased the demand for farm inputs amongst the poorest small-scale farmers in Kenya.

This project aimed to further develop and implement this methodology in close co-operation with the private sector, to make the appropriate fertilizers, maize varieties, and herbicides more accessible to small farmers in Embu and Kirinyaga districts, with the additional dimension of investigating herbicide use for crop protection within the framework of integrated crop management for soil and water conservation. In this respect, the project aimed to build upon a previous DFID project R7405 (ZA0302) implemented by KARI which identified labour constraint in land preparation and subsequent weeding as the most limiting factor in maize production, and which found that controlling weeds by using herbicides resulted in significant reduction of labour requirement and also significantly increased maize yields.

### **Project Purpose**

The overall project purpose is to increase yields of small farmers through the development and implementation of methodologies to introduce small farmers to the appropriate farm inputs. Inputs included fertilizers to increase crop productivity, MSV-tolerant maize varieties to reduce the effects of disease incidence, and herbicides to protect crops from the effects of weeds. Methodologies included dissemination through Farmer Field Schools (FFS), demonstrations, and promotions using small packs of inputs provided by the private sector.

### **Research Activities**

A baseline survey was conducted of small-scale farmers in the target districts to determine their use of inputs, and knowledge of the MSV disease and control methods. Mean farm size was less than 2 acres, and yields were very low – less than 5 bags/acre. Results are summarised in Table 1. 88% and 20% of respondents in Embu district said

they used planting and topdressing fertilizers, respectively. In Kirinyaga district more farmers used topdressing fertilizer than planting fertilizer. Approximately 50% of farmers said they used certified seed. Planting and topdressing fertilizer rates applied were low, particularly for topdressing fertilizers. Farmers were more aware of MSV as a disease in Embu than Kirinyaga, but knowledge of disease control was very low with only 32 and 6% of farmers in Embu and Kirinyaga districts, respectively. Despite use of inputs, yields were very low, less than 5 bags/acre, suggesting poor crop management practices (see above).

Table 1: Data from baseline survey of small farmers in Embu and Kirinyaga districts.

	Embu (n=74)	Kirinyaga (n=47)
Mean farm size (acre)	1.22 (0.25-4)	1.68 (0.25-5)
Maize yield (T/ha)	1.04	1.09
No. farmers using planting fertilizer (%)	88	36
Mean planting fertilizer rate (kg/acre)	36.6	13.6
No. farmers using topdressing fertilizer (%)	20	51
Mean topdressing fertilizer rate (kg/acre)	4.7	17.5
No. farmers using certified seed (%)	55	43
Knowledge of MSV symptoms as a disease (%)	89	57
Knowledge of control of MSV (%)	32	6
Use of herbicides to control weeds (%)	4	8

Three approaches were developed and implemented for disseminating research outputs to the farmers. Firstly, farmer field schools (FFS) were established by KARI-Embu as a means for teaching groups of farmers. A research/demonstration protocol was designed with the aim of demystifying the conservation tillage package promoted by Monsanto. In this way, the individual effects of fertilizer, MSV-tolerant variety, post-emergence and pre-emergence herbicides, tillage method, and use of stover (maize straw) mulch could be demonstrated. Consequently, even if farmers were unable to afford the whole package, they would at least be empowered to adopt the components that they would find most appropriate for their circumstances. Demonstration plots were used as the focal points for training farmers in the appropriate use of fertilizers, MSV-tolerant varieties, and herbicides. Because of the intensive nature of training, only 12 FFS were established with a total of 500 farmers trained.

Secondly, in order to reach more farmers throughout the district, FIPS-Africa designed and implemented simple demonstration protocols to demonstrate the use of improved fertilizers, MSV-tolerant maize varieties, and herbicides. A total of 1500 small plot demonstrations were laid throughout Central Province. In 2004, FIPS-Africa also included the Katumani bean (KB9) variety in its demonstrations. This bean is tolerant to drought, and has been greatly appreciated by farmers. The project range was extended to Meru and Nyeri districts with financial support and in-kind contributions from Athi River Mining. Farmer Field Days were held around selected demonstrations during the growing season to disseminate information to farmers. In order to scale-up the benefits of the technology package offered in the demonstrations, and make it available for farmers, FIPS designed a "food security" package for a 20 x 25 m plot. This contains 1 kg each of WH403 and WS202 maize varieties and 1 kg bean seed (KB9) and 10 kg each of Mavuno planting and topdressing fertilizers. On this small plot farmers can harvest up to 5 bags of maize and 30 kg beans which is enough food for a family of 7 for a 6 month period.

Thirdly, in order to scale up the dissemination of these farm inputs to the general public, FIPS-Africa staff developed a network of stockists throughout the target districts through

which inputs were promoted. FIPS-Africa worked closely with the private sector to develop a new promotion method in which a small 150g pack of improved seed was given away to farmers free-of-charge when they purchased a 1 kg bag of improved fertilizer. Over a one month period, at the start of the 2003 short rainy season, two teams of 4 casual workers catalysed the sales of 10900 kg of Mavuno planting fertilizer through this network of stockists (see table 2). During this season, the sales promotion catalysed the sales of 50 tonnes of Mavuno fertilizers.

Table 2: Statistics of market promotions through farm input stockists in Embu and Kirinyaga districts (Sep-Oct 2003).

Date	Market	Stockist(s)	No. of bales	Market	Stockist(s)	No. of bales
09/15/2003	Kutus	Mjini, Baraka	4	Runyenjes	Ndekere	6
09/16/2003	Kagio	Rehema, MFA	7	Kianjokoma	Gakuyia	8
09/17/2003	Kangumo	Jimia	6	Embu	Greenland	7
09/18/2003	Kutus	Gawa, 4M	6	Runyenjes	Ndekere	11
09/19/2003	Baricho	Kilimo, Erasol	5	Kianjokoma	Gakuyia	11
09/20/2003	Kangumo	Jimia	3	Embu	Tekelezi, Greenland	15
09/22/2003	Kutus	Baraka, Mjini	3	Runyenjes	Ndekere	4
09/23/2003	Karatina	Agriline, Boston	18	Kianjokoma	Gakuyia	3
09/24/2003	Kangumo	Jimia	6	Embu	Kangaru	2
09/25/2003	Kutus	Gawa, 4M	5	Kithimu	Mrimi Mwega	18
09/26/2003	Kagio	Arimis	7	Kianjokoma	Gakuyia	2
09/27/2003	Embu	Gakuyia, Greenland	11.5	Embu	Greenland, Gakuyia	11.5
09/29/2003	Kutus	Baraka, Mjim	4	Runyenjes	Ndekere	5
09/30/2003	Kerugoya	Thabiti	11	Karingari	Karish	13
10/01/2003	Embu	Tekelezi	15	Embu	Tekelezi	15
10/02/2003	Kutus	Gawa	5	Kithimu	Mrimi Mwega	8
10/03/2003	Ngurubani	New Downtown	4	Runyenjes	Ndekere	13
10/04/2003	Karatina	Agriline Agencies	12	Embu	Kangaru	5
10/06/2003	Kutus	Baraka	5	Runyenjes	Ndekere	11
10/07/2003	Kerugoya/Kagio	Thabiti	7	Kerugoya	Glory	2
10/08/2003	Embu	Greenland	8	Embu	Tekelezi	8
10/09/2003	Kutus	Gawa	4	Runyenjes	Ndekere	13
10/10/2003	Kerugoya	Thabiti	8	Kerugoya	Glory	8
10/11/2003	Karatina	Agriline/Boston	13	Embu	Greenland	6

10/13/200 <sub>3</sub>	Kimbimbi		6	Kithimu	Mrimi Mwega	20
10/14/200 <sub>3</sub>	Kianyaga	Farmcare	5	Karingari/Kianjokoma	Karish/Gakuyia	5
10/15/200 <sub>3</sub>	Embu	Greenland/Gakuyia	8.5	Embu	Greenland, Gakuyia	8.5
	Total (bales)		197			239
	Total (kg)		4925			5975
	Grand total (kg)		10900			

Western Seed Co. donated 60,000 small (150g) packets of seed to FIPS-Africa over the two year project period for distribution to farmers free-of-charge. This equivalent to 9 tonnes of seed worth £7,500. To avoid potential negative impact of continued promotion of 150g mini-packs of seed of MSV-tolerant varieties on commercial sales of MSV-tolerant varieties in Embu/Kirinyaga districts, mini-pack promotions were extended to other districts in Central and Eastern provinces (Meru/Nyeri/Kiambu/Murang'a/ Thika/Machakos/Makueni) in 2004 and 2005. Therefore the project was able to have an impact far beyond the originally-proposed target areas.



Figure 1: Many customers taking advantage of the improved seed/fertilizer promotion through Jimia Agrovet in Kirinyaga district.

To date, FIPS-Africa's approach has been extensive in nature, and it is not easy to determine the impact of its approach. Therefore, in the final season, FIPS-Africa is experimenting with the promotion of inputs using a "village" approach. FIPS-Africa is working closely with the provincial administration to mobilise farmers within a village, and to encourage them to purchase 1 kg of Mavuno fertilizer. Those purchasing the fertilizer receive a small 150g pack of disease-tolerant maize seed, a 30 seed pack of KB9 bean seed, and a 2 g package of kale seed. This approach, which has been set up in two villages in 4 districts, has been greeted enthusiastically by farmers, and will enable FIPS-Africa to determine the impact of its promotion methodology more easily.

Due to long protracted negotiations with the private sector to procure small promotion packs of herbicide, the development and implementation of methodology to promote

herbicides was delayed. This is currently on-going, and will be reported at the end of the project extension.

### **Outputs**

Analyses of yield data from the demonstrations at the Farmer Field Schools, managed by KARI-Embu, showed that low soil fertility was the primary factor limiting yields. For example, at Rwanja focal area FFS in Kirinyaga district, fertilizer increased yields by 178% from 1.9 to 5.3 t/ha. Changing the variety from hybrid (H513) to the MSV-tolerant variety (WH403) increased yields by 51% from 3.5 to 5.3 t/ha. Maize yields under conservation tillage (6.6 t/ha) were approximately 40% greater than under conventional tillage (4.7 t/ha).

In addition, the use of herbicides (glyphosate and lasso-atrazine) in a no-till system reduced the cost of production by 50% compared to conventional tillage (digging and hand weeding).

Large maize grain yield increases due to fertilizer shows the importance of the integrated crop management approach used in this project. Failure to address the soil fertility constraint whilst concentrating solely on dissemination of crop protection strategies, would result in reduced impact.

The project established a network of over 120 farm input stockists throughout Central Province through which the project outputs were promoted. Stockists were trained in the identification of MSV, and choice of varieties that are tolerant to this disease.

The project has had success in attracting support from the private sector to provide inputs in small quantities to empower farmers to experiment with their use. A fertilizer company, Athi River Mining, developed two new fertilizers (Mavuno and Mavuno Top), and packaged them in branded 1 kg bags. Western Seed Co., the supplier of MSV-tolerant varieties which performed excellently in demonstrations, supplied over 60,000 small 150g packs of seed, free-of-charge, which FIPS–Africa distributed to farmers through stockists on market days, and farmer groups. Monsanto agreed to package its Roundup Max product (glyphosate) in 100g quantities. The 100g sachet is suitable for a 15 litre knapsack sprayer.



Figure 2: Managing Director of Monsanto East Africa, Kinyua M'bijiwe, at the launch of the Roundup Max 100g sachet at a field day at Mweiga, Nyeri district in August 2004.

A total of about 1,500 small plot demonstrations were conducted on small-scale farmers' fields in 6 districts over four seasons.

500 posters advertising Mavuno fertilizers, commercially-available MSV-tolerant maize varieties and symptoms of nutrient deficiency and MSV were produced and distributed to co-operating stockists.

With materials and financial support from Athi River Mining and Western Seed Company, it was possible to extend the geographical range of the project beyond the originally proposed target districts of Embu and Kirinyaga. Demonstrations and promotions were therefore extended into Nyeri, Meru, Kiambu, Thika, Murang'a and Maragwa districts in Central Province.

**Contribution of Outputs to developmental impact**

The project has succeeded in quickly raising demand amongst small farmers for new varieties of maize which are tolerant to the MSV, drought, and low soil fertility, supplied by the Western Seed Company. Through FIPS-Africa's approach, demand has increased from 0 to 60 tonnes of seed sold through stockists in the extended target area by the 4<sup>th</sup> season (fig. 3).

An analysis of sales data supplied by the stockists has shown that the majority of farmers purchased a 2 kg bag (the smallest bag size available) (fig. 4).

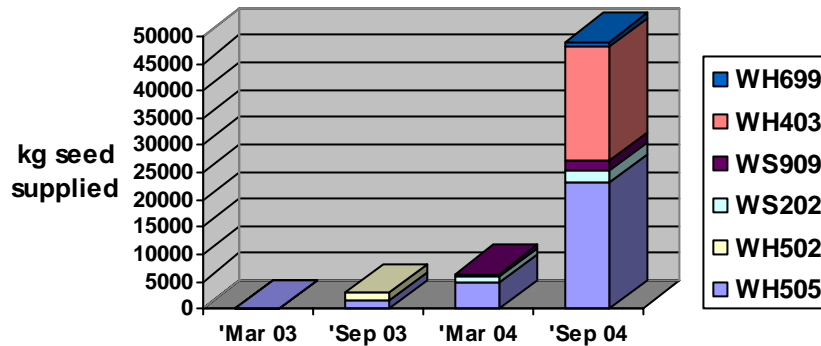


Figure 3: Sales of Western Seed Co. varieties through stockists in Central province during the first four seasons of the project..

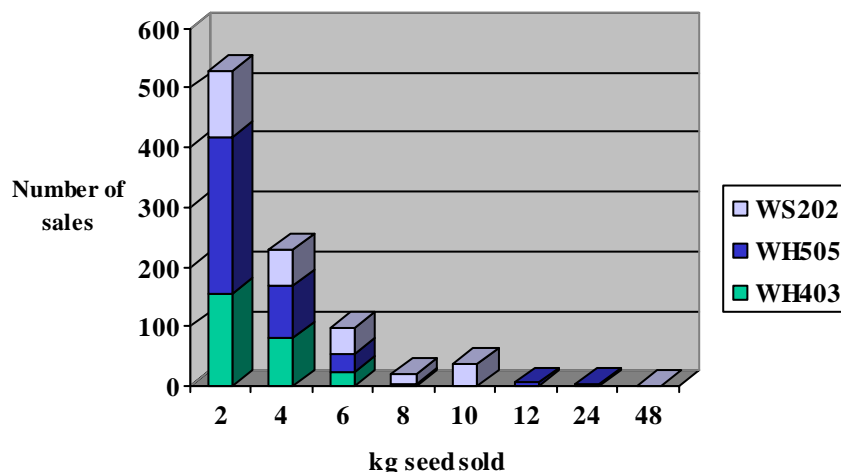




Figure 4: Weight distribution of seed of Western Seed Co. varieties at Tekelezi Agrovet, Embu (Sep-Oct 2004).

The project also succeeded in quickly raising demand amongst small farmers for new improved fertilizers supplied by Athi River Mining. Over 200 Tonnes of *Mavuno* fertilizers were supplied to the project area by October 2004.

Effect of the adoption of these inputs on the livelihoods of small farmers will be determined during an impact assessment in August 2005. However, assuming that the 60 tonnes of improved seed was used effectively to yield an extra 1.3 T maize grain/acre over 6000 acres, then an extra yield of maize grain worth £ 960,000 was produced. This is equivalent to an extra 7 (90 kg) bags of maize produced by each of 12000 farmers each growing an improved variety with fertilizer over half an acre. Seven 90 kg bags is sufficient maize for a family of 4.6 members for one year. As adoption is still increasing exponentially, it is expected that demand for these improved varieties will increase from 100 tonnes per year to 500 tonnes per year over the next two years.

An impact assessment, planned for August 2005, is required to determine the relative effectiveness of the different promotion pathways (FFS, demonstrations, small pack promotions) on adoption. Data will be used to fine tune the promotion approach for future promotion campaigns in neighbouring regions/countries.

The project has had notable success in the promotion of the adoption of fertilizers and improved maize varieties, use of which by farmers is relatively straightforward. Methodology is continuing to be developed for the widespread dissemination of the use of herbicides that is more complex considering higher demands for training in terms of product knowledge, and application methods.

One of the outputs of this project, the realisation of inputs packaged in small affordable packages, will have direct impact upon the livelihoods of farmers throughout Kenya whose access to these inputs will have been greatly improved. Discussions have started with the Ministry of Agriculture to scale up the FIPS-Africa approach, developed in this project, to assist farmers throughout the country. Also, as a consequence of this project, FIPS-Africa has started a pilot project to make the appropriate farm inputs more accessible to small farmers in the Northern Highlands of Tanzania.

The methods developed during this project have wide applicability to alleviate poverty amongst small-scale farmers in other regions in sub-Saharan Africa, characterised by infertile soils, and where diseases of maize and weeds are problematic.

### **Biometricians Signature**

I confirm that the biometric issues have been adequately addressed in the Final Technical Report:

Signature:

Name (typed):

Position:

Date:



