Promotion and dissemination of Integrated Pest and Soil Fertility Management Strategies to combat striga, stemborers and declining soil fertility in the Lake Victoria basin

R8449 (ZA 0674)

FINAL TECHNICAL REPORT

01 April 2005 – 31 January 2006

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International Centre of Insect Physiology and Ecology (ICIPE)

14 February 2005

"This publication is an output from a research project funded by the United Kingdom Department for International Development for the benefit of developing countries. The views expressed are not necessarily those of DFID."

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Promotion and dissemination of Integrated Pest and Soil Fertility Management Strategies to combat striga, stemborers and declining soil fertility in the Lake Victoria basin

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Executive Summary

Demonstrations with best-bet technologies for the control of *Striga* weed and stemborers and enhancement of soil fertility were continued in 2005 in both long rainy season (March to July) and short rainy season (September to January) in Kenya and Uganda. Components of these best-bets were cropping systems (maize intercropped with stemborer moth-repellent *Desmodium* ['push'] with stemborer moth-attractant ['pull'] Napier grass planted around the field [push pull system], continuous maize and rotations with grain [soybean] and herbaceous [*Crotolaria*] legumes). Their effect on suppression of *Striga* and stemborers and soil fertility improvement were compared using two maize varieties (Imidazolinone resistant [IR] and a local landrace or improved commercial variety) under two fertilizer levels (no fertilizer and medium fertilizer). Stemborer damage to maize varied substantially between locations and seasons and the push pull technology was observed to suppress stemborer damage. Except in long rains season of 2005 in Siaya district in Kenya and in short rains season of 2005 in Busia, Uganda, IR maize substantially suppressed *Striga* emergence in Kenya and Uganda. The push pull technology consistently suppressed *Striga* emergence in both seasons in Kenya and Uganda. Fertilizer application did not show significant reductions in either stemborer or *Striga* infestations. Except in long rainy season in Kenya, where significantly more yield was obtained under push pull system, differences in grain yield of maize between cropping systems were minimal and only fertilizer application was observed to increase maize yield. *Striga* seed count before and after six cropping seasons showed that in Kenya the push pull

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system and *Crotalaria* rotation were the only systems where there was a decrease in *Striga* seed population while all the other cropping systems resulted in seed increases. In Uganda, push pull was the only system where the increase in *Striga* seed population after six seasons of cropping was significantly lower than other systems. Assessment of on-farm trials in Vihiga and Siaya districts in Kenya showed that while both push pull system and IR maize effectively controlled *Striga*, push pull was effective in controlling stemborers also.

Farmers from the target villages were exposed to the various options demonstrated during the long and short rainy seasons during field days in the villages in Kenya. This formed the basis for the selection of the options to be tested by them during the adaptation trials during the long and short rainy seasons of 2005 in Kenya (764 farmers; 37.8% male farmers 62.2% female farmers). Some of these farmers combined crop rotation with IR maize, or intercropping IR maize with push pull technology.

Farmer evaluations were done in 6 villages (Kenya and Uganda) in long rainy seasons of 2005 and in 4 villages in Kenya in short rains of 2005. Results showed that in both Kenya and Uganda most of the farmers in all districts (above 60%) selected push pull as their first choice during LR 2005. In the short rainy season most of the farmers (over 75%) in the two districts of Kenya selected push pull system as their first choice.

Background

Maize is one of the most important cereal crops in eastern Africa and serves both as a staple food and cash crop for millions of people in the Lake Victoria Basin. Grain yields under farmers' conditions average about 1.0–1.5 t/ha or less than 25% of the potential yield of 4-5 t/ha. The low maize yield is associated with several constraints. Farmers consistently list *Striga*, stemborers and declining soil fertility as the three major constraints to efficient maize production in the region.

Striga is a parasitic weed that infests approximately 158,000 ha of arable land in the Lake Victoria Basin in Kenya alone. *Striga* could cause yield losses of between 30% and 50%, although losses of up to 100% are not uncommon, with a value in the order of US$ 37-88 million per year.

Stemborers seriously limit maize yields by infesting the crop throughout its growth stages. The yield losses caused to maize vary widely in space and time but range from 20-40% of potential output in eastern Africa, depending on agro-ecological conditions, crop cultivar, agronomic practices and intensity of infestation.

Soil infertility results from the poor inherent fertility status together with high human population pressure and poor soil and crop management practices. Due to the low inherent fertility status of the soils in the target region, their low buffering capacity and the inability of small-scale farmers to invest in soil fertility management strategies, soils are rapidly degrading and are hardly able to sustain acceptable maize yields, with nitrogen and phosphorus being the major production-limiting nutrients. Lack of appropriate soil management also negatively affects the soil organic matter pool that is responsible for a series of production and environmental service functions essential for sustainable crop production in a healthy environment.

A range of technologies addressing various aspects of *Striga*, stemborers and soil fertility management were evaluated under DFID-funded project entitled 'Integrated pest and soil management to combat *Striga*, stemborers and declining soil fertility in the Lake Victoria basin (ZA 0524 /R8212). These include the push pull technology for the control of maize stemborers and *Striga*, herbicide resistant (Imidazolinone resistance-IR)-maize for the control of *Striga* and various crop rotation options for restoring depleted soils. Research conducted at the International Centre of Insect Physiology and Ecology (ICIPE), Kenya, showed that the root system of the maize intercrop (*Desmodium*) in the push pull technology, originally developed to control stemborers in maize, produces both *Striga* seed germination stimulants and lateral growth inhibiting chemicals thereby hindering the attachment of the striga's haustorial root system to that of the host plant (maize). The germinated *Striga* plant soon dies (suicidal germination). Similarly, research at the International Maize and Wheat Improvement Centre (CIMMYT) shows that when applied as a seed dressing, the herbicide in the IR maize (imazapyr) is imbibed by the germinating seed and absorbed into the growing maize seedling before any damage is inflicted on the host plant by *Striga*. Additionally, imazapyr from the seed-coat that is not absorbed by the maize seedling diffuses into the surrounding soil and kills ungerminated *Striga* seeds.

The present phase of the project is an extension of the earlier project (ZA 0524 /R8212) which aimed to promote and disseminate the integrated pest and soil fertility management approach/strategy (IPSFM) developed during the earlier phase. The technologies promoted and disseminated by this project are helping to reduc**e** the vulnerability of small-scale poor farmers to the vagaries of different pests and declining soil fertility that threaten their food security. The project is increasing the local knowledge and capacity to deal with pest and soil fertility problems thereby leading to a sustainable increase in food production. Involving both private and public institutions such as seed companies, non- governmental organizations (NGOs), and agricultural extension and research bodies will also increase access to new technologies. To ensure long term sustainability, the project is working exclusively through existing institutions. Due to severe drought in Tanzania in the year 2005, no crops could be planted whereas in Kenya and Uganda two crops of maize (long rains and short rains) were planted.

Project Purpose

The purpose of the Project is to promote and disseminate an integrated pest and soil fertility management approach/strategy (IPSFM), in particular, against *Striga*, stemborers and declining soil fertility, to enhance food security, income generation and environmental sustainability, thereby reducing poverty in Lake Victoria basin of Kenya, Uganda and Tanzania, resulting in an overall improvement in the communities' livelihood status.

The project seeks to address the following 5 outputs which have been identified as constraints to the realisation of food security in the region:

1. Rigorous evaluation of *Striga*, stemborer and soil fertility management techniques, with emphasis on socio-economic data, using both scientists' and farmers' evaluation criteria (Demonstration and evaluation of IPSFM options)

2. Training farmers in *Striga* and stemborer control and soil fertility enhancement and NGO and extension staff, and researchers in providing useful and relevant information to farmers (Strengthening the capacity of all stakeholders)

3. Facilitating the availability of seeds and fertilizer through public-private partnerships and the implementation of a local credit scheme (Facilitating the availability of inputs and credit)

4. Scaling up and out project products through the development of linkages with other CBOs, NGOs, and extension services **(**Disseminating the project products).

5. Assessing the initial and potential impact of the IPSFM options in the target areas and beyond (Assessing initial and potential impact)

1. Testing of best-bet options

1.1 Identification of options and design of demonstration sites

During the PRA exercise conducted during the first phase in 2003 in all countries, farmers listed and ranked *Striga*, stemborer and low soil fertility as the major constraints to efficient maize production. They then listed several indigenous coping strategies used to combat these constraints. After in-depth discussion among the project scientists, a synthesis of options was compiled. Components of these best-bets were cropping systems (push pull, continuous maize and rotations with grain [soybean] and herbaceous [*Crotolaria*] legumes). Their effects on suppression of *Striga* and stemborer and soil fertility improvement were compared by use of two maize varieties (IR and an improved commercial variety) under two fertilizer levels (no fertilizer and medium fertilizer). Any modification to these was to take into account the dominant cropping system in the target areas. During the long (March-July) and short (September-January) rainy seasons of 2005, a hybrid, Western Seed Hybrid (WH) 502 was used in Kenya, while an improved open pollinated variety (OPV) (Longe4) was used in Uganda. In Tanzania, no crop could be planted due to severe drought that persisted for most of the year. These treatments were demonstrated in 2 farms in each of the 4 villages in Kenya and 2 villages in Uganda. Soil samples were collected from each demonstration site in all the villages and analyzed for *Striga* seed bank in 2002 and after 6 cropping seasons in 2005.

In the push pull and continuous cropping systems, maize was planted in both seasons. In the rotations, the legumes were planted in the long rainy season while maize was planted during the short rainy season in the whole farm. Data on *Striga* emergence, stemborer damage and grain yield of maize were determined in both cropping seasons.

2. Farmer evaluation

Farmer evaluations were organized during the long rains of 2005 in Kenya and Uganda. But during the short rains, farmer evaluations were carried out in Kenya only.

Farmer evaluations of the trials followed a semi-structured guideline. During the introductory meeting, both farmers and scientists introduced themselves, and the purpose of the visit was discussed. A review of the various treatments was presented to the farmers and other participants. Farmers listed and ranked the criteria they would use to evaluate the plots. In the long rains in Kenya and Uganda, farmers in all villages used *Striga* resistance, stemborer resistance, soil fertility enhancement, yield, labour saving and overall criteria to evaluate treatments which had maize planted (the push-pull and monocrop cropping syatems). *Crotalaria* and soybean cropping systems were evaluated for biomass yield, podding, labour saving, seed/grain yield and overall. During the short rains, farmers used *Striga* resistance, stemborer resistance, soil fertility enhancement, yield, labour saving and overall criteria to evaluate all treatments in the Kenyan villages.

Next, each farmer was supplied with an evaluation form consisting of a short component of farmers' characteristics, an evaluation table, and some final questions. The farmers' characteristics included age, gender, experience, farm size, area under maize, type of house, number of animals, and followed by an evaluation table. The evaluation table had row for each treatment, and a column for each of the criteria on which they were being evaluated. Farmers then scored each treatment for each criterion, using a scale of 1 (very poor) to 5 (very good), and also gave an overall score for each treatment. Finally, the farmers chose the top three or four treatments they would like to try in their own fields, and were asked to make any proposals for change, alternative treatments, or other recommendations or remarks. After the individual evaluations, the farmers and scientists regrouped and discussed their choices. This was also the chance for farmers to question scientists and extension staff.

In total, 867 farmers (about 60% women) participated in the evaluation in the 6 villages (Table 1). In Uganda, about 40% of the participants were women while in Kenya they constituted about 60%. Several stakeholders attended the farmer evaluation with the Ministry of Agriculture extension officers participating in all villages as the lead facilitators.

Table 1: Number of participating farmers by gender and stakeholders during the LR 2005 and SR 2005 seasons field days and evaluation of technologies

Country	District	Village	LR 2005				SR 2005			
			Date	Farmers (N)		Stakeholders	Date	Farmers (N)		Stakeholders
				F	M			F	M	
Kenya	Siaya	Ngoya	15/7	35	27	MoA, Chiefs, SCODP, stockists	13/1	28	27	SCODP, MoA, stockist, Chiefs, Councillors
		Nyalgunga	14/7	38	44	MoA, Chiefs, Councillors, SCODP, stockists	12/1	90	53	SCODP, MoA, CAFARD, stockist, Chiefs, Councillors
	Vihiga	Ebulonga	29/6	56	20	MoA, FIPS, FADC, Chiefs stockists	8/12	62	28	MoA, MoL, stockists, Chiefs
		Ematsuli	1/7	78	58	MoA, FIPS, MoL, Chiefs stockists	10/12	114	53	MoA, MoL, stockists, Chiefs
Uganda	Busia	Angorom	27/7	10	15	MoA, DDAO				
		Kubo West	27/7	14	17	MoA				
Total				**231**	**181**			**294**	**161**	

SCODP= Sustainable Community Oriented Development Program, MoA= Ministry of Agriculture, MoL= Ministry of Livestock, DDAO= Deputy District Agricultural Officer, CAFARD= Conservation Agriculture for Sustainable Development, FADC= Focal Area Development Committee, FIPS= Farm Inputs Promotion Services.

2.1. Dissemination of best-bet IPSFM options

Field days were conducted in all villages in Kenya during the 5th and 6th cropping seasons while in Uganda they were conducted only in the 5th cropping season to coincide with farmer evaluations. However, in Tanzania, no field day was conducted during the entire year as there was no crop planted. Farmers and other stakeholders were invited to these field days (Tables 2). Flyers and other extension materials were distributed to all stakeholders during the field days and other stakeholder meetings. Over 100 brochures were distributed to stakeholders and extension staff.

Table 2: Stakeholders who attended farmer evaluation/field days

Stakeholder	Country		
	Tanzania**	Kenya	Uganda*
Policy makers	-	6	2
NGOs	-	15	-
Research	-	5	3
Farmers	-	811	56
Extension	-	8	3
Stockists	-	5	-
Total	-	850	64

* In Uganda, field days/evaluation was only conducted during long rains 2005 as drought affected short rain season crop.
** No crop was planted in Tanzania due to drought most of the year.

Table 3. Stakeholders who took copies of brochures in Kenya during 2005

NAME	ORGANISATION	No. COPIES
Nancy Muchiri	AATF	1
Alex O. Magaga	HAGONGLO CBO	20
Jan Shikuku	H/Bay TC	1
Raphael Ojimbo	Bwafodo	1
William Odongo	Lagrotech	1
Simon Onyango	Lagrotech	1
Cecilia Mwende	AATF	1
Collins Ooko	Lagrotech Seed Company	1
O.M. Odongo	KARI-Kakamega	1
Makhet P.T.M	Min of Agric.	1
T.A. Ajwang’	Min. of Agric.	1
Bonface Musuru	Ruseyala Farmers Group	1
Dismas Okello	SCODP	20
Richard Apamo	AEP H/Bay	20
Joseph Agunda	CARE Kisumu	30
Prof. J.R. Okalebo	Moi University	5
B. Omondi	ARDAP Busia	3
Qureshi	ICRAF-COSOFAP	42
Evans Etiang’	ACAUM Farmers’ Movement	25
MoA	Vihiga	20
MoA	Siaya	10
TOTAL		**206**

2.2. Capacity building

The project scientists worked with the government extension staff during, trial management, farmer evaluation and technology selection for adaptation. During all these stages, they were exposed to project activities thus gained experience in their implementation. Informal training was conducted during farmer evaluations, field days and selection of farmers for adaptation. Topics included general trial management, agronomic recommendations, data collection and scoring treatments during field evaluations. In all countries, several stakeholders benefited from these informal training sessions (Table 1).

3. Outputs

3.1. Technical evaluation of the demonstration trials

Presentation of the data in this section depended on the occurrence of significant interactions between different factors as presented in Tables 4, 5, 6 and 7.

Table 4: Significance levels for the various factors and their interactions for the target sites in Kenya in 2005. Values in bold are significant at 5% or less

Factor	Long rainy season 2005			Short rainy season 2005		
	Stemborer damage at 10 wks	*Striga* emergence at 10 wks	Maize grain Yield	Stemborer damage at 10 wks	*Striga* emergence at 10 wks	Maize grain Yield
District (D)	**0.0124**	**0.0011**	**<.0001**	**<.0001**	**<.0001**	**<.0001**
System (S)	**0.0152**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**0.0002**
D x S	**0.0152**	**0.0007**	**0.0187**	**<.0001**	**0.0013**	0.4891
Variety (V)	0.4254	**0.0139**	0.1347	0.6643	**<.0001**	0.9952
D x V	0.4254	0.9075	0.1451	0.6643	**0.0166**	0.5160
S x V	0.4719	**0.0340**	0.9120	0.9873	**0.0018**	0.5644
D x S x V	0.4719	0.7586	0.3185	0.9873	**0.0309**	0.7879
Fertilizer (F)	0.9243	0.9391	0.0995	0.1643	0.7801	**0.0008**
D x F	0.9243	0.7941	0.8541	0.1643	0.2141	**0.0003**
S x F	0.9866	0.9067	0.8707	0.5861	0.9868	0.9794
D x S x F	0.9866	0.8200	0.5198	0.5861	0.4694	0.9802
V x F	0.4963	0.8065	0.8838	0.9735	0.7254	0.7395
D x V x F	0.4963	0.8200	0.6995	0.9735	0.3419	0.8365
S x V x F	0.5468	0.8537	0.4820	0.5990	0.9370	0.8950
D x S x V x F	0.5468	0.7742	0.5605	0.5990	0.4380	0.8736

Table 5: Significance levels for the various factors and their interactions for the target sites in Kenya in 2003 and 2005. Values in bold are significant at 5%

Factor	Long rainy season 2003	Long rainy season 2005	
	Striga seed count	*Striga* seed count	% Change
District (D)	**<.0001**	**<.0001**	**0.0082**
System (S)	**0.0287**	**<.0001**	**0.0001**
D x S	**0.0485**	**<.0001**	**0.0001**
Variety (V)	0.9563	0.1855	0.0782
D x V	0.6507	0.3051	0.2958
S x V	0.7757	0.5551	0.2365
D x S x V	0.9788	0.9078	0.7701
Fertilizer (F)	0.2949	0.3094	0.7896
D x F	0.9722	0.4298	0.3268
S x F	0.7238	0.8765	0.9934
D x S x F	0.9546	0.9287	0.7119
V x F	0.8461	0.7136	0.5034
D x V x F	0.8539	0.7022	0.4568
S x V x F	0.7937	0.7805	0.9217
D x S x V x F	0.8882	0.9032	0.8964

Table 6: Significance levels for the various factors and their interactions for the target sites in Uganda in 2005. Values in bold are significant at 5%.

Factor	Long rains 2005			Short rains 2005	
	Stemborer damage at 10 wks	*Striga* emergence at 10 wks	Maize grain Yield	Stemborer damage at 10 wks	*Striga* emergence at 10 wks
System (S)		**0.0101**	0.5926	0.2093	**0.0006**
Variety (V)		**0.0198**	0.2910	**0.0363**	**<.0001**
S x V		**0.0202**	0.3454	0.1802	**0.0028**
Fertilizer (F)		0.1684	**0.0022**	**0.0200**	0.9554
S x F		0.1657	**0.0005**	0.2576	0.4981
V x F		0.1760	0.3889	0.4487	0.4791
S x V x F		0.1732	0.2910	0.9894	0.3353

Table 7: Significance levels for the various factors and their interactions for the target sites in Uganda in 2003 and 2005. Values in bold are significant at 5%.

Factor	Long rainy season 2003	Long rainy season 2005	
	Striga seed count	*Striga* seed count	Change
System (S)	0.6592	**0.0256**	**0.0988**
Variety (V)	0.1947	0.5227	0.7993
S x V	0.6783	0.8531	0.9759
Fertilizer (F)	0.4686	**0.0302**	0.6630
S x F	0.8634	0.2794	0.4144
V x F	0.8535	0.2734	0.1459
S x V x F	0.8099	0.7900	0.9366

3.2.1. Maize yield

Kenya

In Kenya, maize grain yields significantly differed among cropping systems and between districts, with a significant interaction between district and cropping systems during the long rainy season (Table 4). In the short rains however, district, cropping system and fertilizer significantly influenced maize yields, with a significant interaction between fertilizer and district (Table 4). In Siaya district during the long rainy season of 2005, maize grain yield was significantly higher in the push pull cropping system compared to continuous mono-cropping (with IR maize or Hybrid 502) (Figure 1). When comparing the varieties during the same period, maize yield from IR maize was similar to the yield from WH502. During the short rains, although the maize grain yield was higher in the push-pull system, it was not significantly different from the other cropping systems (Figure 1). Maize yield was relatively higher in the long than in the short rains, probably due to the significant drop in the amount and distribution of rainfall during the season. Similar results were obtained in Vihiga, where maize yields were significantly higher in the push pull system than in the mono-crops (IR maize and WH502) during the long rains. Maize yields were however not different among the cropping systems during the short rains (Figure 1).

Overall, during long rains, maize grain yield was significantly higher in the push pull system than in the continuous mono-cropping (with IR maize or Hybrid 502) planted with or without fertilizer (Figure 2). Comparing the varieties during the long rains, maize yield from IR was similar to the yield from WH502 (Figure 2). Although maize grain yields in both push pull system and mono-cropping under fertilizer were slightly higher than those planted without fertilizer, the difference was not significant. In short rains, due to drought situation the yields in all systems (both with and without fertilizer) were very low and not significantly different (Figure 2).

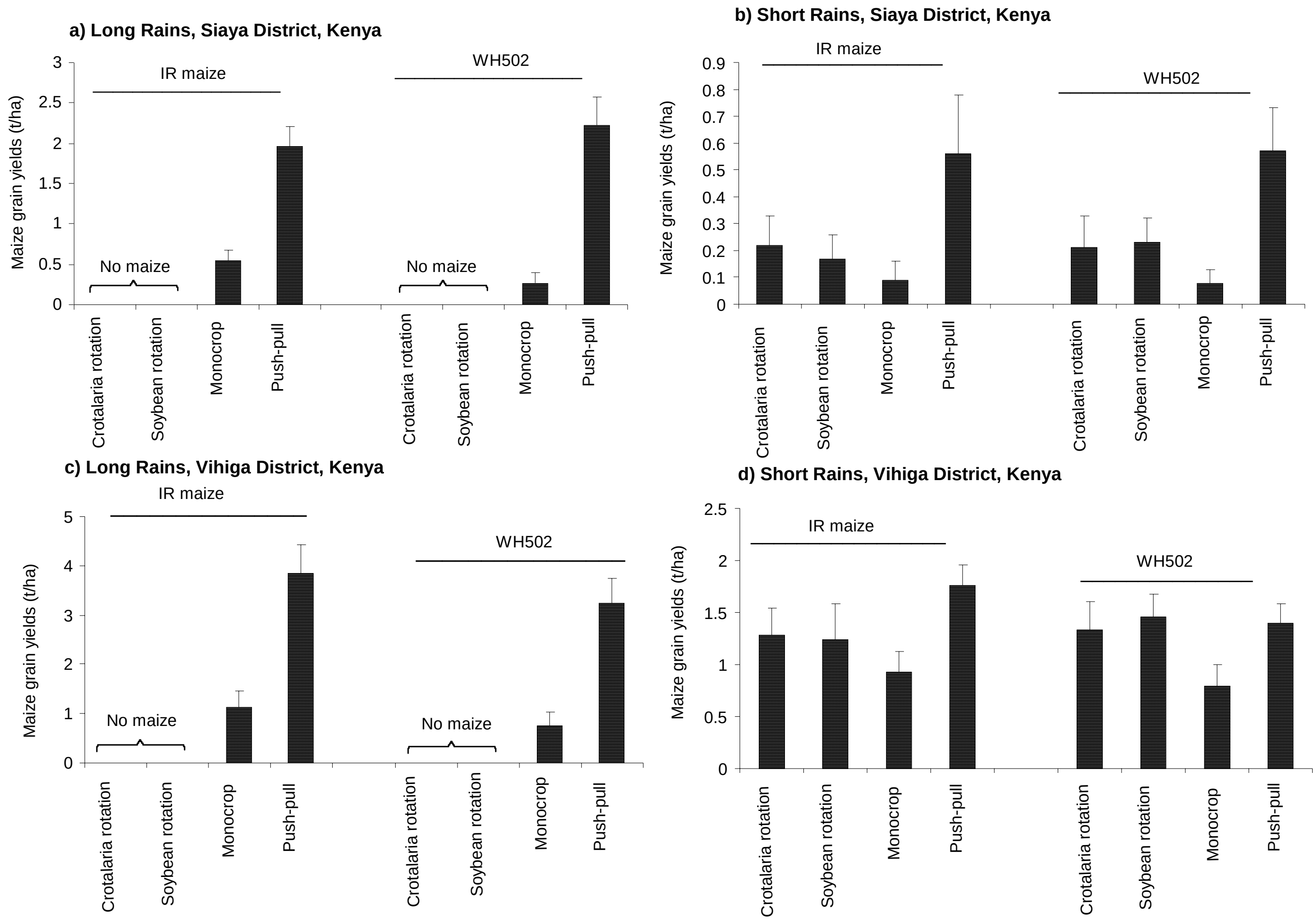


Figure 1. Effect of cropping systems by variety on maize grain yields in Siaya and Vihiga Districts, Kenya

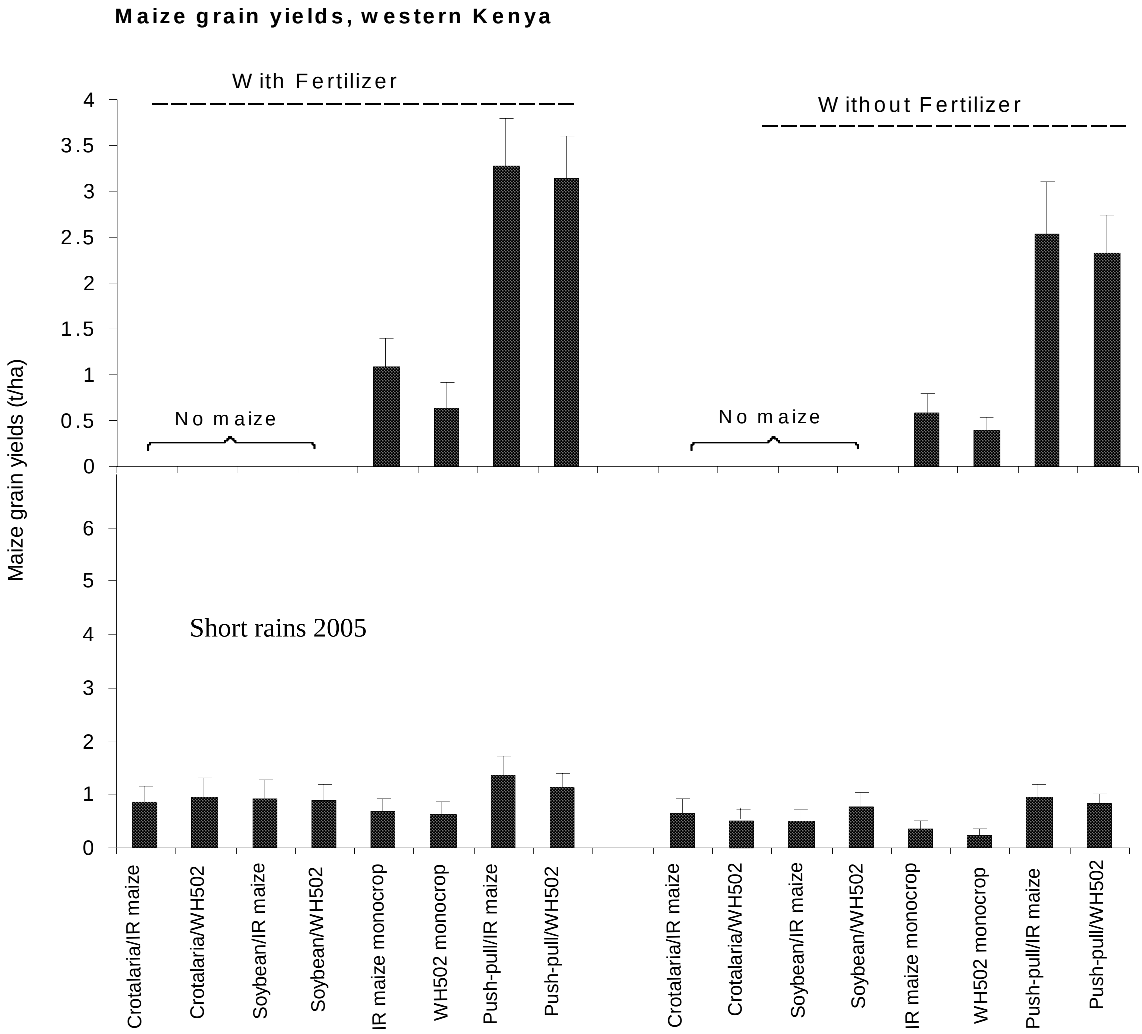


Figure 2. Effect of cropping systems by fertilizer, or lack of, on maize grain yields in Western Kenya

Uganda

In Uganda, maize yield data were collected only during the long rainy season. No yield data were collected during the short rains due to drought. Both the cropping system and variety did not significantly influence maize yields. Fertilizer was the only factor that showed a significant influence on maize yield, with a significant interaction between fertilizer and cropping system (Table 6 and Figure 3). However, under no fertilizer condition, the push pull system with IR maize performed better than the other systems (Figure 4).

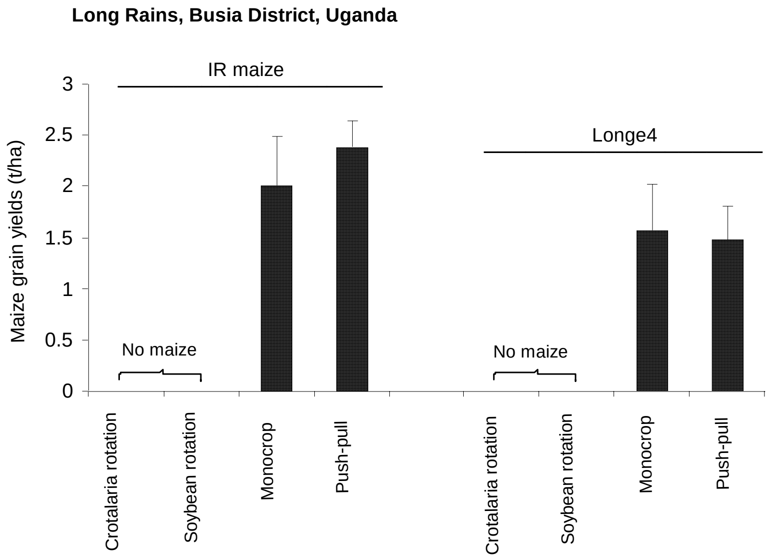


Figure. 3. Effect of cropping systems by variety on maize grain yields in Busia District, Uganda

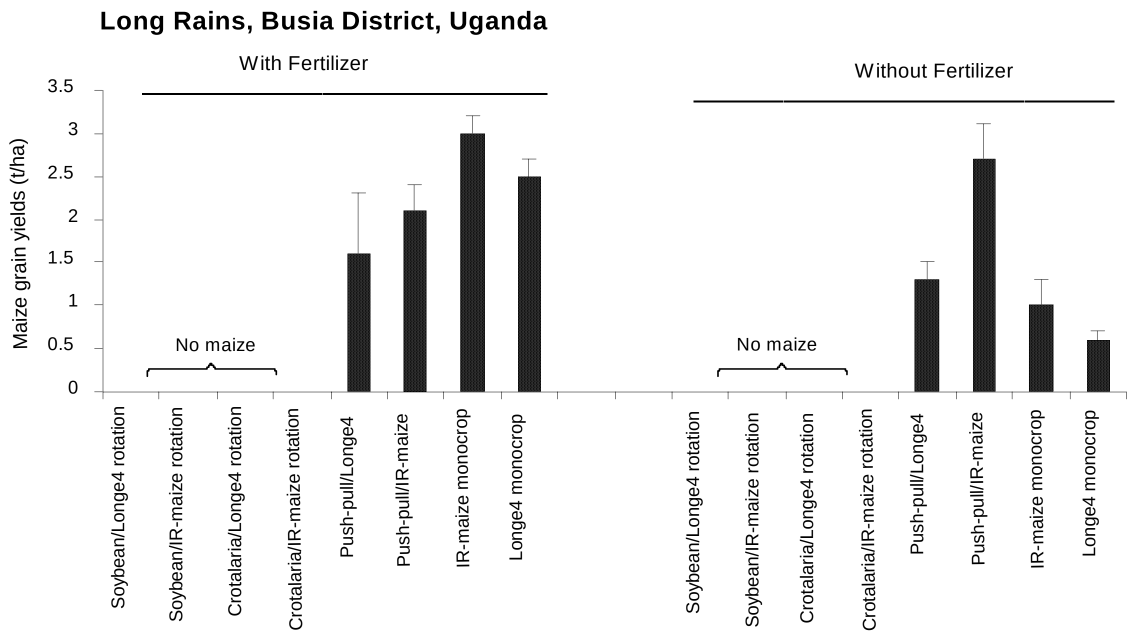


Fig 4. Effect of cropping system on maize grain yield in Uganda target sites during long rains, 2005

3.2.2. *Striga* emergence

Kenya

In Kenya, cropping systems, district and variety significantly affected *Striga* emergence, with a significant interaction between districts and systems and systems and variety during the long rainy season (Table 4). In addition to these, variety also influenced *Striga* emergence during the short rains, with significant interactions between district and variety, system and variety, and district, system and variety (Table 4). In Siaya during the long rainy season, *Striga* emergence was significantly lower in the push pull system than in the continuous maize mono-cropping. *Striga* emergence was lower with IR maize as compared to WH502, but not significantly different (Figure 5). During the short rains of the same year, *Striga* emergence was significantly lower in the push pull system compared to all the other cropping systems (Figure 5). In all cropping systems, *Striga* emergence was lower where IR maize was planted as compared to where WH502 maize variety was planted, showing that IR maize variety significantly reduced *Striga* infestation.

In Vihiga, *Striga* emergence was low in both seasons (Figure 5). During the long rains, *Striga* emergence was lower in the push pull planted with WH502 than continuous mono-cropping of WH502 (Figure 5). *Striga* emergence in push pull planted with IR maize was low but not significantly different from IR maize planted as a monocrop (Figure 5). During the short rains, *Striga* emergence was significantly higher where WH502 was planted followed by *Crotalaria* rotation (Figure 5). Although not significantly different, overall, *Striga* emergence was lower where IR was planted compared to where WH502 was planted in all cropping systems.

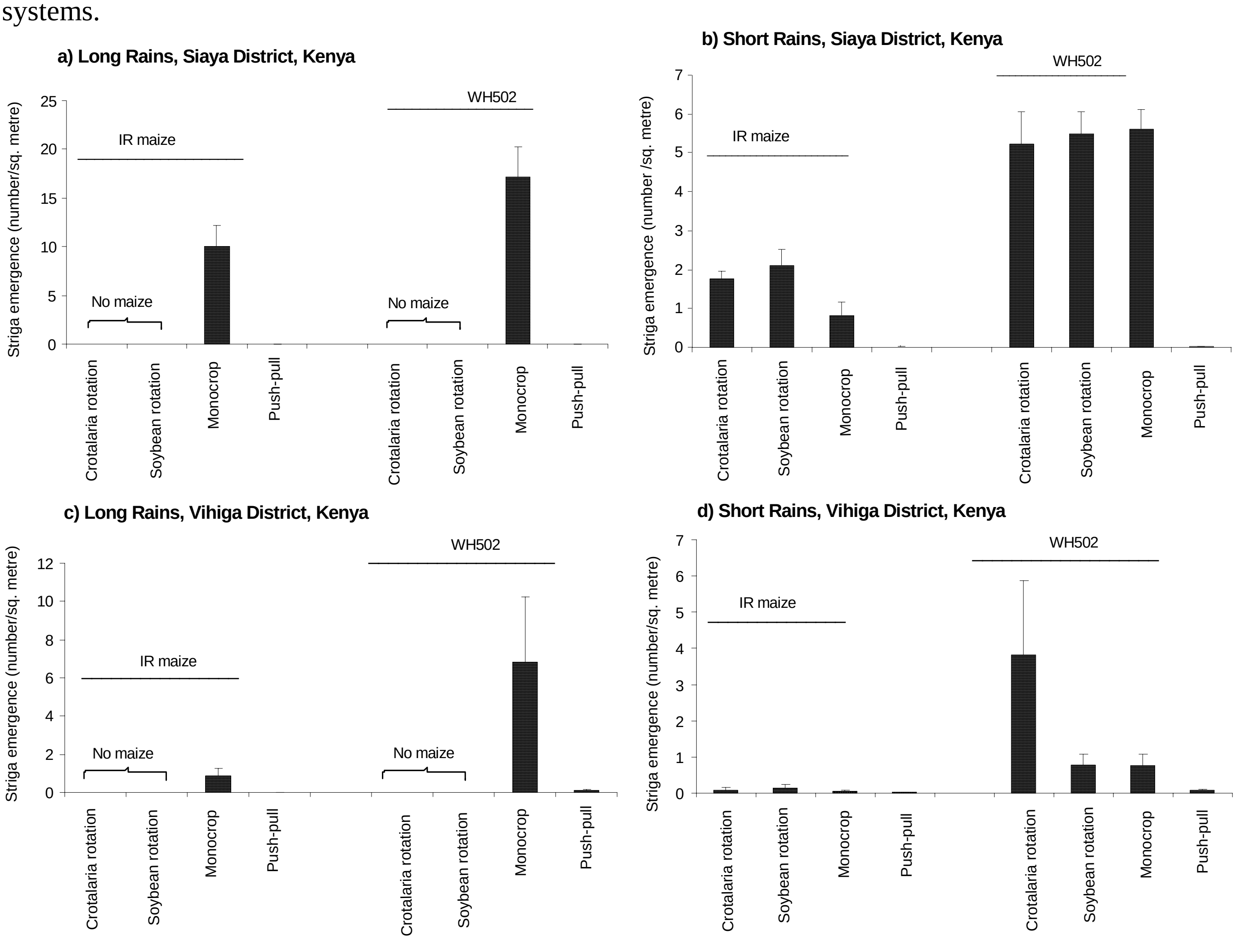


Figure 5. Effect of cropping systems by variety on *Striga* emergence in Siaya and Vihiga Districts, Kenya

During the long rains, *Striga* emergence was significantly lower in the push pull planted with or without fertilizer as compared to maize mono-crop (WH502 or IR maize) planted with or without fertilizer. There was no difference in *Striga* emergence in WH502 and IR maize planted without fertilizer (Figure 6). During the short rains, *Striga* emergence was lowest in the push pull plots planted with IR maize and WH502 (without fertilizer) but not different from *Crotalaria*-IR maize rotation, soybean-IR maize rotation and IR maize mono-crop planted with or without fertilizer (Figure 6)

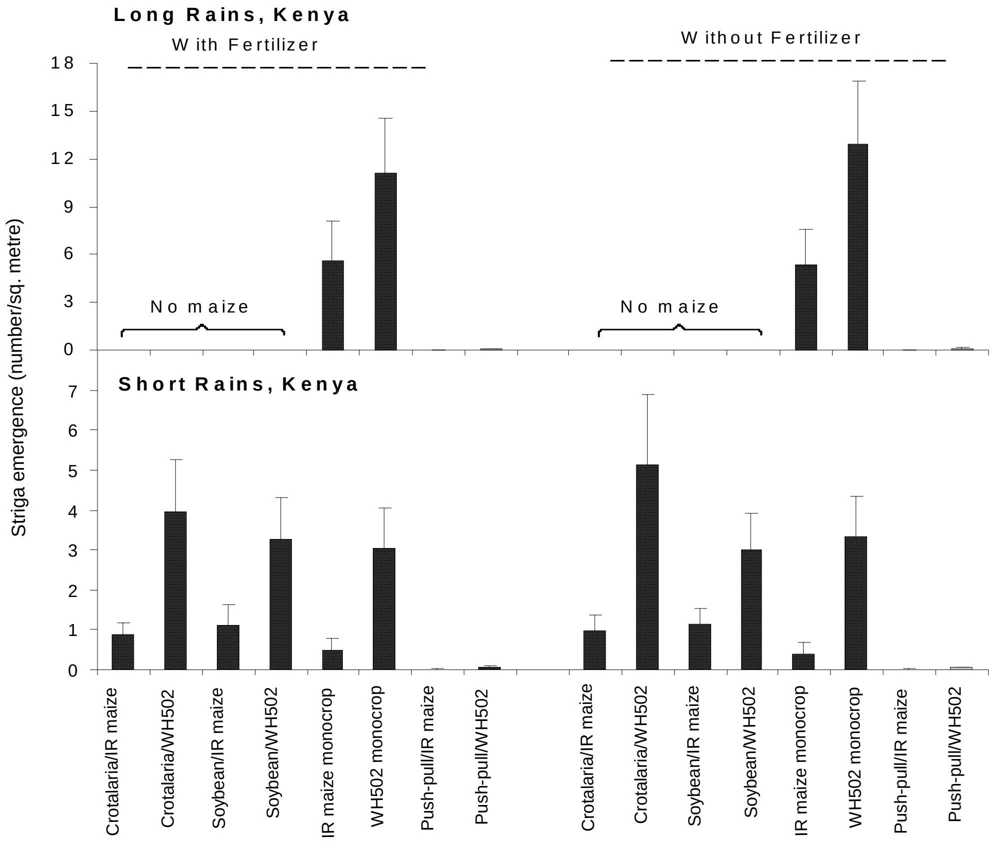


Figure 6. Effect of cropping systems by fertilizer, or lack of, on *Striga* emergence in western Kenya

Uganda

In the long and short rainy seasons in Uganda, cropping system and variety significantly influenced *Striga* emergence, with a significant interaction between the two, while fertilizer had no effect (Table 6). *Striga* emergence in the push pull plots was significantly lower than in the maize mono-crop of Longe4 but at par with IR maize mono-crop, which also effectively controlled *Striga* (Figure 7) during the long rainy season. In the short rains, *Striga* emergence in the push pull plots planted with IR maize was significantly reduced as compared to IR maize mono-crop and IR maize planted in rotation with *Crotalaria* and soybean. There was however, no significant difference in *Striga* emergence among different cropping systems planted with WH502 (Figure 7).

In the long rains, IR maize and push pull system performed equally well, whereas in the short rains, *Striga* emergence in the IR maize mono-crop was significantly higher than in the push pull plots and Longe4 mono-crop (Figure 8). In the short rains however, *Striga* emergence was lowest in the push pull plots and highest on IR maize plots (Figure 8)

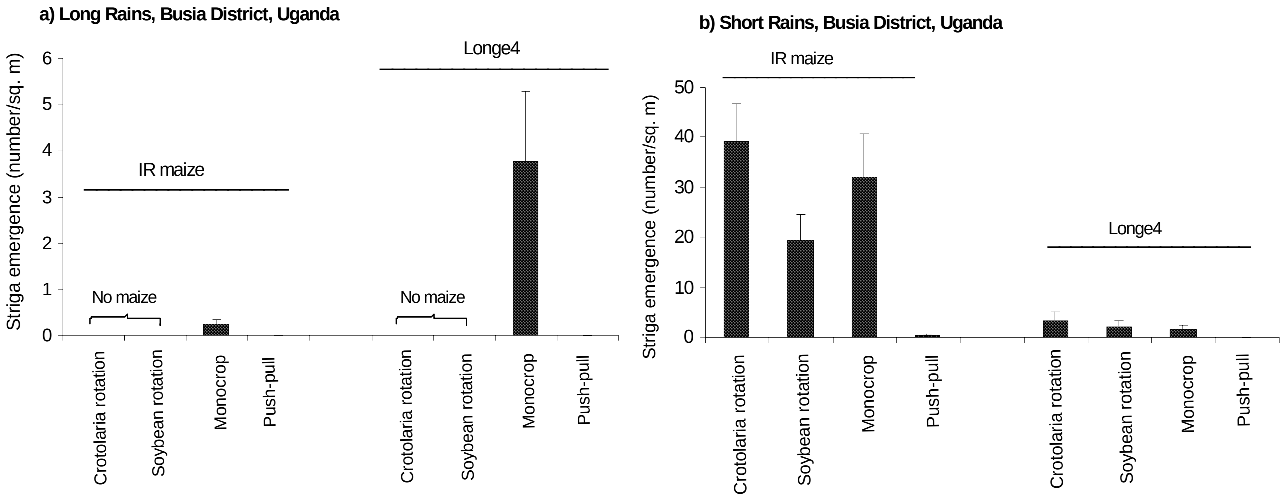


Figure 7 Effect of cropping systems by variety on *Striga* emergence in Busia District, Uganda

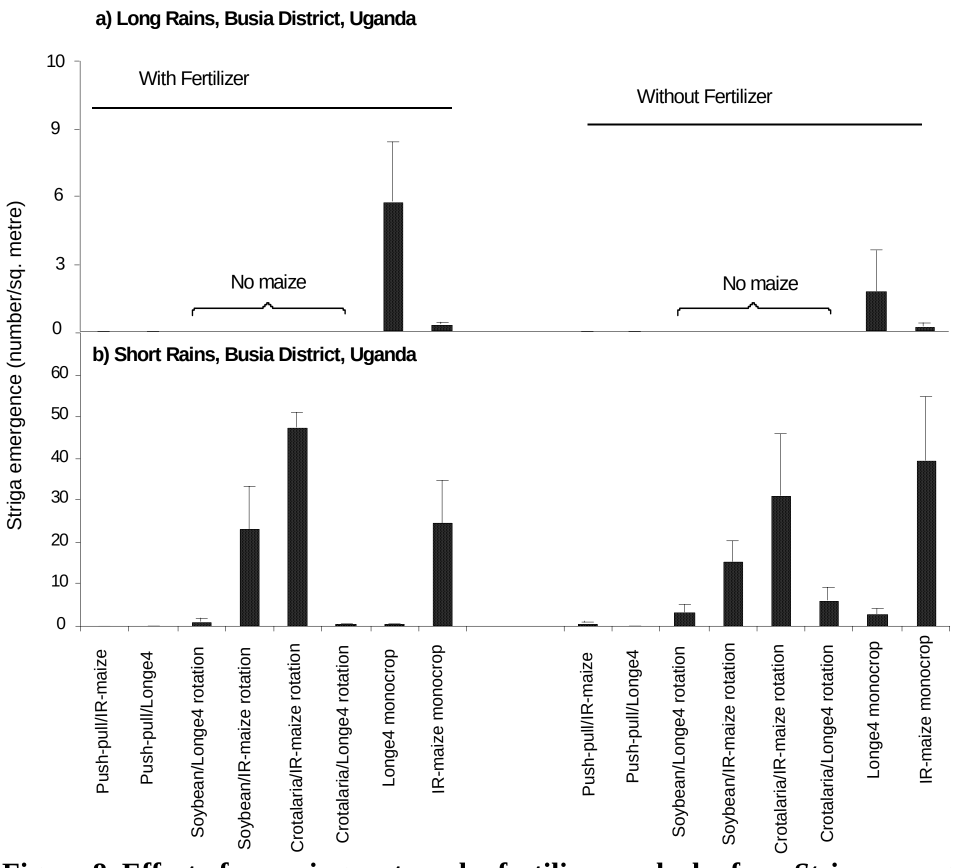


Figure 8. Effect of cropping systems by fertilizer, or lack of, on *Striga* emergence in Busia District, Uganda

3.2.3. Stemborer incidence

Kenya

In Kenya, district and cropping systems significantly influenced stemborer incidence, with a significant interaction between the two, while fertilizer and variety had no effect during both long and short rainy seasons (Table 4). In Siaya, stemborer damage during both seasons was very low and hence there was no significant difference among treatments. In Vihiga, however, during the long rains, stem borer damage was significantly lower in the push pull system as compared to continuous maize mono-cropping when planted with IR maize or WH502 (Figure 9). During the short rains, stem borer damage was significantly lower in the push pull system planted with WH502 than maize mono-crop and maize planted under other systems. While there were no significant differences among cropping systems planted with fertilizer, the push pull system planted with WH502 recorded significantly lower stemborer incidence than the continuous maize mono-cropping and rotation systems under no fertilizer condition (Figure 10). Overall, IR maize and the rotations had no impact on stemborer incidence.

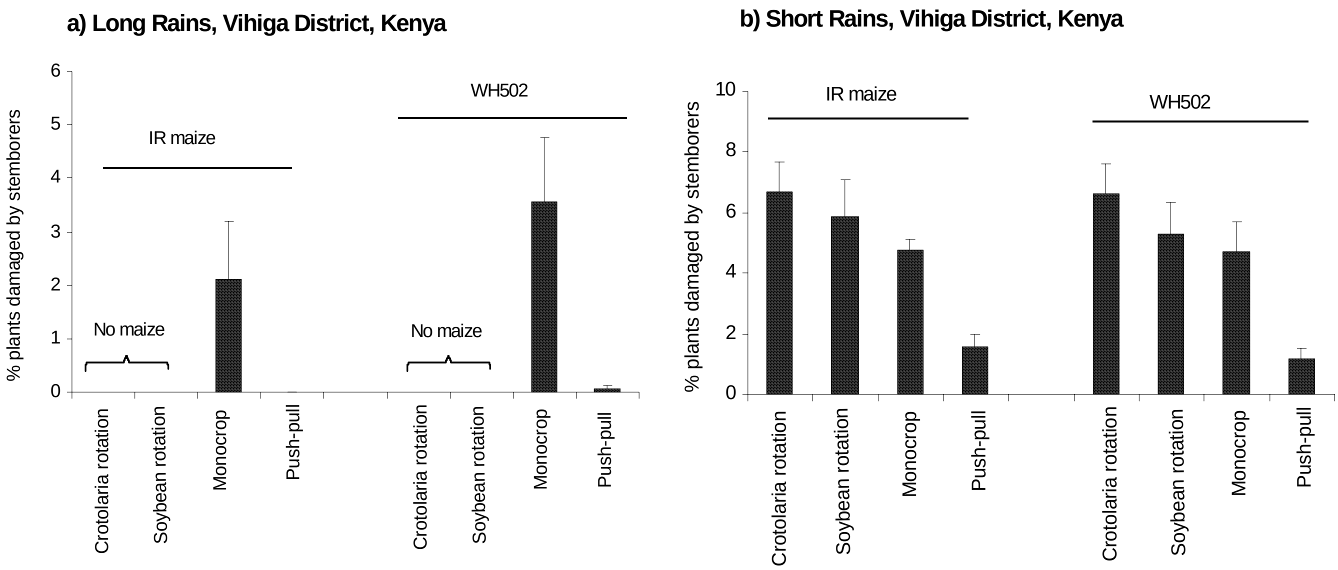


Figure 9. Effect of cropping systems by variety on plant damage by stemborers in Vihiga District, Kenya

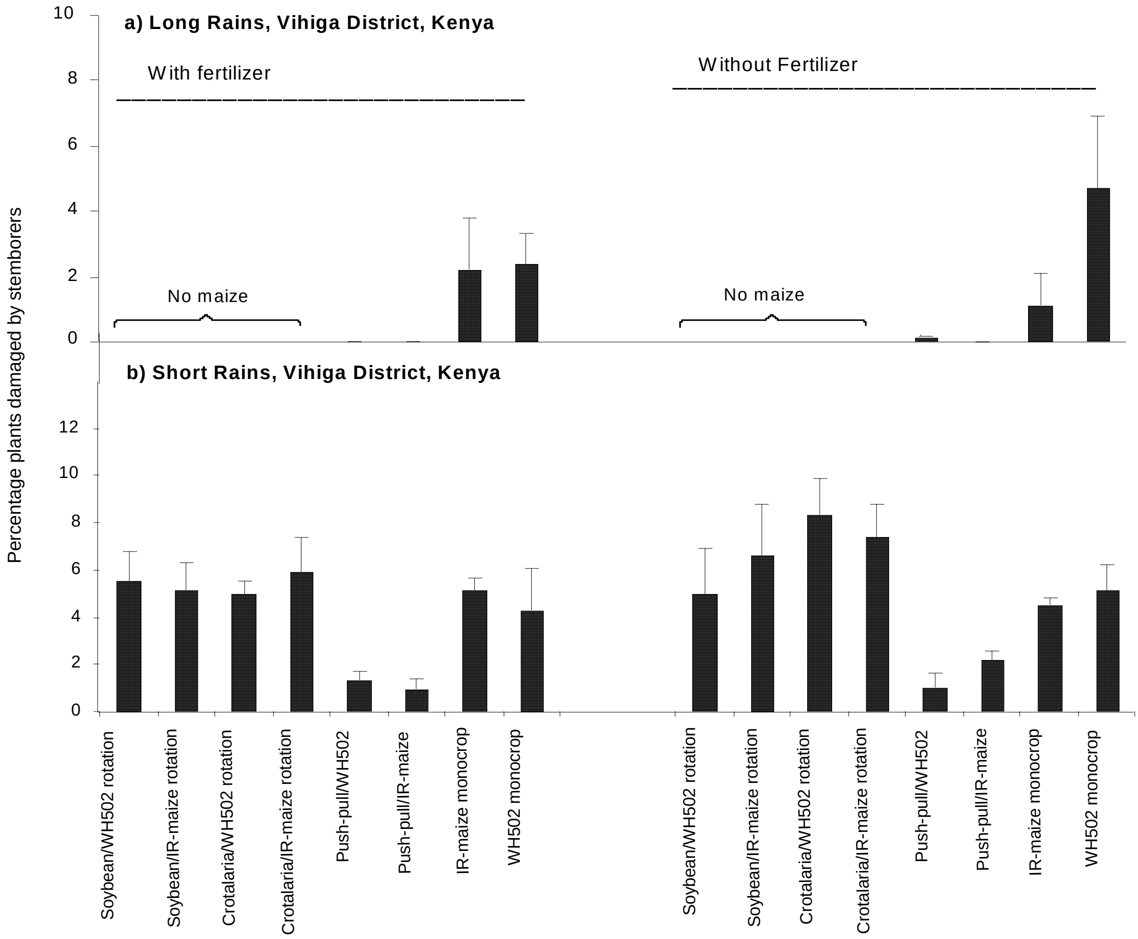


Figure 10. Effect of cropping systems by fertilizer, or lack of, on plant damage by stemborers in Vihiga District, Kenya

Uganda

In Uganda, variety and fertilizer were the only factors that significantly influenced stemborer incidence (Table 4). Stemborer damage was generally low with no significant differences among various cropping systems (Figures 11 and 12). They were however higher in cropping systems planted with IR maize and fertilizer than those planted with Longe4 and without fertilizer respectively (Figures 11 and 12).

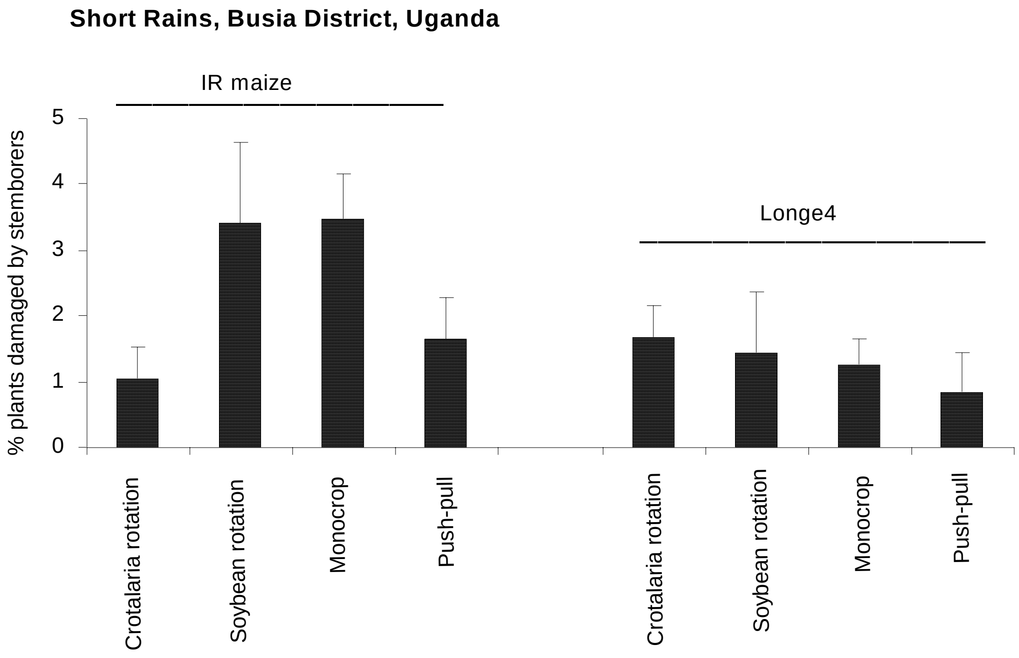


Figure 11. Effect of cropping system on stemborer incidence across villages of eastern Uganda

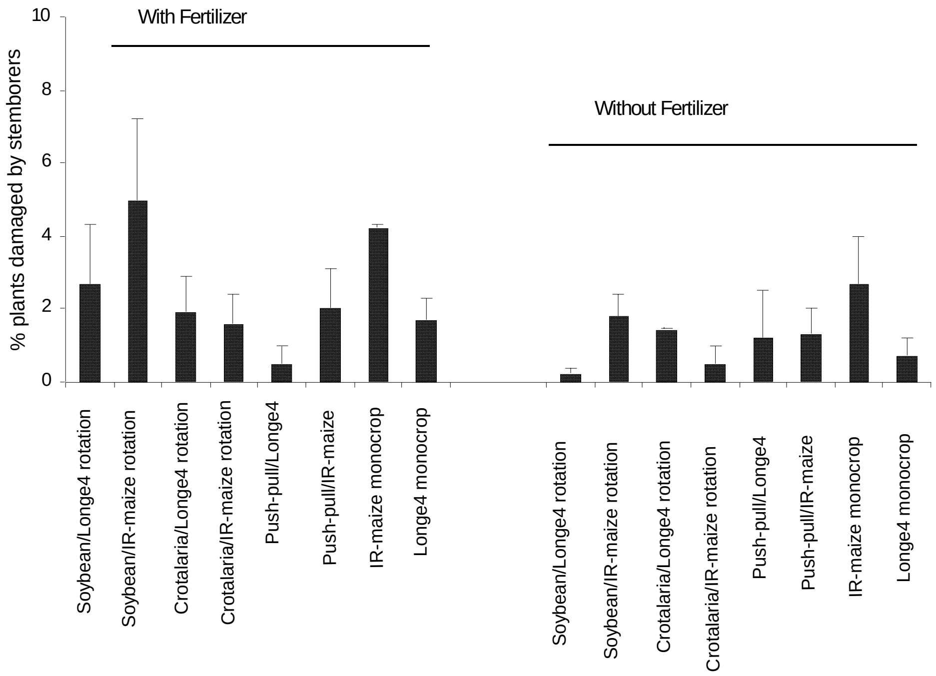
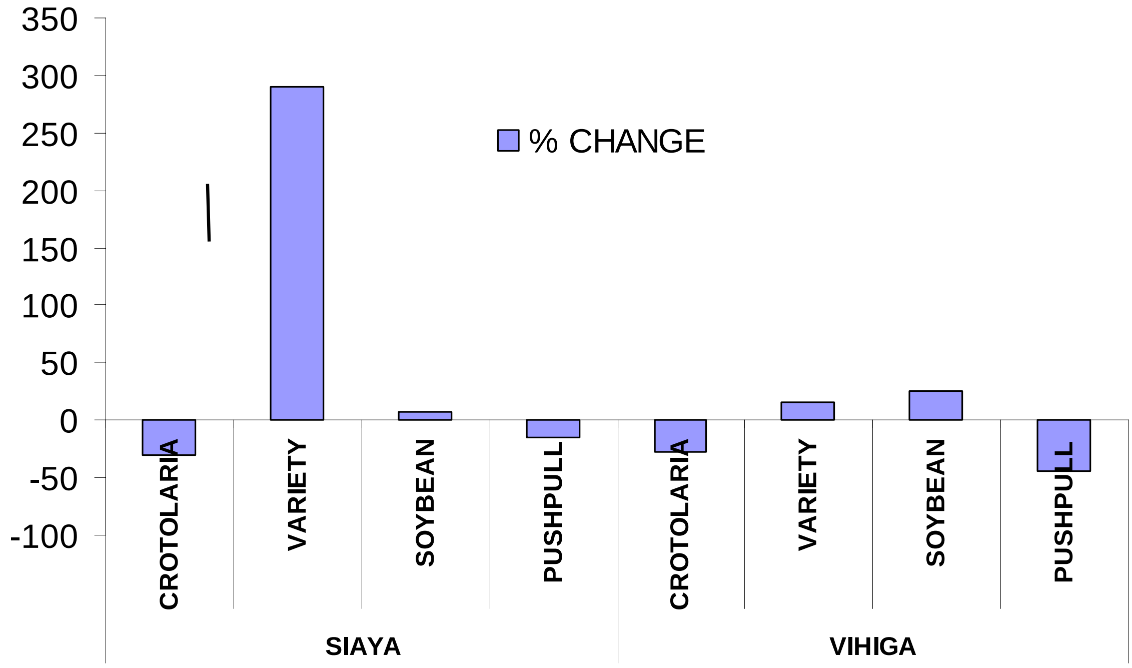


Figure 12. Effect of cropping systems by fertilizer, or lack of, on plant damage by stemborers in Busia District, Uganda

3.2.4. *Striga* seed dynamics in the soil

Striga seeds were counted per 250 g soil in the beginning of establishing the trials and after six cropping seasons. There was a significant district by cropping system interaction in 2003 and 2005 cropping seasons and in percentage change in seed population in the soil (Table 5). In Siaya, there was a significant increase in *Striga* seed population in the soil after 6 seasons of continuous mono-cropping with maize (IR maize and WH502) as compared to Vihiga (Figure 13). Push pull and *Crotalaria* rotation are the only systems where there was a decrease in *Striga* seed population while all the other cropping systems resulted in seed increases



SE of mean = 35.785

Figure 13. Percentage change in *Striga* seed population in the soil after 6 cropping seasons with different management options in western Kenya

In Uganda, there was a significant increase in *Striga* seed population in the soil after 6 seasons in all the cropping systems (Table 7 and Figure 14). The percentage increases in *Striga* seed population in the soil was significantly higher in the mono-crop (IR maize and Longe4) and significantly lower in the push pull system.

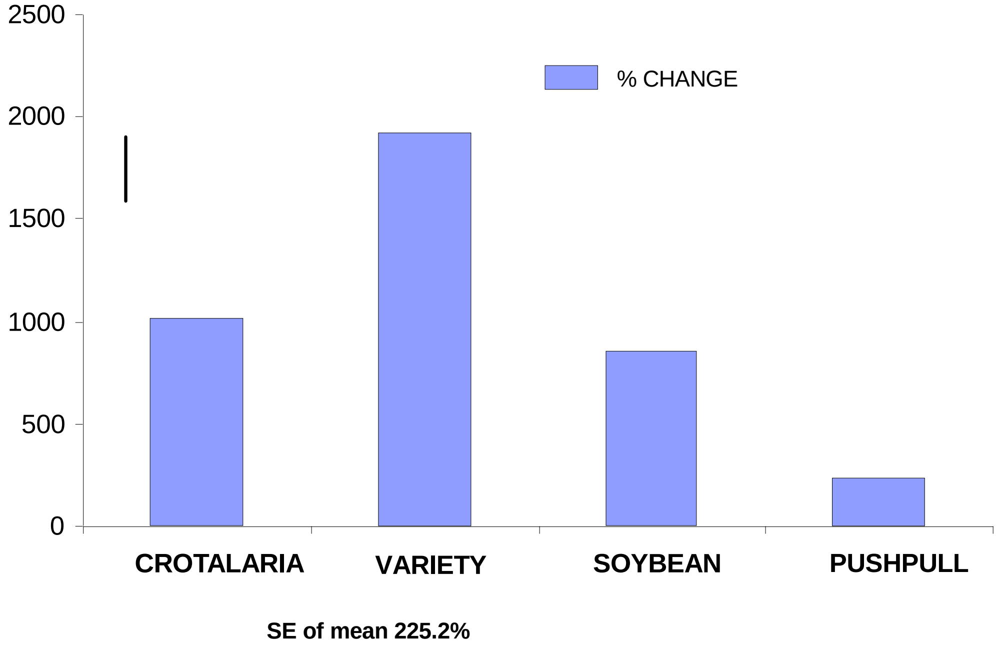


Figure 14. Percentage changes in *Striga* seed population in the soil after 6 cropping seasons with different management options in Uganda

3.2.5. Evaluation of On-farm trials

During the 2005 short rains data were collected on stemborer damage and *Striga* emergence from the farmers in Vihiga and Siaya districts of Kenya who had adopted the push pull and IR maize technologies. In Vihiga, data were collected from 35 farmers who planted IR maize and 34 farmers who planted the push pull system. In Siaya district, data were collected from 8 farmers who planted IR maize and 10 farmers who planted the push pull system. The control was WH502. In both districts, both technologies significantly reduced *Striga* emergence (Figure 15). Stemborer damage in Vihiga district was similarly significantly reduced in push pull as compared to control plots (Figure 15). Stemborer infestation in Siaya district was very low and therefore no data were collected. The yield data was not available for analysis by the time this report was submitted.

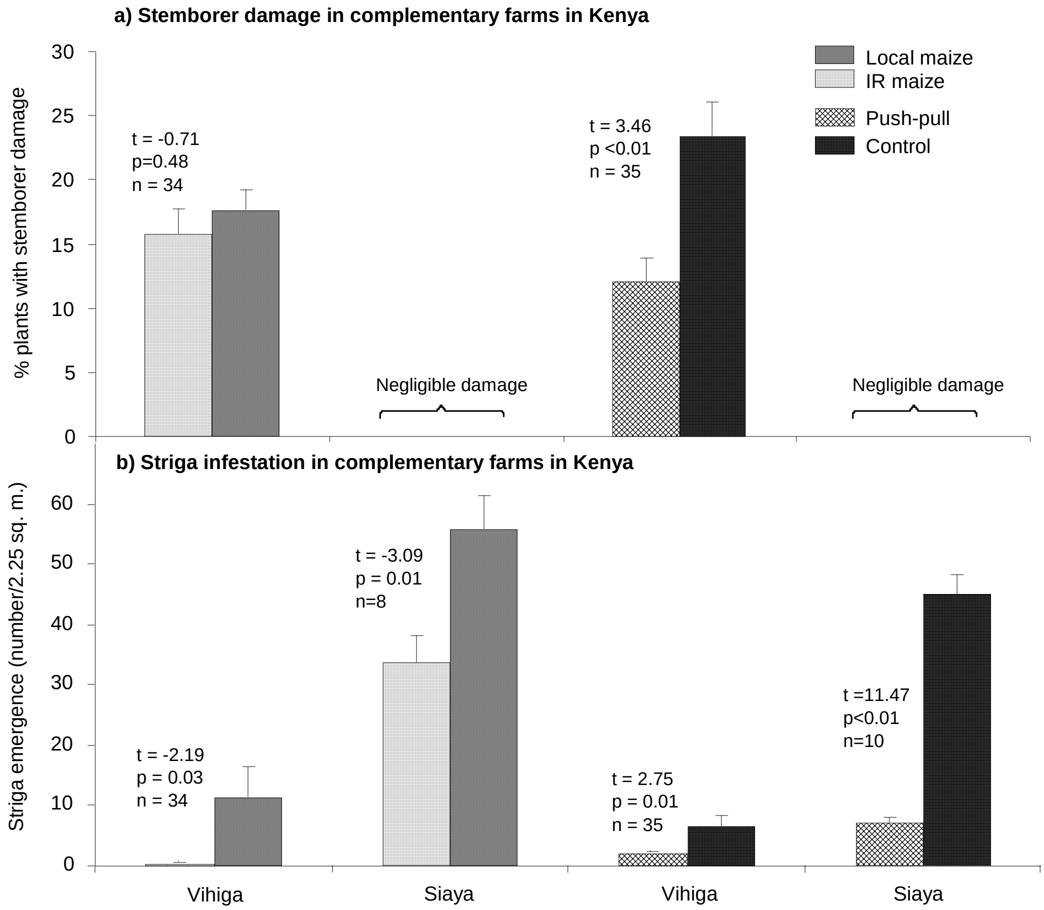


Figure 15. *Striga* and stemborer damage on on-farm trials planted with IR maize and push pull technologies.

3.3. Farmers evaluation of demonstrations

3.3.1. Statistical analysis of farmers' scoring of different technology options

Scores are ordered categorical data. Ordinal regression is seen as the theoretically correct way of analysing these data through log likelihood ratios.

In the long rainy season of 2005, the analysis reveal that all treatments were significantly preferred to the base (MON L-F) in both countries (Table 8). The basic model shows that in both Vihiga and Siaya districts of Kenya, push pull with IR maize and with fertilizer was the most preferred treatment, while mono-crop IR maize with fertilizer was the most preferred in Uganda. In Kenya, the log-odds ratios for all treatments with fertilizer were higher than those without, indicating that fertilizer was most appreciated. In Uganda, maize-*Crotalaria*, maize-soybean and mono-crop except the push pull cropping systems showed that there were high preference for treatments with fertilizer.

The model with site specification compares ratings between the two districts in Kenya. The results show that the ratings by farmers in the two districts are significantly different at 10%. The interaction coefficients for Vihiga are negative, indicating that Siaya farmers appreciate these technologies a lot more. In Siaya, maize-soybean, maize-*Crotalaria* and push pull cropping systems were the most preferred systems followed by the mono-crop cropping systems. In Vihiga, push pull was most preferred followed by *Crotalaria*-maize rotation, maize monocrop and lastly by maize-soybean rotation. In Uganda also, push pull system was the most preferred followed by maize-soybean rotation, maize-*Crotalaria* rotation and lastly by mono-crop cropping system.

Table 8: Appreciation of technologies in general (country) and by district during LR 2005

				Estimates of log-odds ratios								
	treatment components			Basic model coefficients				Model with site specification				
Treatment	Cropping system	Maize variety	Fert.	Kenya		Uganda		Coefficients for Siaya		Cross effect of Vihiga		Coeff. for Vihiga
1	push-pull	IR	yes	4.59	***	3.30	***	5.43	***	-0.52	*	4.90
2		IR	no	2.99	***	4.50	***	4.69	***	-2.36	***	2.33
3		Local	yes	3.82	***	2.10	***	4.93	***	-1.13	***	3.80
4		Local	no	2.84	***	2.80	***	4.61	***	-2.51	***	2.10
5	Maize-	Soybean	yes	2.81	***	3.57	***	4.73	***	-2.87	***	1.86
6	Soybean	Soybean	no	2.68	***	1.10	***	5.03	***	-3.63	***	1.41
7		Soybean	yes	3.07	***	3.82	***	5.23	***	-3.24	***	1.99
8		Soybean	no	1.93	***	2.43	***	4.86	***	-4.89	***	-0.03
9	Maize-	Crotalaria	yes	4.06	***	2.10	***	4.89	***	-0.64	**	4.25
10	Crotalaria	Crotalaria	no	3.18	***	0.87	**	5.38	***	-3.26	***	2.12
11		Crotalaria	yes	4.38	***	4.67	***	5.77	***	-1.58	***	4.19
12		Crotalaria	no	2.34	***	2.42	***	3.69	***	-1.88	***	1.81
13	Monocrop	IR	yes	2.38	***	4.92	***	2.92	***	-0.42		2.51
14		IR	no	0.98	***	1.04	***	2.37	***	-2.33	***	0.04
15		Local	yes	2.31	***	3.41	***	1.03	***	2.75	***	3.78
16		Local	no	0.00	.	0.00	.	0.00	.	0.00	.	0.00
Log likelihood				714.68		299.3		824.4				
X2				1740.22		411.5		2756				

The methodology also allowed comparing farmer evaluations by gender in the two countries (Table 9). In Kenya, interaction coefficients (male effect) for gender are negative and not significant for the push pull and maize-*Crotalaria* technologies. This indicates that women prefer the push pull and maize-*Crotalaria* methods more than men. In Uganda, nearly all interaction coefficients are negative, indicating that the technologies are appreciated mostly by women. The overall conclusion is that technology preference is gender-neutral.

Table 9: Appreciation of technologies by gender in Kenya and Uganda LR 2005

	treatment components			Estimates of odds ratio for Kenya					Estimates of odds ratio for Uganda			
Treatment	Cropping system	Maize variety	Fert	Female		cross effect male		Male	Female		Cross effect male	Male
1	push-pull	IR	yes	4.73	***	-0.29		4.43	3.61	***	-0.49	3.12
2		IR	no	3.01	***	-0.03		2.98	4.85	***	-0.55	4.29
3		Local	yes	4.01	***	-0.40		3.60	2.22	***	-0.21	2.01
4		Local	no	3.00	***	-0.36		2.64	2.85	***	-0.07	2.78
5	Maize-	Soybean	yes	2.69	***	0.28		2.97	3.99	***	-0.69	3.29
6	Soybean	Soybean	no	2.69	***	0.01		2.69	1.37	***	-0.44	0.93
7		Soybean	yes	2.84	***	0.51	*	3.36	4.31	***	-0.81	3.49
8		Soybean	no	1.79	***	0.33		2.12	2.68	***	-0.41	2.28
9	Maize-	Crotalaria	yes	4.19	***	-0.27		3.92	2.22	***	-0.17	2.05
10	Crotalaria	Crotalaria	no	3.28	***	-0.21		3.07	1.55	***	-1.11	0.43
11		Crotalaria	yes	4.52	***	-0.30		4.22	4.64	***	0.1	4.74
12		Crotalaria	no	2.26	***	0.19		2.45	2.91	***	-0.81	2.1
13	Monocrop	IR	yes	2.37	***	0.04		2.41	5.03	***	-0.12	4.91
14		IR	no	0.95	***	0.08		1.03	0.89	*	0.23	1.12
15		Local	yes	2.38	***	-0.16		2.21	3.84	***	-0.7	3.15
16		Local	no	0.00	.	0.00	.	0.00	0		0	0
Log likelihood				988.68					463.48			
X2				1771.7					419.55			

*** Significant at 100%; ** significant at 99%; * significant at 95%

Using the basic model, results show that all treatments are significantly preferred to the base (Table 10). The push pull system was rated highly in general, followed by maize-*Crotalaria*, and then maize-soybean and lastly mono-crop cropping system. Treatments with fertilizer were rated higher than those without.

There was no clear difference between the IR maize variety and the local variety (WH 502). The local variety with fertilizer performed better than IR maize with fertilizer under maize-*Crotalaria*.

Model with sites specification, shows that farmers in Siaya preferred all treatments significantly to the base at 1%. Farmers in Vihiga, on the other hand, preferred eight treatments significantly at 1%. The ratings for farmers in Vihiga were higher than those of their Siaya counterparts. The push pull system was highly appreciated in Vihiga with IR+F being the most preferred with log-odds ratio of 5.40.

Table 10: Appreciation of technologies in general and by district during SR 2005 in Kenya

				Estimates of log-odds ratio			
	treatment components			Basic model	Model with site specification		
Treatment	Cropping system	Maize variety	Fertilizer	Estimated coefficients	Coefficient of Siaya	Cross effect of Vihiga	Coefficient of Vihiga
1	push-pull	IR	yes	4.46***	3.83***	1.57***	5.40
2		IR	no	2.96***	2.73***	0.68**	3.40
3		Local	yes	4.06***	4.17***	0.05	4.22
4		Local	no	3.31***	3.18***	0.48*	3.66
5	Maize-Soybean	IR	yes	2.95***	2.10***	1.91***	4.02
6		IR	no	1.53***	1.06***	1.02***	2.08
7		Local	yes	2.70***	1.79***	1.95***	3.75
8		Local	no	1.75***	0.74***	2.06***	2.80
9	Maize-Crotalaria	IR	yes	2.65***	2.80***	-0.09	2.71
10		IR	no	1.58***	2.02***	-0.88***	1.14
11		Local	yes	3.38***	3.08***	0.86***	3.94
12		Local	no	1.18***	0.83***	0.79**	1.62
13	Monocrop	IR	yes	1.77***	1.44***	0.81**	2.25
14		IR	no	1.47***	1.37***	0.31	1.67
15		Local	yes	1.53***	0.82***	1.56***	2.38
16		Local	no	0.00	0.00.	0.00.	0.00
Log likelihood				522.14	885.51		
X2				1662.1	1962.9		

*** Significant at 100%; ** significant at 99%; * significant at 95%

All treatments were significantly preferred to the base at 1% significance level in Kenya during SR 2005 (Table 11). Women ratings were higher than those of men. Women appreciated the push pull system a lot more than men. Fertilizer was preferred by both men and women. Men significantly preferred four treatments to the base; IR+F under the push-pull and maize-soybean system (at 1%), and local variety with fertilizer under maize-*Crotalaria* and mono-crop systems. the local variety performed as good as the IR maize in most cropping systems.

Table 11: Appreciation of technologies by gender during SR 2005 in Kenya

	treatment components			Estimates of log-odds ratios				
Treatment	Cropping system	Maize variety	Fertilizer	Female		Male cross effect		Male
1	push-pull	IR	yes	4.96	***	-1.23	***	3.72
2		IR	no	3.14	***	-0.40		2.73
3		Local	yes	4.05	***	0.11		4.16
4		Local	no	3.42	***	-0.24		3.18
5	Maize-Soybean	IR	yes	3.36	***	-0.98	***	2.37
6		IR	no	1.69	***	-0.39		1.30
7		Local	yes	2.97	***	-0.65	**	2.32
8		Local	no	1.94	***	-0.46		1.48
9	Maize-Crotalaria	IR	yes	2.83	***	-0.44		2.39
10		IR	no	1.66	***	-0.18		1.48
11		Local	yes	3.58	***	-0.46		3.12
12		Local	no	1.38	***	-0.48		0.90
13	Monocrop	IR	yes	1.88	***	-0.24		1.64
14		IR	no	1.39	***	0.23		1.63
15		Local	yes	1.76	***	-0.58	**	1.18
16		Local	no	0.00	.	0.00	.	0.00
Log likelihood				807.19				
X2				1708.58				

*** Significant at 100%; ** significant at 99%; * significant at 95%

3.3.2. Farmers' selection of technologies

Most of the farmers in all districts (above 60%) selected the push pull system as their first choice during LR 2005 (Figure 16). Mono-crop was selected by farmers in Vihiga (13%) and Busia (21%). Soybean was selected by slightly more farmers compared with *Crotalaria* in the three districts.

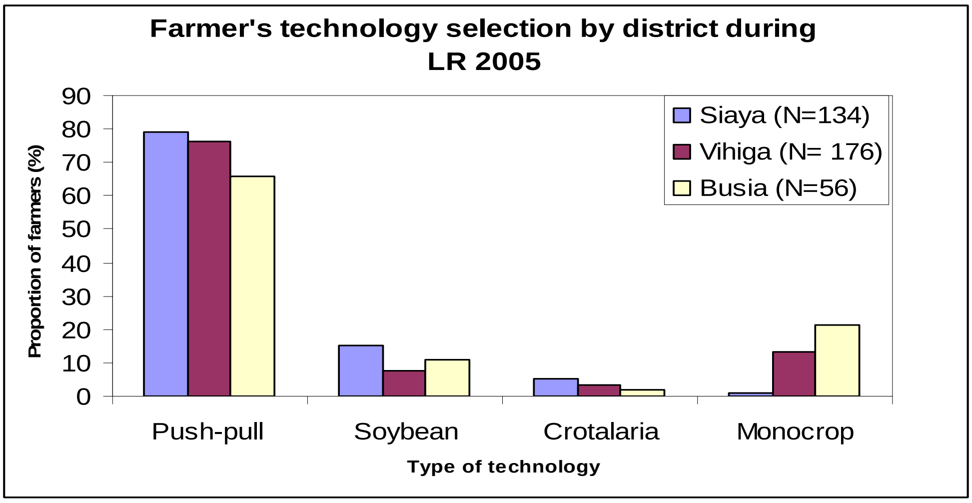


Figure 16. Technology selection by district during legume phase LR 2005

Most of the farmers (over 75%) in the two districts selected the push pull system as their first choice (Figure 17). Maize-*Crotalaria* followed the push pull system, though was selected by much fewer farmers (12%).

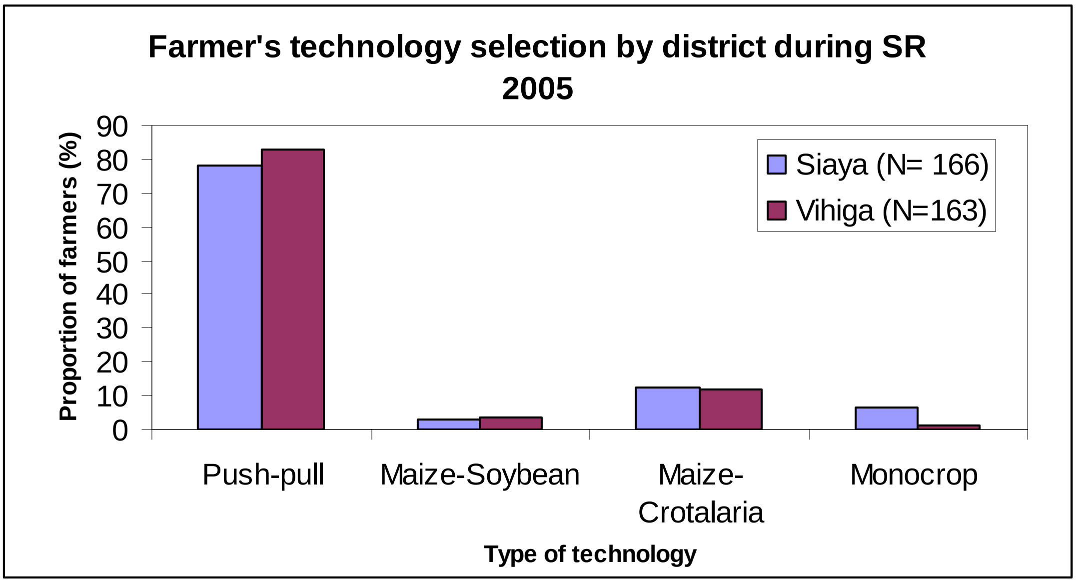


Figure 17: Technology selection by district during maize phase SR 2005

During the long and short rains of 2005, a total of 764 farmers were given inputs of various technologies according to their preferences (Table 12). IR maize was taken by a total of 400 farmers (136 male and 264 females), followed by the push pull system which was preferred by 238 farmers (101 males 137 females). Soybean was preferred by 136 farmers (52 males and 74 females).

Table 12. Seed distribution to core and adaptation farmers in western Kenya Long Rains and short rains 2005

Long Rains	IR		Push pull		Soybean		Total
	Male	Female	Male	Female	Male	Female	
NGOYA	4	8	10	5	1	7	35
NYALGUNGA	28	80	21	39	33	48	249
EMATSULI	16	18	16	13	11	10	84
EBULONGA	7	42	11	25	7	9	101
TOTAL	**55**	**148**	**58**	**82**	**52**	**74**	**469**
Short Rains	IR		Push pull		Soybean		Total
	Male	Female	Male	Female	Male	Female	
NGOYA	13	10	7	8	--	--	
NYALGUNGA	22	27	5	13	--	--	
EMATSULI	26	44	21	18	--	--	
EBULONGA	20	35	10	16	--	--	
TOTAL	**81**	**116**	**43**	**55**			**295**
GRAND TOTAL	**136**	**264**	**101**	**137**	**52**	**74**	**764**

3.4. Dissemination of best-bet IPSFM options

Field days/farmer evaluations offered a platform for dissemination of technologies as various stakeholders participated, especially stockists who would help in marketing of these technologies (Table 3). Brochures were distributed (Table 3) to various stakeholders. The project presented a paper on the project results during the African Crop Science Conference in Entebbe, Uganda, and brochures distributed.

Many organizations were found working in the target areas (Table 13). However, coverage was usually limited, with most organizations only covering a few of the sites. Notably lacking was access to credit facilities as only a few of the farmers had access to rural credit.

Table 13: Projects active in the target sites

	Kenya	Tanzania	Uganda
Research	ICRAF	ARI-Ukiriguru: research	
Extension	- Ministry of Agriculture(NALEP) - MoALD	- Agricultural extension - Tanzania Cotton Authority (TCA)	- Extension Staff
International NGOs	- CARE	- Catholic Relief services (CRS): - CARE-International: - CARITAS: tree nurseries - Heifer Project International (HIP): - FINCA: credit	- FINCA - SG 2000
Local NGOs and CBOs	- Christian Relief development agency - CRDA, (NGO) for dairy goats - CPDA, - KICRP, - Women groups, - Youth groups. - Integrated christian based project-Kima, - SCODP	- HESAWA: well construction -KIMKUMAKA: extension and input supply - Environmental Management project - DSPDE: Rehabilitation Schools - Roman catholic church	- Babiri Bandu (CBO) - BUDIFA - COWE - FFS - FITCA - Focus - FOSEM - IPPM/FFS - NAADS - WCA

In Kenya, the International Centre for Research in Agroforestry (ICRAF), working on soil conservation methods, and the international NGO, CARE, are active in Siaya. The extension service of the ministry of agriculture and a local NGO, SCODP, working on making fertilizer and other agricultural inputs available to farmers, are active in both sites. Many other local projects and community based organizations (CBOs) are also active in the region.

In Tanzania, the active institutions in the project include two government institutions: the Lake Zone Agricultural Research and Development Institute (LZARDI) in Ukiriguru, the extension service and two NGOs, Kimkumaka and CARE international. LZARDI is a government research institute with a mandate to develop new technologies for farmers in the Lake zone of Tanzania and also educate them on general improvement of agriculture. It is located in Misungwi district in Mwanza. Agricultural extension is one of the core functions of the Ministry of Agriculture and Food Security. The main objective of the extension is to transfer recommended agricultural technologies from researchers to farmers. CARE-International is an international NGO with a local office in the Misungwi district of the Mwanza region. It is responsible for educating farmers on the improvement of agricultural production through the use of improved agronomic practices. Kimkumaka, a local NGO located in the Nyamagana district of Mwanza, is linked to the Catholic Church. It provides advice to farmers on the improvement of agricultural activities besides provision of inputs such as seeds and low cost farm implements.

In Uganda, all the villages had some development projects except one that relied entirely on the public extension services. There was a disparity in the number of projects between men and women of the same village, which could relate to the gender orientation of the projects.

4. Capacity building

4.1. Students

Rutto, Esther, 2005. Economic Evaluation of Innovative Technologies to Combat *Striga*, Stemborer and Declining Soil Fertility in Western Kenya. MSc dissertation, Agricultural Economics, Moi University, Kenya.

4.2. Farmer and stakeholders

For farmer and stakeholder capacity building refer to Table 2.

5. Impact assessment

5.1. Factors influencing adoption

The farmer evaluation results revealed that the livestock breeds kept, size of landholdings, primary crop grown, market availability for the products, cost of inputs and price stability of the outputs/products and effectiveness of the technology in pest control and grain yield enhancement were the factors influencing technology adoption in the target areas. In areas where farmers keep mainly local breeds of livestock, like Siaya and Busia, there is generally low demand for high quality fodder, which is a major by-product of the push pull technology. In such cases, save for the technology's effectiveness in *Striga* and stemborer control, the adoption of the technology would not be as expected. In places where land is not a limiting factor, like eastern Uganda, farmers may not value continuous cropping, rotational crops or push pull cropping systems. Fallowing is still an option for farmers in Busia but in Vihiga where land holdings are small, farmers may not forego a whole maize cropping season. Maize in Uganda is not a primary crop; therefore farmers may not be keen to adopt maize-based farming systems. Lack of market for these technologies' outputs inhibits adoption. For example, farmers in Busia have no value for *desmodium* and market for Napier, while in Vihiga there is high demand for the fodder, which is a major driving factor for adoption of the push pull technology. The output prices for soybean and maize are fluctuating while input prices are steadily rising, thereby influencing adoption of these technologies. Effective control of *Strig*a weed and high maize grain yields realised also foster technology's adoption.

5.2. Farmers' interest

During farmer evaluations, those in Kenya preferentially chose push pull technology (77%). This trend however, changed during adaptation trials/technology selection where 40% preferred IR maize, 29% preferred push pull and 31% adapted soybean and *Crotalaria* rotation.

6. Contribution of outputs to development (impact)

This project is creating benefits related to various aspects of rural livelihoods in the target areas which are in line with DFID's development goals:
(i) **Food Security**: By increasing food production and decreasing variability on a sustainable basis, the project is contributing directly to food availability and food security.
(ii) **Human Health**: Enhancing the production of soybean in local communities has shown clear beneficial impacts on health indices, especially for children.
(iii) **Gender Empowerment**: Women's contribution to agricultural production in Africa is very high. Despite variations across cultural and socio-political backgrounds, women contribute enormously towards agricultural resource allocation decisions.
(iv) **Dairy and Livestock Production**: The proposed strategies will contribute significantly to increased livestock production by producing more fodder, especially on small farms where competition for land is high.
(v) **Soil Conservation and Fertility**: *Desmodium* and other legumes such as dual purpose grain legumes have been introduced into eastern Africa for livestock fodder and to increase soil fertility. Appropriate legume-cereal rotations/combinations can substantially reduce the need for external mineral nitrogen inputs and improve the use efficiency of other inputs.

The project has firstly, yielded conclusive information on the medium to long-term effects of the best-bet options on the *Striga* seed bank, stemborer reduction, the overall soil fertility status and economic performance for the target areas. This information is essential for ensuring food security, income generation and environmental sustainability. Secondly, farmers' assessment on the best-bet options requires several feedback cycles over several seasons, keeping in mind the nature of the technologies evaluated (e.g. rotations require at least 2 seasons to assess residual effects) and the relatively high potential for drought occurrence around Lake Victoria. Thirdly, the project has delivered its products to a large number of farmers within and beyond the target villages around the Lake Victoria basin through enhanced linkages with farmer groups, NGOs and other projects operating in the Lake Victoria basin. Fourthly, some components of the best-bet technologies require access to improved seeds and/or fertilizer. Public-private sector linkages with seed companies and input suppliers operating around Lake Victoria have helped in fostering access to seed and fertilizer. Lastly, the potential for alleviating poverty and spreading the products through areas beyond the target areas should be evaluated through impact assessment activities.

In Kenya, the promotion of soybean as both human and animal feed through other stakeholders will enhance the uptake of the technology for soil fertility improvement and its ability to stimulate suicidal germination of *Striga* seed in the soil. The project has linked with other stakeholders in the promotion of *Desmodium* forage legume for livestock feed as a way of accelerating the uptake of the push pull technology. In Uganda, the addition of forage value into the project is a strong inducement for the uptake of the push pull technology. The use of soybeans as animal feed will also promote the use of soybeans in rotation with maize to improve soil fertility and *Striga* control. Since *Desmodium* and IR maize seeds are not enough to satisfy the growing demand, NGOs and community-based groups will be encouraged to multiply the seeds.

In Kenya, the organizations to benefit from the research activities are the four farmer groups we are currently working with directly, as well as a large number of farmer groups that will be reached through NGOs like Care for Relief Everywhere (CARE), the Christian Relief Development Agency (CRDA), the Kima Integrated Christian based Rural Project (KICRP), the Sustainable Community Oriented Development Program (SCODP) and Farming in Tsetse Control Areas (FITCA). The Ministry of Agriculture (MoA) and the Ministry of Livestock Development (MLD) will also greatly benefit. In Uganda, the organizations to benefit are the two farmer groups we are currently working with and the farmer groups that will be reached through linkages with NGOs such as COWE (Care for the Orphan, Widows and the Elderly), BUDIFA (Busia District Farmers Association), FITCA (Farming in Tsetse Control areas), and LWDA (Lumino Women Development Association). LGDPs (Local Government Development Program) and NAADS (National Agricultural Advisory Services) will also benefit. In Tanzania, the expected organizations and groups that will benefit are the four farmer groups currently involved in the project and others reached through contacts with NGOs like CARE-International, the Evangelical Lutheran Church of Tanzania and the World vision of Tanzania.

7. STAKEHOLDERS WORKSHOP FOR DISCUSSIONS WITH PARTNERS TO WORK OUT EXIT STRATEGIES

In Kenya, a one day stakeholders' workshop was organized in February 2006 to chart the way forward in terms of sustainability, especially input availability and scaling up of the technologies which farmers had preferred. A number of institutions were represented (Table 14). As a way forward in scaling up and developing exit strategies, it was discussed and agreed that:-

1. Ministry of Agriculture is going to assist in scaling up the activities in their areas of operation by conducting demonstrations in the new focal areas. For this they will need demo kits for proper implementation of these technologies
2. Farmers' Field School. These technologies will be planted in farmers' field schools. In Siaya, there is network 10 farmers' field school with an average of 30 members.
3. Stockists operating in the region should be given some IR maize seed, pack them in smaller quantities and give free to farmers who come to buy other maize seeds to test and compare with other maize varieties in their fields.
4. NGOs and CBOs to provide information and extension services to the groups they work with and hence taking the activities to a wider community than so far reached.
5. KARI/TSBF-CIAT/CIMMYT/ICIPE partners will continue providing technical backstopping. Demo plots will continue to be managed by the research partners to assess the long-term effect of these technologies on *Striga* seed bank and fertility changes in the soil.
6. It was noted that IR maize seed is still not commercially available. In the meantime SCODP informed the meeting that through the AATF, about 11 tons of the seed is available for experimental purposes and that stakeholders present would on request be provided with some quantities for their farmers to test in 2006 long rains. For the push pull technology, it was agreed that while Napier grass is easily accessible, *Desmodium* seed is still expensive to most farmers. It was agreed that local stockists would purchase in bulk then package and sell in small quantities affordable to most farmers. KIMA

informed the meeting of their success with vine propagation of *desmodium* especially when it is very wet. Stakeholders were therefore encouraged to disseminate this method of establishing the fodder legume. Soybean production was noted to do well during short rains so that the long rains are left for maize production. To this end, TSBF-CIAT informed members that they have contracted some farmers who are producing seed for them which they sell at 50/= per kg. To enhance adoption, it was noted that there was need to train farmers on utilization as value addition.

In Tanzania a stakeholders' meeting was held in February, 2006. Farmers from different areas where the technologies were demonstrated including adoption farmers said that IR maize was good because of the good results they got from the first season. They also said that push pull should be continued because of the potential of increasing maize yields, controlling stemborers, *Striga* weed and improving soil fertility. However they reported difficulty in weeding Desmodium and protecting the fields from destruction by grazing animals.

CBO's, NGO's and Stockists operating in the region presented their activities which included formation of saving and credit societies, promotion of legumes for soil fertility improvement and cash income earning, improved seed distribution to farmers, better livestock keeping methods, environment conservation education including tree planting and planting demo plots on the performance of their different crop varieties.

Observations that emerged from the meeting were that (1) although the push pull technology solved their problems of *Striga*, stemborer, soil infertility, fodder insufficiency and led to an overall improvement of their livelihoods, they had difficulty in accessing the planting materials (Desmodium seeds and Napier grass) and complained of its being labor intensive. They also observed the menace of wandering/grazing animals that destroy the Desmodium and Napier grass, (2) IR maize although controlled *Striga* there still was no clear information on the difference between it and GM material, as the latter is clearly detested by the majority in the country, (3) although the rotations improved yields and enhanced food security, they needed more time, space and expertise for management. It was concluded that Extension officers, NGO's like MRHP, CARE, and KIMKUMAKA would continue disseminating the technologies with occasional backstopping from the current project partners.

Biometricians Signature

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

Signature:

Name (typed): Anthony Wanjoya
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Date: 17-02-06

Abbreviations

MoA	Ministry of Agriculture
CPDA	Christian Partner Development Agency
DAO	District Agricultural Officer
DIO	District Information Officer
DDAO	Deputy District Agricultural Officer
CAFARD	Conservation Agriculture for Sustainable Development
ICRAF	International Centre for Research in Agroforestry
CARE	Care for Relief Everywhere
CRDA	Christian Relief Development Agency
KICRP	Kima Integrated Christian Based Rural Project
SCODP	Sustainable Community Oriented Development Programme
FITCA	Farming in Tsetse Control Areas
IPPM/FFS	Integrated Pest and Production Management/Farmer Field School
NAADS	National Agricultural Advisory Services
COWE	Care for the Orphan, Widows and the Elderly
BUDIFA	Busia District Farmers Association
SG 2000	Sasakawa Group 2000