Maize farmers strike back against Striga and stemborer

RIU

Validated RNRRS Output.

Poor farmers in 30 villages in Tanzania have increased their demand for Striga-tolerant maize varieties, as well as green manure and improved maize seed that is distributed in small, affordable packs. The reason: they've seen how well they work. Previously, Striga, a parasitic weed, and the stemborer insect pest took a terrible toll on these farmers' maize crops. Now, improved understanding of cropping strategies, on-farm evaluation of selected technologies, improved access to inputs and stronger partnerships are giving them new hope. Soil fertility has also increased using simple farming practices, such as rotation and rainwater harvesting to increase soil moisture.

Project Ref: **CPP14:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Ilonga Agricultural Research Institute (ARI-Longa), Tanzania**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP14

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Nigeria, Tanzania,

Target Audiences for this content:

Crop farmers, Livestock farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.

In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Increasing food security and improving livelihoods through the promotion of integrated pest and soil management in lowland maize systems.

Suggested title: Improving lowland maize productivity

2. Name of relevant RNRRS Programme(s)

Also indicate other funding sources, if applicable.

The Crop Protection Programme funded the projects which validated the core outputs described in this dossier. Salaries and facilities for zonal research, university and extension staff of Tanzanian partner institutions were funded by the Government of Tanzania. *Striga* tolerant maize lines provided to farmers by the projects included two developed by CIMMYT.

3. Relevant R numbers, institutional partners and contacts

(and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R8215 and R8452

Institutional partners	**Contact person**
Agricultural Research Institute – Ilonga P.O. Ilonga, Kilosa, Tanzania.	AM Mbwaga
Agricultural Research Institute-Mlingano Private Bag Muheza, Tanga, Tanzania	George Ley
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4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? (max. 400 words).

This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.

The project developed and promoted strategies that reduced the impact of pests in particular the parasitic weed ***Striga*** (at the same time improving **soil fertility**) and stemborer on poor people's maize crops, through an improved understanding of coping strategies, identifying constraints to adoption, **on-farm evaluation** of selected technologies, improving access to inputs and linking stakeholders as partners.

Key outputs were:

i) An improved understanding of local pests of **maize**, coping strategies and constraints to adoption of improved technologies. The project brought key stakeholders together using a participatory research and extension approach (PREA) that ensured that farmers and farmer institutions were fully involved in planning, implementation and evaluation activities. This also ensured that stakeholders had a clear understanding of the interrelated nature of farmers' problems. These include declining yields due to falling soil fertility, caused by continuous cereal cropping, deforestation, increasing soil erosion, and frequent drought compounded by increasing *Striga* and **stemborer**. These are exacerbated by non-availability and non-affordability of improved seed, fertiliser and pesticides as well as low output prices.

ii) Validation of farmer selected pest and **soil fertility management** options suitable for lowland maize production areas, through farmer testing. This was based on participatory technology development (PTD) of appropriate Open Pollinated (OPV) maize varieties (TMV1, Syn98 and Syn White), grown in rotation with green manure crops (***Canavalia*****,** ***Mucuna*** and ***Crotalaria***) and low cost methods of controlling stemborer (neem and napier grass) as well **rain water harvesting** to increase soil moisture. Work was undertaken over a three-year, six-season evaluation period. Although early seasons were adversely effected by low rainfall conditions, improved rains in the latter period were critical in the PTD process, whose use ensured the development of appropriate and viable technologies, which were being adopted within the District by project completion.

iii) Improved access to improved maize seed through community based, farmer group managed maize **OPV seed production units**. Ready access to inputs particularly maize seed in small packs had been identified as important in promoting adoption. Seed production on farmer managed plots was validated as an appropriate, low-cost model to improve the availability of seed of improved maize lines. A partnership with a private sector company played a role in stimulating the demand for the improved seed.

iv) Enhanced capabilities of local extension staff, farmers and researchers to provide useful information to farmers through use of PREA and PTD supported by training manuals, and posters for extension workers and leaflets for farmers.

5. ***What is the type of output(s) being described here?***

Please tick one or more of the following options.

Product	*Technology*	*Service*	*Process or Methodology*	*Policy*	*Other Please specify*
X Improved seed	**X Management practices**		**X PREA/PTD**		

6. What is the main commodity (ies) upon which the output(s) focussed?

Could this output be applied to other commodities, if so, please comment

The main commodity was maize, but the process used is designed to identify and focus on farmer's priority problems in a process of participatory technology development. It could therefore be applied to other commodities and management practices. The problem of soil fertility and *Striga* is a regional problem in East and southern Africa affecting cereal (maize, upland rice, sorghum and finger millet) crops of resource poor small scale farmers who cannot afford to purchase inorganic fertilizer. Application of legume/cereal rotations validated by the projects described in this dossier can benefit these cropping systems, although choice of the green manure or pulse species will vary with environment.

7. ***What production system(s) does/could the output(s) focus upon?***

Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	*High potential*	*Hillsides*	*Forest-Agriculture*	*Peri-urban*	*Land water*	*Tropical moist forest*	*Cross-cutting*
X		**X**	**X**				

The area was originally identified as having high potential, but it soon became clear that the range of agro-ecological zones in the target area although all below 1000 masl included hillsides, semi-arid and some forest-agriculture with only limited areas of high potential with rainfall distribution proving particularly problematic.

8. ***What farming system(s) does the output(s) focus upon?***

Please tick one or more of the following options (see Annex B for definitions). Leave blank if not applicable

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

9. ***Clustering these outputs***

How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other

*sources (RNRRS and non RNRRS)? (**max. 300 words**). Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.*

Outputs from this source include:

- Use of legumes-green manures for soil fertility improvement and *Striga* control.
- *Striga* tolerant maize lines.
- Use of neem and Napier for stem borer control.
- Rain water harvesting that includes the use of Napier.
- Local production and distribution of improved OPV maize suited to the environment with tolerance to Striga.
- A Participatory Research and Extension approach incorporating participatory technology development
- Extension and training material

This source could be clustered with the following:

Title	R number	Lead organisation	Lead person
CPP			
Improved methods for management of *Striga*	R6921	University of Sheffield	Prof M Press
Green manure to control Striga	R8436, R8194, R 7564	ARI-Kilosa, Tanzania	AM Mbwaga
Promotion and dissemination of integrated pest and soil fertility management strategies to combat Striga, stemborer and declining soil fertility in the Lake Victoria basin	R8449, R8212	ICIPE	Zeyaur Khan
NRSP			
Integrated land management of Striga and low soil P (based in Kenya).	R7962	Imperial College Wye, UK	Colin Poulton
Rain water harvesting	R8088, R8116	Sokoine University of Agriculture, Tanzania	Henry Mahoo
DFID's CRF			
Reducing poverty through improved *Striga* Control [1]	R7864c	IITA, Ibadan, Nigeria	David Chikoye

[1] This project was concerned with both *Striga* and *Imperata* control. In this case only Striga is noted.

Those under CPP and NRSP have been selected as being located in east Africa and include outputs that are concerned with *Striga* and associated land management and could add value to those outlined in this dossier. Further links with work undertaken in Nigeria by IITA, funded by DFID's competitive research facility' also offer scope for rotating maize with other legume crops, notably soybean, groundnuts and cowpeas that cause suicidal

germination of *Striga* seed. In addition the availability of other *Striga* tolerant OPV maize varieties from IITA could be important in the battle against *Striga.* The modification of extension material developed by R7864c for use in East Africa has already been an advantage.

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*

*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

Outputs were validated by farmer groups testing the selected technologies on their own fields under their own management. The PREA approach involved both mid and end of season evaluations, concentrating on comparing agronomic aspects during mid season and evaluating yield, benefit and cost effectiveness at the end of season. Group discussions and participatory budgeting were facilitated by the research team. Yield data collected from individual farmers was used in a statistical and economic validation, sites being used as replicates. Training in use of rain water harvesting techniques was provided by the NGO INADES, after which farmers were encouraged to adopt those options they considered appropriate. Validation was undertaken during mid season PTD evaluations.

Groups in four core villages actively participated in the research over six seasons. In the final two seasons after training of village extension workers and lead farmers from each research group, six more villages participated as part of a pilot scaling out initiative led by the Muheza District Council. Each farmer group comprised +/-20 members, including both males and females in a range of age groups. Individual farmers were volunteers from existing farmer associations, rather than being purposively selected. They would be described as "moderate" poor according to the RIUP definition of poverty grouping and moderate and poorly resourced farmers according to local people's own definition. All had their own land though in varying sizes and held under customary tenure.

Maize yield increases of up to 147% were achieved over a two year period from the green manure-maize rotation compared with continuous maize. The preferred green manure varied in different locations. *Canavalia* was ranked best overall, with *Mucuna* second and *Crotalaria* third, indicating the need for ongoing local farmer experimentation in different agro-ecological zones. In fact some farmers had started adapting the technologies in a further process of testing, including relay planting of *Canavalia* and *Crotalaria* in maize towards the end of the growing season. With regards stemborer chemical control with endosulphan was the most effective (150% increase in productivity) with neem second (130%) and napier third (70%), providing different options for different farmer resource groups, catering for those without cash to purchase chemicals.

Market studies (Akulumuka and Hella, 2003) had confirmed that there were very few input supply agents, with inputs rarely being promoted and suppliers having little knowledge of the inputs they sold. Although greatest demand was for improved seeds, these were also rarely available and when available, this was in large pack

sizes, when greatest demand was for smaller packs. This demand was initially met by a private seed company supplying TMV-1 in two-kg packs. However other varieties, notably Staha, Syn White and Syn 98 also proved popular and many farmers expanded the area planted by using seed saved from either trial plots or seed sold or given to them by neighbours. Three of the farmer research groups (Mtakuja, Mbambakofi and Mapatano) initiated seed production of TMV-1 and/or Syn 98. Training was provided on appropriate seed production practices and the process monitored to learn lessons for scaling up.

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

Outputs were validated in ten villages in Muheza District, Tanga Region in the eastern lowland zone of Tanzania (Table 1). This included within Muheza semi-arid, hillsides and forest-agriculture interface smallholder rainfed farming systems, primarily with moderate poor male and female farmers. In this area maize is the major food crop, occasionally inter-cropped with cowpea. Manual tillage with hoes is universal with crops planted on the flat. Casual labour opportunities are available on nearby sisal estates, otherwise households are dependant in their smallholdings or remittances from migrant labour. This is a bimodal rainfall area with the short *vuli* season (± October to January) and the longer *masika* season (± March to July).

Table 1: Participating villages and technologies validated

	Nov 02 -Jan 03	**March -July 03**	**Nov 03 -Jan 04**	**March -July 04**	**Nov 04 -Jan 05**	**March -July 05**
Villages	*Vuli*	*Masika*	*Vuli*	*Masika*	*Vuli*	*Masika*
Mtakuja and	GM	M	GM	M	GM	M
Mbambakofi	-	GM	M	GM	M	GM
		SB		SB	SB	SB
				RWH	RWH	RWH
Mapatano and	-	GM	M[2]	GM	M	
Paramba	-	-	GM	M	GM	
				RWH	RWH	
Songa Kibaoni, Songa Kilongo, Potwe, Masuguru, Ngomeni, and Mkanyageni					M/GM [1]	M/GM [1]

GM=Green Manure, M=Maize, SB=Stemborer, RWH=Rain Water Harvesting.
[1] Expansion with TMV-1, Syn 98 and Syn White maize seed and *Crotalaria*

Green manures and maize varieties were evaluated over a three-year, six-season period with stemborer control and rain-water harvesting tested for three and four seasons respectively. The short (*vuli*) and long (*masika*) rains in both 2003 and 2004 were well below average with very poor distribution resulting in maize crop failure in 2004 *masika* season. Better rains in the 2004-5 *vuli* and 2005 *masika* season provided suitable conditions to asses the impact of technologies on maize productivity. The rainfall variability experienced, although less than long term means remains typical for the district. This provided challenging conditions for both farmers and researchers to assess the risk associated with the improved practices.

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used?*
*Please give a brief description **(max. 250 words**).*

Project partners are using the project findings and approaches in implementing new development activities in ways that are appropriate to local conditions. This has given impetus to the work of ARI-Ilonga and ARI-Mlingano as well as underlying the importance of use of participatory research and extension approaches by the Muheza District Council (MDC). Project activities have stimulated a demand for *Striga* tolerant maize varieties and green manure seed for distribution in small packs that farmers can afford.

It is envisaged that Tanzania's Agricultural Services Development Project (ASDP) will initiate operations in Muheza from 2007. This project has therefore worked closely with the District Council in preparing the ground for the Districts involvement in ASDP. As a result outputs reported in this dossier are likely to assist in increasing demand from farmers in the District for ASDP support. However some additional support will need to be provided to ensure that the process approach is continued, monitored and adapted to fit local circumstances. This will be particularly important for monitoring and evaluation of the collaborating institutions success in achieving the longer-term benefits of the processes implemented, if optimum benefit is to be achieved.

*13. **Where** are the outputs currently being used?*
*As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

The outputs are being used primarily in Tanzania, with similar PREA approaches being piloted in Nigeria, initially through R7864c in Kaduna State where low soil fertility and Striga infestation are major problems (Emechebe *et al*., 2004, Ellis-Jones *et al*., 2005, Franke *et al*, 2006). This pilot was subsequently expanded on a larger scale in Borno State also in lowland maize production areas through a CIDA-funded project [2] with additional attention being given to community institutional and marketing aspects (IITA, 2006).

In Tanzania activities expanded from the original four research villages in Muheza District to a further six villages during the life-time of the project. This has subsequently been increased to 30 villages. The outputs being promoted include TMV-1 maize seed, *Canavalia* and *Mucuna.* Unfortunately *Crotalaria* seed is in short supply and is not being promoted despite its suitability for the moister more temperate parts of Muheza. Limited quantities are being sourced from other Districts (Kyela and Peramiho in particular).

Mtakuja, Mbambakofi and Mpatano villages are continuing with maize seed multiplication (TMV-1 and Syn 98) although production figures are not presently available. Muheza District Council (MDC) and have budgeted modest funding (Tsh 1.2million equivalent to £600) to support local seed production in the District during the 2006 *vuli* season.

[2] PROSAB (Promoting Sustainable Agriculture in Borno State) managed by IITA is currently working with over 300 farmer groups using a PREA approach to resolve Striga and soil fertility problems. Promoting community based seed production and developing market linkages form key components of project activities.

14. What is the scale of current use?

Indicate how quickly use was established and whether usage is still spreading ***(max 250 words).***

After project completion, MDC continued to promote the project's outputs in 30 villages in the District. Although no detailed statistics on current use are available from the 30 villages, reports from lead farmers and extension workers in two villages demonstrate considerable success of farmer-to-farmer extension in promoting new groups and interest in the technologies (Table 2). At both villages new groups had acquired green manure and maize seed for testing and farmers were requesting more seed, which was made available for sale in Mbambakofi.

Table 2: New farmers groups in two villages testing technologies

Village/ Sub village	Number of new groups	Total participants
Mbambakofi		
Mwele Mwenye	3	48
Mwanyumba	2	30
Maramba A	1	10
Kumbe	1	15
Tewe	1	18
Kata Mwinduro	1	15
Mtakuja		
Mtakuja (new women's group)	1	14
Lugongo (women's group)	1	12
Mapinduzi	1	13
Maramba B	1	13

In addition visits to Muheza farmer groups were arranged for farmers from Kilombero, Ulanga, and Kilosa Districts, all in the Eastern Zone to encourage farmer to farmer learning and extension of seed production and green manure management practices. Within Muheza there has been increasing demand for *Crotalaria* seed (purchased from Kyela) and Syn 98 maize seed (purchased from ARI-Ilonga) for planting in the 2006 *vuli* season for further scaling out of the outputs to more new villages.

No detailed follow up has been possible to ensure an appropriate process is being followed or to estimate the present scale of farmer use of the technologies.

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

Although there is no simple recipe for promoting uptake, the process followed gave attention to both institutional and community issues. This included the involvement of all stakeholders in a PREA process, where farmers

identified and prioritised the problems with which they were faced. At the same time potential solutions jointly agreed by farmers, extension and research personnel, were implemented by farmers and then jointly evaluated by all stakeholders. This process required commitment from both research and extension organisations involving greater emphasis on facilitation and less on teaching as well as recognition of the key role that farmers must play in the research and development process. A key partnership was that of MDC whose extension staff participated throughout, benefited from training and developed the capacity to continue to promote farmer testing and adoption of technologies and most importantly maintain activities after the research was completed. Other facilitating factors included:

- Building institutional and community capacity in participatory approaches.
- Ensuring that institutional roles were well defined.
- Ensuring close integration of research and development activities.
- Ensuring feed back to local communities after researcher analysis of results.
- Ensuring farmers participating in the process were representative with the capacity after training to lead and communicate with other farmers and promote farmer-to-farmer extension.
- Ensuring ready availability of training and extension material that could be used as an integral part of a communication process.
- Ongoing access to OPV maize and green manures seed.

Current Promotion

D. Current promotion/uptake pathways

*16. **Where** is promotion currently taking place?*
*Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion **(max 200 words).***

During the final phase of the project Muheza District Council, indicated that it wished to scale-up both the methodologies and the technologies to other villages under their jurisdiction. To facilitate this process, 10 village extension workers and lead farmers received training in PREA, *Striga* control practices, seed production and rain water harvesting. At the same time the District Council included similar but expanded activities in their five-year strategic plan, the first year of which is being currently implemented. At the same time a number of other District Councils within the Tanga Region who have similar problems were keen to initiate similar activities. These include Pangani, Handeni, Korogwe, Tanga, Morogoro, Kyela, Mbozi and Chunya District Councils

17. What are the current barriers preventing or slowing the adoption of the output(s)?
*Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. **(max 200 words)**.*

Pilot scaling-out was supported by the CPP projects that had undertaken validation in Muheza. Muheza is fairly typical of other districts in the coastal lowlands of Tanzania in terms of the capacity of the District Council Agriculture team to promote agricultural technologies. Human resources are limited as are funds and essential facilities such as transport. This lack of capacity limits the pace of promotion.

In addition validated technologies for improving maize productivity depend on continuing supplies of quality seed of new maize lines. At present Syn 98 and Syn White maize varieties can not be formally disseminated until they are released as registered cultivars by the Tanzania Official seed Certification Institute (TOSCI). The registration process involves submission of trial results by maize breeders followed by a season of independent verification trials undertaken by TOSCI. Once this process has been completed multiplication of foundation seed by Government's seed agency are required for local seed growers (Annex 2). Until these components are in place adoption will be limited to farmer to farmer spread on a local scale.

Further once new seed is formally released, accepted and being grown, the possibility of total loss of seed [3] through drought requires measures such as "community seed banks" to secure seed during such situations.

[3] During CPP supported activities two crop failures in five seasons resulted in total loss of seed, which had to be replaced by project intervention.

18. What changes are needed to remove/reduce these barriers to adoption?
This section could be used to identify perceived capacity related issues ***(max 200 words).***

Given the limited human resource capacity at district council level it will be important to harness local partnership to increase the pace of promotion and to reach a larger number of communities which can in part be achieved through i) improved collaboration, networking and partnership, ii) ensuring partners are adequately resourced, have clearly identifiable roles for which they are accountable and iii) most importantly ensures that community level organisations are able to sustain a process of innovation and, iv) input and output markets are effectively working. District level staff and village extension officers can make most impact working with farmer groups and their elected lead farmer representatives using PREA approaches. The use of training manuals prepared for Muheza by the CPP projects will assist with this but an on-going partnership for training between zonal research and district council extension staff will be essential.

Such an approach reinforces recommendations made by the Research and Analysis Working Group (R & AWG) of the Poverty Monitoring System on behalf of the Government of Tanzania which suggests consideration of new institutional arrangements, which would encourage smallholders to become better organised through "producer associations in integrated systems of production, extension services, transportation, processing and marketing" (Annex 1). We believe this is a worthy aim and although well tested with cash crops such as coffee, there is scope for such arrangements to be initiated for basic food crops

For instance community and individual farmer seed production has shown its potential, but requires training of farmers and facilitation of the Quality Declared Seed process to maintain seed quality. At the same time a commitment will also be needed from Zonal level and the GoT seed agency to complete registration of new maize lines and undertake multiplication of foundation seed. The problem of loss of seed as a result of drought requires measures such as "community seed banks" to secure seed during such situations. In an environment where most farmers recycle their own maize grain as seed, the introduction of improved seed, including OPV maize varieties is unlikely to be resolved by the private sector [4] acting on its own. It will require a joint initiative by with public sector, in this case Muheza District Council, where the public sector provides logistical support to the private sector for periodic introduction of improved cultivars, previously validated by research facilitated PREA activities.

[4] Many private seed companies want to sell only hybrid maize seed, seeing little profit in OPV maize varieties

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

Scaling up the benefits of project outputs needs to be considered in at least three phases (Ellis-Jones et al., 2005, Hagmann et al, 1998, Middleton et al., 2004, Gundel et al, 2003).

- an orientation and action planning phase, where i) communities are facilitated by extension agents to have a common understanding of their problems, set priorities, agree action plans with targets for problem resolution and productivity increases, together with appropriate indicators, ii) a strategy for ensuring sustainability is developed by stakeholders that ensures resource availability for capacity building, communication, monitoring and evaluation, with role and cost sharing agreements within partnerships. At the same time realistic time horizons for establishing support mechanism at community level need to be established.

- An implementation phase where the capacity of local institutions is improved through training, collaboration, networking and alliances where institutional roles are defined and undertaken. During this stage it is crucial that priority community constraints are addressed using participatory extension approaches that test and demonstrate technology options appropriate for all poverty groupings. Local monitoring and evaluation (M&E) reinforced by appropriate awareness raising and training are essential components. In addition those institutions working at community level must be accountable to the communities with which they are working.

- A sustainability phase that ensures long term sustainability. This requires that communities agree from the outset a timeframe for achieving their goals. District Councils will need to commit resources to improving local organisational capacity, ensuring farmer access to inputs and providing technical support. Although these are essential for ensuring sustainability, they must be established in the implementation phase.

- In addition M&E and impact needs to be assessed using indicators developed at planning stage with mechanisms established to provide feedback on issues and problems as they arise to communities and district administrations.

Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place?
This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

No formal poverty impact study or poverty mapping work has been undertaken. However an economic cost-benefit analysis was undertaken based on results from farmer trials which are included in the final technical report for R8452. Productivity increases quoted in this dossier are taken from this source.

In addition discussions were held towards the end of the project in all 10 (four research and six extension) villages with the farmer groups participating in the project to establish the extent of distribution of green manure and improved OPV maize seed. Again results are detailed in the FTR for R8452.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

The discussions with farmer groups provided an indication of the adoption of green manure and new maize variety technologies as a result of project activities (Table 3).

Table 3: Numbers of men/women involved in discussions and giving or selling seed (January 2006)

Village	**n=**	**Men/women**	**Canavalia**	**Mucuna**	**Crotalaria**	**TMV1**	**Syn 98**	**Syn White**	**Staha**
Older villages									
Mbambakofi	16	12/4	5/2	3/2	4/1	7/4	6/2	1/0	4/0
Mtakuja	11	5/6	5/4	1/2		5/5	4/3	0/0	1/0
Mapatano	9	5/4	5/3	2/2	0/1	2/3	1/1	0/1	0/2
Paramba	11	7/4	2/0	1/0	1/0	1/0	1/0	1/0	2/0
Sub totals	*47*	*29/18*	*17/9*	*7/6*	*5/2*	*15/12*	*12/6*	*2/1*	*7/2*
New villages									
Kilongo	9	5/4		1/1		1/2			
Mashewa	14	3/11	0/1	0/1			2/8		
Ngomeni	28	11/17				1/2	1/4		
Sub totals	*51*	*19/32*	*0/1*	*1/2*		*2/4*	*3/11*		
Totals	***98***	***48/50***	***17/10***	***8/8***	***5/2***	***17/16***	***15/18***	***2/1***	***7/2***
		49%/51%	28%	16%	7%	34%	34%	3%	9%

Discussions showed that sales or gifts of *Canavalia* were greatest, followed by *Mucuna* and lastly *Crotalaria* further validating the results of the research. Interestingly the sales or gifts of new OPV maize lines was considerably greater than green manures, with TMV-1 being the most popular, Syn 98 not far behind, restricted only by seed availability with some Syn White and Staha distribution. This demonstrated not only the high demand for improved maize but also that improved maize cultivars were likely to be adopted faster than new management practices.

Where TMV-1 maize had been grown during drought periods, farmers indicated that this was the only cultivar that had provided a yield. All local cultivars had failed completely. Food security was seen as a major benefit. In addition farmers felt that working as a group in seeking solutions to their own problems improved social cohesiveness in the community. This was supported by a study by Juma (2006), which showed that participation in trials/demonstrations were the greatest contributory factor to promoting further adoption, either on own fields or through farmer-to-farmer extension.

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Recent estimates from the International Fertiliser Development Centre have drawn attention to the scale of plant nutrient loss through erosion and nutrient mining in sub-Saharan Africa. While average fertilizer use in Tanzania was less than 2 kg ha^{-1} in 2002, loss of nitrogen, potassium and phosphorus was estimated at 61 kg ha^{-1}, one of the highest annual rates of loss in Africa (Henao and Baanante, 2006):. As few poor farmers are in a position to purchase fertiliser, which is rarely sold in stores in Muheza in any event, the use of a low-cost organic approach, one of the key outputs described in this dossier is an essential alternative. Trials in Muheza have demonstrated that *Canavalia* dry biomass production levels of more than 4 t ha^{-1} can be achieved. Regular incorporation of these levels of organic material will add up to 120 kg ha^{-1} nitrogen AND also improve soil water holding capacity. As cereal yields have fallen in Muheza so farmers have cleared additional fields from forest. As the legume green manure rotations can reverse the yield declines experienced in the area over recent years they will help relieve pressure from farmers expanding cultivation and further deforestation. Rain water harvesting and the use of napier fodder field margins for trapping stemborer moths will have a direct environmental benefit through improved soil moisture and a reduction in soil erosion. A further advantage of adoption of green manures, either in rotation or as relay inter-crops with maize will be that more biomass will be carried on agricultural land than is now the case. This will result in longer periods of annual carbon sequestration from atmospheric CO_2 compared to where land is under bare fallows. Adoption of such modifications to the cropping pattern a broader landscape scale have been suggested as a possible contribution to mitigating increased levels of CO_2 (Vagen TG *et al.* 2005).

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

The outputs provide an organic approach to improving agricultural productivity and no adverse environmental impact is foreseen.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of

natural disasters and increase their resilience? ***(max 200 words)***

This answer is included in that for Q22

Current climate models suggest an increase in mean annual temperature of 2-4^{0}C in Tanzania by 2100 with decreased and more variable rainfall and a consequent increase in the variability of agricultural productivity. Average maize yield in Tanzania is predicted to fall by up to 33% by 2075 if actual atmospheric CO_2 concentrations and temperatures are in line with these models (Downing, 2002). Under this scenario farmers will need to optimise land productivity more than ever. Rotation with leguminous crops is a low cost approach that does not expose farmers to losses of cash investment as is the case when droughts follow use of fertiliser. Greater attention needs to focus on protecting land from erosion in periods of heavy rainfall on the one hand AND maximising soil moisture conservation for periods of drought but labour intensive approaches (contour bunds, terraces, etc) are only likely to find favour if accompanied by practices such as green manuring and simple water harvesting practices that provide a rapid return to investment.

Annex

References

Akulumuka V., and Hella J., 2003. Input-output chain for smallholder maize growers in Muheza District, Tanzania. Survey report. ARI-Ilonga and Sokoine University of Agriculture.

Blackie M., Farrell G., and Giga D., 2000. *Programme development review of maize pest management research in East and Southern Africa*. East Malling, Kent: Crop Protection Programme.

Dashiell, K., di Umba, U., Kling, J.G., Melake-Berhan, A., Berner, D.K., 2000. Breeding for integrated management of *Striga hermonthica*. In: Haussman, B.I.G., Hess, D.E., Koyama, M.L., Grivet, L., Rattunde, H.F.W., Geiger, H.H. (Eds.), Breeding for Striga resistance in cereals, 273-281, Weikersheim, Germany: Margraf Verlag.

Downing, T.E. (2002). Protecting the vulnerable: climate change and food security. eds. Brining, J.C. and Downing, T.E. *Managing the Earth: The Linacre Lecture.* (Oxford University Press ,Oxford, UK) pp 5-34.

Ellis-Jones J., Schulz S., Chikoye D., de Haan N., Kormawa P., and Adedzwa D., 2004. Participatory research and extension approaches: A guide for researchers and extension workers for involving farmers in research and development. Research Guide 71. International Institute for Tropical Agriculture, Ibadan, Nigeria and Silsoe Research Institute, UK.

Ellis-Jones J., Schulz S., Douthwaite B., Hussaini M.A., Oyewole B.D., Olanrewaju A.S., and White R., 2004. An assessment of integrated *Striga Hermonthica* control and early adoption by farmers in northern Nigeria. Experimental Agriculture 2004, Volume **40**, pp. 353-368

Emechebe A**.,** Ellis-Jones J., Schulz S., Chikoye D., Douhwaite B., Kureh I., Tarawali G., Hussaini M.A., Kormawa P., and Sanni A., S.2004. Farmers' perceptions of the *Striga* problem and its control in Northern Nigeria. Experimental Agriculture, Vol: 40, 215-232.

Franke A.C., Ellis-Jones J., Tarawali G., Schulz S., Hussaini M.A., Kureh I., White R., Chikoye D., Douthwaite B., Oyewole B.D., Olanrewaju A.S., 2006.Evaluating and scaling-up integrated *Striga*

hermonthica control technologies among farmers in northern Nigeria**.** Crop Protection 25 (2006) 868-878*.*

Gündel S., Hancock J., and Anderson S., 2001. *Scaling-up strategies for research in natural resources management. A comparative review.* Chatham, UK. Natural Resources Institute.

Hagmann, J., Chuma E., Murwira, K., and Connelly, M. (1999). *Putting process into practice: operationalising participatory extension.* In ODI Agricultural Research and Extension (AGREN) Network Paper No. 94. Overseas Development Institute, London. http://www.odi.org.uk/agren/papers/agrenpaper_94.pdf..

Hassan R.M., Mekuria, M. and Mwangi, W. *2002 Maize breeding research in Eastern and Southern Africa: Current status and impacts of past investments made by the public and private sectors, 1966-1997*. Mexico, D.F.: International Maize and Wheat Improvement Centre (CIMMYT). Web site.

Henao and Baanante, 2006. Agricultural production and soil nutrient mining in Africa: Implications for resource conservation and policy development. International Fertilizer Development Center)

IITA, 2006. Promoting Sustainable Agriculture in Borno State. PROSAB http://www.iita.org/cms/details/cereal_legume_project_details.aspx?newsid=269&rid=15577&pg=o&activity=Cereal%20and%20legume%20systems&mainzoneid=67

Juma W., 2006. Farmers' knowledge and information flow towards integrated pest and soil management technologies: A case study of maize farmers in Muheza district. Ministry of Agriculture and Food Security. ARI-Ilonga report.

Kaliba, A.R.M., Verkuijl, H.and Mwangi, W. 2000. Factors affecting the adoption of improved maize seeds and use of inorganic fertiliser for maize production in the intermediate and lowland zones of Tanzania. *Journal of Agricultural and Applied Economics,* **32**: 35-47.

Lagoke, S. T. O., Parkinson, V., Agunbiade, R. M., 1991. Parasitic weeds and control methods in Africa, In: Kim, S. K. (Ed.), Proceedings of the International Workshop on Combating *Striga* in Africa. IITA, Ibadan, Nigeria, pp. 3-14.

Masuki, K.F.G., Meliyo, J.L., Mbogoni, J.D.J, Ley, G.J. and Senkoro. C.J. 2001. Integrated soil fertility management approach in the eastern zone: The Case of Muheza District, Tanga, Tanzania. Paper presented in the NZ-ISFM workshop held in Tanga on 22-23rd November 2001. Mlingano, Tanzania: Mlingano Agricultural Research Institute.

M'Boob, S. S., 1989. A regional programme for *Striga* control in Africa. In: Robinson, T. O., Broad, H. R. (Eds.), Proceeding of FAO/OAU All-Africa Government consultation on *Striga* control, Maroua, FAO plant production and protection paper, 96, 190-194.

Middleton T., Antonio M.R., Ellis-Jones J., Garforth C., Goldey P. 2002. Best practice guidelines: Scaling-up successful pilot experiences in natural resources management. Report for NRSP Hillsides systems. .

Oikeh, S. O., Weber, G., Lagoke, S. T. O., Awad, A. E., 1996. Assessment of yield losses from *S. hermonthica* in farmers' fields in the northern Guinea savanna. Nigerian J. Weed Sci., 9, 1-6.

Riches, C.R. (Ed.) 2000. *Striga distribution and management in Tanzania*. Proceedings of a stakeholder workshop held in Dar es Salaam, September 1999, Chatham, UK: Natural Resources Institute.

Sauerborn, J. (1991). The economic importance of the phytoparasites *Orobanche* and *Striga. Proceedings of the 5th International Symposium of Parasitic Weeds, Nairobi, Kenya*, 1991, 137–143.

Schulz S; Hussaini M A; Kling J G; Berner D K; Ikie F O., 2003. Evaluation of integrated *Striga hermonthica* control technologies under farmer management. *Experimental Agriculture*. **39,** 99-108

Tanzania Government, 2005. *Poverty and human development report*. Research and Analysis Working Group (R & AWG) of the Poverty Monitoring System, Poverty Eradication Division at the Ministry of Planning, Economy and Empowerment.

Vagen T.G., Lal R., and Singh R. 2005. Soil carbon sequestration in sub-Saharan Africa: A Review. *Land Degradation and Development* 16: 53-71.

Wickama, J.M., Veldkamp, W.J., Ley, G.J. and Nyaki, A.S. 2000. Integrated soil fertility and plant nutrient management research in Tanzania: The National Soil Service experience. Paper presented at the INCO-CA Workshop on diversity, Policy and Scaling-up held in Entebbe, Uganda from 15-20 May 2000.

Annex 1: Agriculture, income poverty reduction and rural growth
(Tanzania Government, 2005)

GDP growth rates overall, and in agriculture, have increased in recent years, with especially positive growth in 2004 when GDP overall grew by 6.7 per cent and agricultural GDP by 6.0 per cent. The extent to which this growth has reduced poverty is mitigated by changes in inequality and may be affected by international and rural-urban terms of trade. Growth has had a greater impact on poverty reduction in areas where the proportion of households with incomes below the poverty line is lowest, notably in Dar es Salaam. Projections suggest that rural poverty may have been reduced somewhat, but there are uncertainties around data and modelling assumptions.

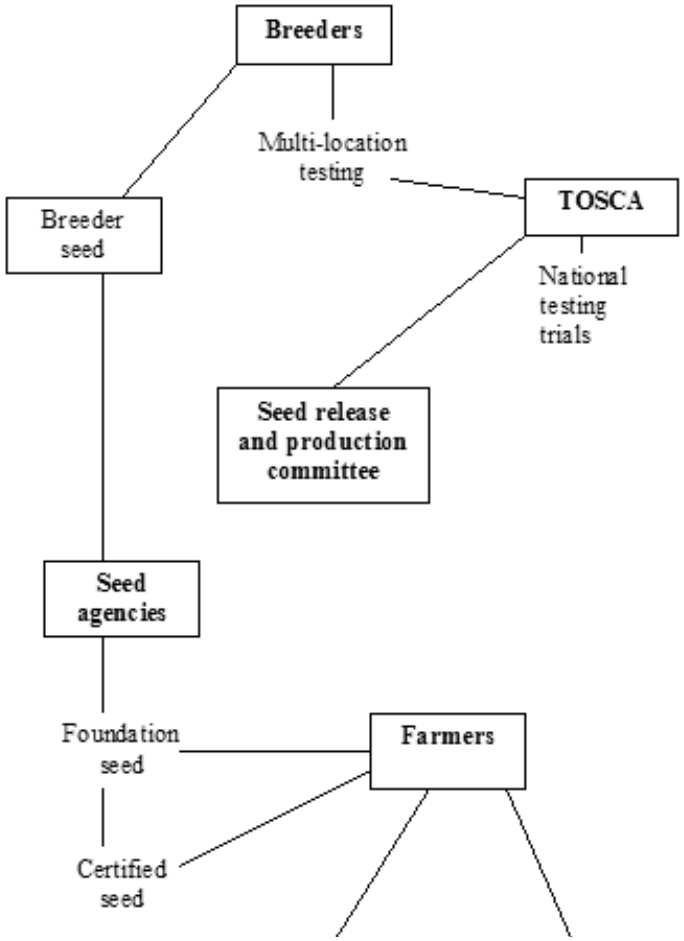
If poverty reduction targets are to be met, it is clear that rural poverty reduction needs to be accorded critical priority. Since poverty reduction is sensitive to growth, a strategy must be put in place that ensures high growth for a sustained period of time. This calls for two things to happen. First, agriculture must grow at a sustained rate of at least 6 per cent per annum. Second, growth needs to be broad based and strategies that promote such broad based growth must be developed and implemented.

Agricultural production has fluctuated around low levels for most food and cash crops. Similarly, productivity has remained low, especially among smallholder farmers who constitute the majority of agricultural producers in Tanzania. The quality of export crops has remained low relative to export crops produced by neighbouring countries. A combination of low production, low productivity and low quality of agricultural produce has significant limiting effects on rural growth and therefore on poverty reduction. Major factors contributing to this situation include low levels of education and literacy among smallholder farmers, exposure to variable weather conditions, price shocks, limited investments and weak institutional arrangements. These structural problems justify the consideration of alternative institutional arrangements, which would involve smallholders becoming increasingly better organised - in forms generally referred to as producer associations – and in integrated systems of production, extension services, transportation, processing and marketing. Such an integrated approach could help overcome many of the constraints faced by smallholders by encouraging increased production and productivity, raising prices by increasing the quality of produce and by taking advantage of supply chain linkages and ensuring greater access to productive opportunities. Producer associations can play a critical role in safeguarding the interests of smallholders. They also provide a vehicle to ensure a steady supply of produce for processing and marketing. Investment in cooperative producers' associations could encourage vertically integrated enterprises of production, processing and marketing, adding value to members' produce. The democratic development of such associations needs to be accelerated under the programme for small and

medium-scale enterprises and the Cooperative Reform and Modernisation programme.

There is much the Government can do to encourage the development of such integrated systems. Macroeconomic stability must be sustained, more investment needs to be directed to improving rural infrastructure, action should be taken to reduce the cost of doing business, and regulatory mechanisms must be strengthened. Government's own capacity needs to be enhanced to keep up with global changes to help the economy thrive within the international environment in which it is operating. Improvements in the rural infrastructure are critical – roads, power, communication, water. The development of integrated producer systems will place additional demands on the infrastructure compared with the demands of current systems of production. The more widespread use of cost effective technologies, especially in road improvements and maintenance and in the provision of improved water supplies, will be an important part of a strategy to ensure equitable access. Households and individuals should be enabled to take full advantage of the emerging opportunities. This is only possible if they are appropriately educated and healthy, and this means that efforts to ensure equitable access to basic social services must be continued and sustained.

Annex 2: Seed production and certification in Tanzania



Basically “Breeder seed” was passed to “Seed Agencies” to produce “Foundation Seed” and “Certified Seed”. This can only occur after TOSCI has authorised seed release after consideration by the Seed Release and Production Committee. Foundation seed can also be sold to farmers, who can also produce “Certified Seed” or “Quality Declared Seed” (QDS), provided they meet certain minimum standards. “Farmer Seed” is unregulated and is grain that is used for seed purposes.

Annex 3: Requisites for faster scaling-up of activities in Muheza
Project hand over notes to MDC at project completion

Institutional issues to promote faster adoption

1. Good leadership from the Village Extension Officer (VEO) and within each farmer group with strong backing from the village leaders. We identified a need for training in leadership and communication
2. The ability of the VEO to be a good facilitator, rather than a teacher. We were concerned about a lack of clarity on their roles and lack of a work plan. We identified a need for training in participatory extension methods with increased support from the District in planning and implementing effective work programmes. We envisaged that this should follow the PREA cycle of social mobilisation, planning, trying out and evaluating new ideas and evaluating the process.
3. Dynamic and strong farmer groups. We identified a need for training in group functions and individual responsibilities and roles.
4. Improving links with the market, to ensure crops could be sold and inputs purchased.

Technology concerns

With regard to the technologies tested, we identified the following issues:

Green manures

- A need to look at means of improving their attractiveness, such as relay cropping.
- Concerns about seed supplies especially after periods of drought. In the lifespan of the project 3 bad droughts (over six seasons had been experienced). Local seed banks should be considered.
- A need to look at the recommended seed rates especially for Canavalia (100 kg per ha looks high-see the extension leaflet).
- Exchange visits should be arranged by EZCORE in conjunction with Inades.

Use of neem and Napier for stemborer control

- Shortage of suitable Napier grass was a constraint to scaling up and local nurseries should be encouraged.
- Use of neem offered economic opportunities which could be promoted.

Improved maize seed

- Although farmers are keen to use improved seed, they are often unwilling to pay for it. Ongoing training in seed selection for both community and individual farmers should be provided, but farmers should be encouraged not to recycle their seed beyond three years.

- Concerns about drought and loss of seed can be overcome through the encouragement of seed banks.
- In view of the problems experienced with MTI, and the difficulties of encouraging the private sector in an area where there was very limited use of improved seed, it would be necessary for the District Council to consider special arrangements with the private sector for supply of new seed, possibly providing a subsidy for these purposes.
