**CROP PROTECTION PROGRAMME**

# Project Title: On-farm verification and promotion of green manure for enhancing upland rice productivity on Striga infested fields in Tanzania

**R 8436 (ZA0660)**

# FINAL TECHNICAL REPORT

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## Executive Summary

**Project Purpose**: This was: "Promotion of strategies to minimise impact of target pests in rice-based Land-Water interface cropping systems, for benefit of poor people". Since 2002 project R 8194 had been evaluating and promoting legumes (the green manure *Crotalaria ochroleuca* or pigeon pea) in rotation with upland rice to improve productivity on *Striga* infested soils. In a 10-month extension of this work the activities aimed to further promote the technology in 13 villages of Kyela and Morogoro Districts, provide additional extension materials, derive policy lessons and assist local agencies plan for up-scaling promotion beyond the life of the project.

**Output 1. Participatory evaluation and promotion of *Striga* management practices:** Participatory monitoring and evaluation of the demonstration programme undertaken by 139 farmers was completed. Median rice yields were increased by 33 and 81% by a one year break-crop of pigeon pea or *Crotalaria* respectively in Kyela. There was a 234% increase in median yields of rice and 241% increase in Maize in Matombo following a crop of *Crotalaria*. During 2005 farmer group members increased the areas planted to green manures on their fields outside the demonstration areas and sold or gave seed to non-participants. Knowledge provided by the project and extension on soil fertility, how to use rotations to reduce *Striga* abundance and reverse yield decline has given farmers confidence to tackle their own problems. By adopting rotations rice yields have been boosted on the poorest fields from 2-3 to 7-8 bags per acre. Farmers believe they are on course to achieve 10 + bags per acre. This will once again make rice production very profitable as there is a strong market and many buyers in Kyela. Individuals believe that use of the rotations has reached the stage of sustained adoption with plots of more than one acre on some farms.

**Output 2. Strategies up-scaling promotion of legume rotations by district councils developed:** Training of extension workers, staff of an NGO, and ward officials on the use of green manures was undertaken. Farmer groups were assisted to strengthen their structures and planning to increase chances of sustainability. Additional extension material developed included a training manual, picture set and series of videos. Collaboration between district council agricultural extension and education staff was strengthened. A primary school programme incorporating knowledge on *Striga* and improvement of soil fertility was supported in 21 villages. A stakeholder workshop included participation of district council policy makers. Subsequently plans were drawn up for up-scaling promotion beyond the life of the project and funds allocated by Kyela District Council and CARE International in Matombo.

**Output 3. Lessons from evaluation and promotion of legume rotations for *Striga* infested land documented:** This study indicated that promotion of *Crotalaria* in Tanzania has previously been un-co-ordinated and lacked a clear process for providing farmers with seed and knowledge. In many cases seed was distributed as far as district offices but did not reach farmers. Key policy implications from work since 2002 are that farmer group learning approaches including exchange visits and demonstration plots are keys to successful promotion. Partnership between district council agricultural extension and education teams to involve primary schools in promotion of agricultural knowledge should be expanded.

**Contribution of outputs:** A technology for increasing cereal productivity of *Striga* infested land has been validated and accepted by farmers with adoption leading to higher yields of rice for which there is ready market demand and of maize of which many families produce too little to be food secure. Increased adoption of legume-cereal rotations has been documented as farmer to farmer extension has gained momentum. The value of the technology and the appropriateness of the dissemination processes and extension materials developed by the project have been acknowledged by policy makers in the project areas leading to the allocation of local funds to scale-up the dissemination process beyond the life of the project. Ten lead farmers will be trained in each 21 villages of Kyela district by the district council.

## Background

The activities described in this report build on previous work (R8194) undertaken in Kyela and Matombo-Morogoro rural districts in Mbeya and Morogoro regions. Upland rice is an important cash crop in many areas of eastern and southern Tanzania, including Morogoro Rural and Kyela districts (Riches, 1999[1]). Under continuous cultivation, rice yields have been in decline in recent years. This is associated with falling soil fertility and an increase in infestation by the parasitic witchweed, *Striga asiatica*. In order to tackle this problem a group of researchers and extensionists initiated on-farm trials in two villages in Kyela in 1996 (CPP project R7564) demonstrating that up to 60% reduction in *Striga* numbers and 45% increase in rice yield can be achieved by applying urea fertiliser (Mbwaga, 2001[2]). Although the farmer groups involved described how they had learnt through this work that *Striga* infestation is associated with low soil fertility they also indicated an unwillingness to adopt the use of urea as a widespread practice. This is largely due to a lack of funds for fertiliser purchase. Although a seasonal credit programme was available in Kyela, operated on a group basis through the district agricultural extension programme, farmers generally considered the terms to be unfavourable. In particular loans were repaid at harvest time when rice grain prices are low. Another approach to managing *Striga* was therefore needed.

The green manure species *Crotalaria ochroleuca,* called Marejea in Kiswahili, has been grown for many years at St Benedicts Abbey, Peramiho, southern Tanzania, where it is used to maintain the fertility of organic gardens. At Peramiho, *Crotalaria* grows up to 2 m in height and has been found to be fairly drought tolerant, recovering well when rain returns. When broadcast as a sole crop growth is vigorous so that weeds are suppressed. This provides a clean entry for the subsequent crop. It was also known from the literature and experimental results from Project R7564 that *Crotalaria* stimulates *Striga* seed germination although it is not a host. This allows the green manure to cause suicidal germination of and reduce the seed bank of the parasite. Seed obtained from Peramiho was distributed to the two farmer groups in Kyela by the research team and was initially planted by participating farmers in 2000. A number of farmers were familiar with *Crotalaria* as it had been included in on-farm trials undertaken in the area a number of years before by Uyole Research Institute. According to farmers in Njugilo village a team from ARI Uyole was active in Kyela in 1989-90 seasons and in near by Mbula village, research was said to have been operational in about 1996 for four seasons. Trials investigated use of *Crotalaria* in rotation with upland rice. However the farmers view is that this was "just an experiment" and there seems to have been limited farmer participation, no follow up promotion or capacity building in extension or target communities. Although farmers had expressed interest in testing the species further, no seed was supplied. Farmers were very impressed by the growth of the plots planted in 2000 by Project R7564, especially those placed on what was judged by the community to be poor, worked out land. Farmers took particular interest in one site where the farmer had planted sufficient *Crotalaria* to allow a comparison in 2001 of rice growth following the green manure compared to that following rice. Farmers observed that no *Striga* emerged on the plot previously sown to the green manure. This yielded 2100-kg $ha^{-1}$ rice compared to 1000 kg where no fertiliser was used and 1600 and 1900-kg $ha^{-1}$ respectively where 25 and 50 kg N $ha^{-1}$ had been applied. At a field day in May 2001 and at a results and planning meeting for 2001/2002 season in November 2001, Kyela farmers selected the green manure plots and requested further support to test the use of *Crotalaria* more widely.

CPP agreed to support further work under project R8194 (2002-2005) designed to promote options for improving the fertility of *Striga* infested fields. The project undertook field demonstration and other promotional activities in two districts of Tanzania. Activities were

[1] Riches C R (Ed.) 1999 *Striga distribution and management in Tanzania*. Proceedings of a stakeholder workshop, Dar es Salaam, 8-9 December 1999. Natural Resources Institute, University of Greenwich, UK.

[2] Mbwaga A M 2001 *Striga* research activities in Central, Eastern, Lake and Southern Highlands Zones of Tanzania: on-station and 0n-farm trials for 2000-01 season. Ilonga Agricultural Research Institute, Tanzania.

extended to four villages in Kyela district and were initiated in Matombo division, Morogoro Rural district in Eastern Zone. Both upland rice and maize yields have been in decline on the steep slopes of this area of the Uluguru Mountains and *Striga* has increased in abundance. The district council in Morongo-Matombo selected two villages to work with.

The project used two routes to promote the soil fertility enhancement for *Striga* management. The major focus was formation of farmer groups, which undertook on-farm demonstrations used as sites for farmer learning. Between 2002 and 2005 groups established and monitored 117 and 122 demonstrations of the legume rice rotations in 8 villages in Kyela and 5 villages in Matombo respectively. Ilonga Agricultural Research Institute had, since 1995, been evaluating pigeon pea cultivars that are resistant to the soil borne wilt disease, *Fusarium udum*, which is widespread in Tanzania. Promising cultivars had been introduced to farmers in Kyela in villages participating with project R7564. Pigeon pea is planted in this area but farmers had reported yields to be generally low. The crop is well known to have potential for increasing soil fertility and enhancing yields of following cereals (e.g. MacColl, 1989[3]) and trials demonstrated the potential of the new cultivars in Kyela. The crop was therefore included in the legume/rice rotations demonstrated by project R8194 as an alternative to *Crotalaria* as it provides an economic grain yield. Farmers prefer to learn from the experiences of other farmers rather than by simply accepting new knowledge directly from extension providers. The project therefore arranged exchange visits for elected lead farmers and village extension staff from the "new" villages in both districts to established groups in Kyela. From the demonstration plots farmers assessed rice and maize planted following the legumes to be more vigorous than continuous cereal. Only one light weeding was needed in rice after *Crotalaria* compared to two or three in continuous rice, *Striga* infestation was much reduced. Rice yield following *Crotalaria* increased more than 80% compared to continuous rice. A steady increase in the number of farmers adopting rice/legume rotation through "farmer to farmer" extension was observed and demand for *Crotalaria* seed out stripped supply. Kyela farmers sold 400kg of seed to neighbours, to villages in Matombo and to farmers participating in project R 8215 in Muheza district. The process of farmer evaluation of green manure, which was initiated by the research team, became increasingly farmer driven.

A second promotion approach used interaction with teachers at village primary schools in both districts. .A total of 21 village primary schools participated in the project by including knowledge on biology and *Striga* management in the agricultural school science curriculum. Schools demonstrated the value of *Crotalaria* and pigeon pea to increase soil fertility and control of *Striga* using songs, plays, poems, traditional dances and setting up demonstration plots with pupils. 2000 copies of a leaflet on the use of *Crotalaria* were produced for use by extension staff, farmers, schools and farmers buying the *Crotalaria* seed. A poster on *Crotalaria* use was also produced and 500 copies distributed to schools, hospitals, churches/mosques, extension offices to increase community awareness. A video was also produced documenting the use of green manure to improve soil fertility and to reduce the impact of *Striga* on the rice crop to allow wider dissemination of the technology.

During 2004 project R 8194 undertook a second season of evaluation/promotion of rice-legume rotations in Kyela and Matombo. This was the first season in which the majority of farmers adopting the practice had planted either green manure or pigeon pea on a field scale (up to 1.5 acres). Rice is harvested in June/July so with the project due to end in March 2005 it would not have been possible to monitor rice yield response under rotation nor to fully explore farmer opinions. CPP therefore agreed to extend funding to January 2006 to allow the full impact of the legumes on cereal crop production to be monitored in 2005. Plans were agreed to strengthen existing farmer groups and undertake additional training of extension staff. The challenge was to accelerate and scale-up adoption by extending promotion to additional communities. The project extension also provided time to develop an exit strategy to allow promotion activities to continue in the future with district council funding.

[3] MacColl, D. 1989. Studies on maize (*Zea mays*) at Bunda, Malawi. II. Yield in rotation with legumes. *Experimental Agriculture*, **25**: 367-374.

**Project Purpose**

The project purpose addressed the CPP output "Promotion of Strategies to minimise impact of target pests in rice-based land-water interface systems, for benefit of poor people". This was the same purpose as for R8194 (2002-2005) for which the work described in this report was a 10 month extension. Work in this period was designed to validate and promote soil fertility management strategies to reduce infestations of the parasitic weed *Striga asiatica* and increase yields of resource poor farmer's upland rice and maize crops. Although originally targeted at upland rice, farmers requested that maize was included when activities were initiated in Matombo.

The specific objectives were:

- To promote the use of legumes to increase soil fertility so that the impact of *Striga* on rice/maize is reduced. This would contribute greater yields and income for households, whose major source of livelihood is agriculture;
- Document the lessons and implications on the use of legume-cereal rotations and to guide similar work in other environments in Tanzania;
- To prepare and publish information sources to support the promotion of green manures in rice/maize-based systems.
- Support Kyela and Matombo district councils to devise strategies for up-scaling promotion of cereal-legume rotations.

## Research Activities

**Research partnerships:** The project followed an inter-disciplinary approach. In addition to an agronomist and *Striga* specialist (project leader) from Ilonga Agricultural Research Institute, partners included district council agricultural extension and primary school education staff, the NGO INADES Formation Tanzania, which specialises in community analysis and empowerment, a soil fertility specialist from Mlingano Agricultural Research Institute and a social economist from Sokoine University of Agriculture. The Natural Resources Institute, UK, assisted with developing protocols for monitoring farmer involvement in the demonstration work, development of the field programme and dissemination materials.

**Research sites:** Research work was continued in the same two locations used for project R8194. Kyela district is mainly a rice-based farming system with production of low-land rice on the flood-plain of Lake Nyasa and of dry land ("upland") rice at lower elevations on hills rising from the flood-plain. Near to the lake, communities are also involved in fishing and livestock grazing. Tree crops, particularly cocoa, oil palm and citrus are important sources of income. Matombo ward is located at around 1500 to 2000 m above sea level in the Uluguru Mountains. Farmers produce a range of field and tree crops. Maize is important in valley bottoms and on lower slopes close to settlement while rice is dominant on steep hillsides further way from villages. Citrus, banana, pineapple, black pepper and cloves are high value products exported from the mountains to urban areas of Tanzania and beyond. Detailed descriptions of each area are to be found in the FTR for project R8194 (Mbwaga, 2005[4]).

[4] Mbwaga A m (2005)On-farm verification and promotion of green manure for enhancing upland rice productivity on *Striga* infested fields in Tanzania R No. 8194 (ZA No0511): Final Technical Report. Kilosa, Tanzania; Ilonga Agricultural Research Institute.

## Output 1. Participatory evaluation and promotion of *Striga* management practices

**Monitoring and evaluation of demonstration programme:**
Demonstrations of legume-cereal rotations had been established by farmer groups in a total of 12 villages during 2004. In general at each farm there had been three plots, side by side, of *Crotalaria*, disease resistant pigeon pea (Cv. Mali) and rice (in Kyela) and rice or maize in Matombo. All plots were planted to rice (local cultivars selected by farmers) or maize (Cv. TMV1) in 2005. The Sinyanga group decided not to plant pigeon pea as they considered that their rice fields were too moist for the crop to perform well. The Kilasilo group had added a plot of the legume *Canavalia ensiformis* at three sites. This had produced copious biomass at one site where it had been planted for observation in 2003. During mid-season evaluations group members visited easily accessible sites in their respective areas accompanying the multidisciplinary project team (Table 1). Each of the host farmers described his demo plot. Farmers were encouraged to discuss what they had observed so far during the season. This included the advantages and disadvantages of growing green manure, or pigeon pea in rotation as compared to continuous rice or maize cropping. Rice yields were assessed during 2005 at demonstration sites in three villages in Kyela (6 farms in Konjulas, 11 farms in Kilasilo and 5 farms in Sinyanga) and from 6 farms in Kibangile village in Matombo. The effect of legume rotations on maize yield was also assessed in Matombo on 8 farms in each of Kibangile and Kiswira villages. In previous seasons the project had collected data and reported on the effect of rotations on *Striga* abundance. In 2005 extension workers, who collected data for the project with farmers, concentrated on yields to maximise time spent on dissemination.

**Table 1: Village and farmer participation in legume-cereal rotation demonstration during 2005 season.**

| | Village | Group size | | | Number of sites monitored |
|---|---|---|---|---|---|
| | | Male | Female | Total | |
| **Kyela District** | Kilasilo | 20 | 6 | 26 | 19 |
| | Itope | 12 | 6 | 18 | 15 |
| | Konjulas | 17 | 10 | 27 | 5 |
| | Sinyanga | 11 | 4 | 15 | 11 |
| | Kandete | 7 | 3 | 10 | 10 |
| | Ibanda | 5 | 4 | 9 | 9 |
| | Ngana | 5 | 6 | 11 | 11 |
| | Ushirika | 8 | 3 | 11 | 11 |
| | Kyela -Total | ***85*** | ***42*** | ***127*** | ***91*** |
| **Matombo-Morogoro Rural District** | Kibangile | Not noted | | 35 | 13 |
| | Konde | | | 12 | 7 |
| | Gozo | | | 19 | 14 |
| | Mtombozi | | | 35 | 4 |
| | Kiswira | | | 25 | 10 |
| | Matombo - Total | | | ***109*** | ***48*** |
| | ***Grand Total*** | | | ***236*** | ***139*** |

**Participatory rice variety selection:**

As a result of work undertaken by project R5228 (1992-96) the West Africa Rice Development Association (WARDA) bred a series of rice lines incorporating tolerance to *Striga* species. Initially these were grown on small, two row observation plots at two sites in Kyela in 2003. Farmers selected five promising lines, supporting the emergence of low numbers of *Striga*. These were multiplied by farmers in Kilasilo during 2004, producing from 4.5 to 15 kg per line. Seed was subsequently distributed to five farmers selected by the community in Kilasilo for field scale evaluation in 2005. Each line was planted on *Striga* infested land under farmer management. Plot size, dependent on seed availability was a maximum of 350 $m^2$. The project had initially planned to evaluate the rice lines in Matombo. This was not done as too little seed was available.

**Output 2. Strategies up-scaling promotion of legume rotations by district councils developed**

**Review of promotion activities since 2002:**
In addition to undertaking field-scale evaluation of production practices, project R8194 worked as an enabling project to assist district council extension teams to promote the use of rice/maize-legume rotation on *Striga* infested land. During 2005 the project also continued to work through primary schools. Project staff interacted with extension and education department managers during 2005 to review progress since 2002 in order to plan and identify funds for implementation of district wide promotion in the 2006 crop season and beyond. Progress was summarised and future options were discussed at a two-day stakeholder workshop held in Kyela in mid-June. Participants included farmers, District Agricultural and Livestock Extension Officers (DALDOs), District Education Officers, extension staff, and teachers from Kyela and Matombo. In addition DALDOs attended from two further districts in Mbeya and two in Morogoro region where it is thought that the legume-cereal rotations are also applicable. NGO staff, including those of organisations active in the Uluguru Mountains also participated. A full list of participants can be found in Mbwaga *et al*. (2005d) in Annex. 1. Working groups outlined potential future promotion programmes.

**Monitoring of the primary schools programme:**
Collaboration between the agricultural extension and the education departments of the district councils resulted in primary schools participating in the project. Agriculture teachers from 6 schools in Matombo and 15 in Kyela with ward education co-ordinators attended a planning session in November 2002 and a follow-up meeting in July 2003. The meetings allowed teachers to exchange experiences on incorporating awareness of measures to improve soil fertility and manage *Striga* into the school curricula. Strategies used have included demonstration plots, classroom teaching and cultural activities including poems, songs, plays and local dances. The programme of activities continued through 2004 and 2005 with strong support from the respective District Education Officers. A group of project researchers, village extension and district staff visited the schools to review performance of activities during the 2005 crop season. A team composing of ward executive secretary ward agricultural extension officer, ward education officer and division secretary was formed in Matombo to monitor the school activities and make recommendation for any modification and to give feedback on the progress to the project leader.

**Training of Trainers:**
An important aspect of project activities since 2002 has been building capacity within extension and education departments in Kyela and Matombo to undertake promotion of soil fertility enhancing measures for the management of *Striga.* Further support to ensuring the sustainability of the process was provided through "training of trainers" workshops, undertaken in Matombo in July and in Kyela in August.

**Farmer group strengthening:**
In discussions that took place during mid-season evaluation of the demonstrations, the farmer groups requested training on group management. In response the project funded training workshops in Kyela and Matombo in November and December, 2005. These were led by Mr Lameck, (INADES Formation, and Tanzania).

**Output 3. Lessons from evaluation and promotion of legume rotations for *Striga* infested land documented**

The process of evaluation and promotion of rotation practices in Kyela and Matombo undertaken by projects R7564 and R8194 was reviewed to identify factors contributing to adoption. This is not the first attempt to promote legume green manures in Tanzania. Discussions were therefore held with key informants to gather information on the use of *Crotalaria* since the early 1970s; these included farmers in Kyela, Morogoro Rural, Songea Rural districts (origin of the technology), DALDOs (Kyela, Rungwe, Mbeya Rural, Morogoro Rural and Songea Rural districts), researchers (Sokoine University of Agriculture, ARI-Uyole, ARI-Ilonga, ARI-Mlingano) and NGOs (Peramiho missionaries, MRUMA Centre, Kiswira mission and Bigwa

sisters). A literature review was also undertaken. In addition a questionnaire was used to source information from 120 farmers in Morogoro-Matombo (Kiswira, Mtombozi and Kibangile villages) and Kyela (Kilasilo, Mbako and Lema villages) on their views of the promotion process. Policy implications of lessons learnt were presented during a Stakeholders workshop June 2005.

## RESEARCH OUTPUTS

### Output 1. Participatory evaluation and promotion of *Striga* management practices

Mid–season evaluation of crop performance on demonstration plots was undertaken by farmers and project team members during April when rice was at grain filling stage and maize in Matombo was at the vegetative stage. Findings were reported in Project Working Paper No. 9 (Mbwaga *et al.* 2005a – Annex 1). Yields were subsequently assessed by extension staff and farmers from whole plots in Matombo (2 villages) and by sampling 25 $m^2$ of plots in Kyela (three villages).

### Performance of rice in 2005

Rotation with a legume led to significantly higher rice yields in Matombo ($p < 0.001$). Rice performance at demonstration sites in Kibangile village was similar in the season after growing either *Crotalaria* or pigeon pea (Table 2). The yield increase after planting either legume for just one season was at least 100% at all sites.

**Table 2:** Effect of rotation on mean upland rice yield (kg $ha^{-1}$) at six sites in Kibangile village, Matombo.

| Previous crop | Kg $ha^{-1}$ |
|---|---|
| Rice | 411 |
| Crotalaria | 1356 |
| Pigeon pea | 1300 |
| S.E.D. (10 d.f.) | 88 |

Figure 1: Effect of green manure on rice in Kibangile village, April 2005. Rice following Crotalaria

In Kyela district the effect of rotation was also highly significant ($p<0.001$). Due to different numbers of comparisons of the two green manures in each village, data has been analysed by a "restricted, maximum likelihood" mixed model (REML) using the linear mixed model routine in GENSTAT. Across the district rice after *Crotalaria* (predicted yield 1850 kg $ha^{-1}$) significantly out-yielded both rice after pigeon pea (1259 kg $ha^{-1}$) and continuous rice (939 kg $ha^{-1}$ S.E.D. $\pm$ 137). The actual observed yields of upland rice are shown in Table 3. Median yields were increased by more than 1000 kg and 800 kg in Kibangile and across Kyela district villages respectively by planting rice following the use of *Crotalaria* as a green manure.

Pigeon pea was also an effective option at some sites in both Kibangile and Kilasilo. However, farmers tended to establish pigeon pea at low densities which restricted the amount of biomass accumulated. This was reflected in only modest increases in subsequent rice yields shown by the low minimum yields after pigeon pea compared to those of rice following *Crotalaria* (Table 3). Use of green manures resulted in considerable increases in the lowest yields recorded at individual demonstration sites in each village. Mean rice yield increases following *Crotalaria* were 67 % in Sinyanga, 78% in Kilasilo and 114 % in Konjulas.

Three farmers in Kilasilo also tested *Canavalia* as an alternative green manure, planted during 2004. Subsequent rice yields averaged 1507 kg $ha^{-1}$ ± 107 compared to 1733 kg ± 176 following *Crotalaria*, 1306 kg following pigeon pea and 1013 kg $ha^{-1}$ ± 104 for continuous rice.

**Table 3:** Observed yields (kg $ha^{-1}$) of upland rice following green manure crops on-farm in Kibangile in Matombo, Konjulas, Kilasilo, Sinyanga and across three villages in Kyela.

| | **Previous crop** | | |
|---|---|---|---|
| | **Rice** | ***Crotalaria*** | **Pigeon pea** |
| ***Kibangile*** | | | |
| No. of sites | 6 | 6 | 6 |
| Mean | 411 | 1356 | 1300 |
| Median | 433 | 1450 | 1300 |
| Minimum | 100 | 800 | 800 |
| Maximum | 700 | 1867 | 1733 |
| S.E.Mean | ± 86 | ±182 | ±129 |
| ***Konjulas*** | | | |
| No. of sites | 6 | 6 | 4 |
| Mean | 700 | 1500 | 600 |
| Median | 500 | 1600 | 600 |
| Minimum | 200 | 800 | 400 |
| Maximum | 1600 | 2000 | 800 |
| S.E.Mean | ± 236 | ± 229 | ± 82 |
| ***Kilasilo*** | | | |
| No. of sites | 10 | 11 | 11 |
| Mean | 1476 | 2622 | 1898 |
| Median | 1100 | 1800 | 1400 |
| Minimum | 800 | 1200 | 920 |
| Maximum | 2845 | 4800 | 3600 |
| S.E.Mean | ± 245 | ± 464 | ± 344 |
| ***Sinyanga*** | | | |
| No. of sites | 5 | 5 | Not planted |
| Mean | 680 | 1040 | |
| Median | 680 | 1000 | |
| Minimum | 600 | 800 | |
| Maximum | 1000 | 1600 | |
| S.E.Mean | ± 80 | ± 147 | |
| ***All Kyela villages*** | | | |
| No. of sites | 21 | 22 | 15 |
| Mean | 1065 | 1856 | 1552 |
| Median | 840 | 1520 | 1120 |
| Minimum | 200 | 800 | 400 |
| Maximum | 2800 | 4800 | 3600 |
| S.E.Mean | ± 158 | ± 279 | ± 293 |

**Performance of maize in 2005**

Planting of either *Crotalaria* or pigeon pea resulted in significantly higher mean yields of the subsequent maize crop in Matombo ($p<0.001$). Rotation with *Crotalaria* or pigeon pea increased mean maize yield by 180% and 153% respectively but choice of legume had no significant difference on maize performance in either village (Table 4 and 5). Overall yields were considerably lower in Kiswira than in Kibangile ($p<0.001$), possibly a reflection of a longer history of cultivation and greater population pressure in the former. Use of either *Crotalaria* or pigeon pea increased median yield by an average of 188% in Kibangile and by 269% in Kiswira (Table 5). Rotation with green manure also increased the lowest yields observed at individual demonstration sites in each village.

**Table 4:** Effect of rotation on mean maize yield (kg $ha^{-1}$) at 16 sites in Kibangile and Kiswira villages, Matombo.

| **Previous crop** | **Kg $ha^{-1}$** |
|---|---|
| Maize | 296 |
| *Crotalaria* | 829 |
| Pigeon pea | 750 |
| S.E.D. (35 d.f.) | 46 |

**Table 5:** Yields (kg $ha^{-1}$) of maize variety TMV1 following green manure crops on-farm at eight sites in each of Kibangile and Kiswira villages, Matombo.

| | **Previous crop** | | |
|---|---|---|---|
| | **Maize** | ***Crotalaria*** | **Pigeon pea** |
| ***Kibangile*** | | | |
| Mean | 333 | 975 | 879 |
| Median | 367 | 933 | 817 |
| Minimum | 133 | 800 | 667 |
| Maximum | 353 | 1200 | 1233 |
| S.E.Mean | ± 50 | ± 42 | ± 69 |
| ***Kiswira*** | | | |
| Mean | 258 | 683 | 621 |
| Median | 200 | 667 | 608 |
| Minimum | 67 | 533 | 383 |
| Maximum | 533 | 867 | 817 |
| S.E.Mean | ± 61 | ± 50 | ± 49 |

**Farmer observations from Matombo – Kiswira and Kibangile**

Farmer evaluation of the advantages and disadvantages of legume-cereal rotations and participatory budgeting of the economic viability of growing green manures were investigated in depth during 2004 and reported in the FTR for project R8194. Discussions at mid-season evaluations in 2005 concentrated on farmer's views on the progress their groups had made to date to reverse yield decline due to poor soil fertility by adopting rotations.

*How do farmers rate progress?*

- Big change observed compared to 2004. Previously cereal crops were stunted but now after use of green manure or pigeon pea the maize and rice are vigorous with higher yield (Figure 1). On continuous maize plots yield is around 2 to 3 bags per acre. This has increased to 6 to 7 bags where green manure has been used. Farmers think that yields after *Crotalaria* would have been higher if rain had not been erratic;

- Farmers believe it is now time to increase size of plots to 0.3 to 0.5 acre as *Crotalaria* works well. Some have already done this;
- Farmers impressed by relay planting of *Crotalaria* at weeding in maize as this saves a season (Figure 2). Agreed this is a good idea unless rains are poor in which case there may be too much competition between the green manure and maize. Farmers agreed to evaluate relay planting on a wider scale in 2006 as this saves loosing a cereal crop completely as is the case with sole cropping green manure.

Figure 2: Effect of green manure on maize in Kiswira village, April 2005. Left: Continuous maize, yield 133 kg $ha^{-1}$. Right: Maize following *Crotalaria,* yield 533 kg $ha^{-1}$. Both plots planted on the same day.

**Figure 3:** Relay planted *Crotalaria* in maize at Kiswira village in main rains 2005. This is a farmer adoption of green manure from sole-crop to relay-crop to save a season.

*Is knowledge moving in the community?*

- Group members reported having told other farmers about using the rotations and have given out seed of *Crotalaria*. No records kept by groups or follow-up made to new growers. Often farmers want seed but do not want to join the group.
- Farmers suggested that the rate of adoption had been limited by seed availability. However, some members of the community still have view that growing *Crotalaria* is a waste of land.
- Very good demonstration plots have been established at village primary schools. It was suggested that good plots should also be maintained at the church with sign boards as many people go there regularly.
- Support of village leadership for groups is thought to be essential for the spread knowledge to others

**New villages in Matombo**

- Farmers are keen to obtain higher rice yields as currently they do not harvest enough to feed families for a whole year. Cassava is a major crop.
- Farmers generally well aware of the soil fertility problem. Farmers indicated that with out green manure cereals will not give good yields. They are very positive about the opportunity to grow *Crotalaria* as they saw effect on cereal crops in Kiswira and Kibangile. This year the green manure is growing well.
- Plots are very distant from the villages which may reduce demonstration effect, increasing the importance of plots at the primary schools.

**Farmer observations from Kyela – Itope, Kilasilo, Konjulas and Sinyanga**

- More seed is needed to scale up the number of farmers involved. However many are now keeping portions of their green manure plots for seed multiplication.
- There was considerable discussion in all villages on the value of *Crotalaria* seed. Many farmers consider that as it was given to them free by the project they should pass samples free to others in the community. An alternative view is that some compensation should be recouped for the labour needed to harvest and process seed. Some seed has been sold to non-group members @ Sh. 500 per kg. The project and extension staff has bought seed at Sh. 600 but farmers doubt many growers will buy at this price. It appears that seed is moving from farmer to farmer mostly as a gift. Recipients initially plant small plots for seed multiplication.
- A reduction in *Striga* abundance has been seen on fields where green manures have been planted with an associated increase in rice vigour (Figures 3 & 4).
- Farmers observed that where pigeon pea had been grown *Striga* is still seen in following rice crop. Noted that pigeon pea stands are rather sparse and variable compared to dense planting and therefore high root volumes of *Crotalaria.* Where dense stands of pigeon pea have been established *Striga* number in the following rice had been reduced and the rice had produced a good yield.
- Groups feel that exchange visits to see existing plots of other farmers provided considerable stimulus and motivation to their own efforts and that this is a very useful extension tool.
- Knowledge provided by the project/extension on soil fertility, how to use rotations to reduce *Striga* abundance and reverse yield decline has given farmers confidence to tackle their own problems. By adopting rotations rice yields have been boosted on the poorest fields from 2-3 to 7-8 bags per acre. Farmers believe they are on course to achieve 10 + bags per acre. This will once again make rice production very profitable as there is a strong market and many buyers in Kyela. Individuals believe that use of the rotations has reached the stage of sustained adoption with plots of more that one acre on some farms in Kilasilo (Figure 5).
- The groups continue to request training materials – leaflets and posters
- Strong motivated group leaders are the key to success! This had been demonstrated by increases in activity in some villages after original leaders, often older traditional leaders stepped down, in favour of more active younger farmers.
- The groups formed to evaluate technologies with the project are providing a focus for other agricultural activities. Some (e.g. in Kilasilo and Itope) have registered as legal entities and have opened bank accounts to operate a Savings and Loan facility for members.

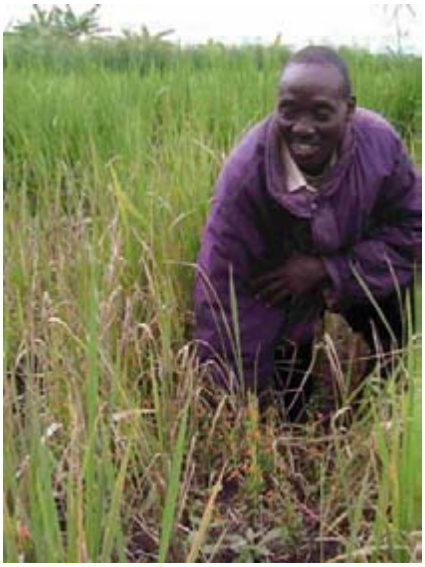


**Figure 4:** *S. asiatica* infestation of upland rice in Kyela


**Figure 5:** Farmer group at demonstration site in Itope, Kyela. A: Continuous rice with patches stunted by *S. asiatica*. B: Rice following *Crotalaria* in the previous season.

**Figure 6:** Field-scale adoption of *Crotalaria*, grown in rotation with upland rice in Kilasilo, Kyela.

**Extent of up-scaling**

The use of the legume-cereal rotation expanded during the year both on farms of previous project participants and through initial adoption by new growers in both existing and expansion villages. In Itope and Kilasilo, the first villages in Kyela where green manures were demonstrated from 2002, individual areas planted to *Crotalaria* in 2005, additional to demonstration plots averaged 660 and 2862 $m^2$ respectively (Table 6). Farmers adopting the green manure for the first time in Kilasilo have planted up to 0.5 $ha^{-1}$. The largest grower planted 1 $ha^{-1}$ of a total farm size of 2ha. In Sinyanga, where plots were planted for the first time in 2003 individual farmers planted up to 0.6 $ha^{-1}$ in 2005 with new adopters sowing areas of 350 to 550 $m^2$. Group activities were initiated in Ngana and Ushirika during 2005 with plots greater than 200 $m^2$ being planted at nine of 16 sites where areas were measured. The project has been unable to undertake an extensive survey to assess the extent of adoption beyond the participating groups. However in a spot survey in early 2005 in Itope, Konjulas, and Kilasilo, 11 farmers reported either giving or selling *Crotalaria* seed to a total of 37 others who had learnt of the benefits of the legume-rice rotation from the demonstration plots.

**Table 6:** Areas planted ($m^2$) to *Crotalaria* in Kyela during 2005

| Village (No. measured) | Mean | Range |
|---|---|---|
| Itope (5) | 660 | 300-800 |
| Kilasilo (13) | 2862 | 10,000-100 |
| Sinyanga (8) | 1620 | 6000-350 |
| Konjulas (5) | 250 | 400-100 |
| Ngana (7) | 327 | 375-50 |
| Ushirika (9) | 241 | 600-75 |

Expansion of the area planted to pigeon pea in Kyela has been more limited. Of the sites monitored the crop was planted off the demonstration area by two farmers at Itope, two at Sinyanga including one planting 1100 $m^2$ in the first year of trying the new cultivar, and three farmers in Kilasilo where the largest plot was 0.35 $ha^{-1}$. Limited seed availability prevented the project offering seed to farmers in the villages who participated for the first time in 2005.

Adoption beyond the demonstration plots is an earlier stage in Matombo as initial farmer group evaluation of rotations was held up by drought in the 2003 main rains season. This also prevented significant seed production. A further batch of seed was provided to Kiswira and Kibangile and was planted by some farmers in the 2003/4 short rains (October to February) and elsewhere in the 2004 long rains from February/March. Sufficient seed for expanding areas planted was not therefore available before 2005. Among group members in Kiswira, areas planted to *Crotalaria* outside of demonstrations (plot size 150 $m^2$) in 2005 had increased to 300 $m^2$ while in Kibangile farmers planted plots of up to 720 $m^2$. In the villages that formed groups in 2005 farmers also planted field-scale rather than “research” size plots. In Mtombozi, for example plots ranged from 75 to 900 $m^2$ depending on seed availability. Generally smaller plots were earmarked for seed multiplication with farmers planning to expand the area under the green manure in 2006. There was insufficient seed available of the *Fusarium* resistant pigeon pea at Ilonga to provide this to farmers prior to 2005. Unfortunately the seed batch of Cv. Mali distributed in 2005 was of poor quality and resulting stands were poor. As a result there has been little expansion of pigeon pea among group members in Kibangile or Kiswira. A further batch of high quality seed was therefore distributed to all the farmer groups in Matombo in good time for the 2006 main rains season. Each farmer received 0.5 kg.

During the 2005 season, farmers in Kyela produced Crotalaria seed, as indicated in the Table below. This is available for sale to neighbours and other farmers outside Kyela district.

| Village | Marejea seed (kg) |
|---|---|
| Ushirika | 57 |
| Ngana | 65 |
| Kilasilo | 1248 |
| Ibanda | 3 |
| Itope | 168 |
| Sinyanga | 13 |
| Konjulas | 13 |
| Kandete | 74 |
| **Total** | **1641** |

**Participatory rice variety selection:**
Five rice varieties from WARDA were plated by 5 farmers at Kilasilo village for seed multiplication and at the same time to evaluate their adaptation, yield performance and cooking qualities. Out of the five varieties three of them have been advanced; while the other two have been lost because they were not liked by farmers in terms growth or cooking qualities. Those which have been advanced give good indication that they are liked by farmers and are shown in Table 7.

**Table 7:** Amount of seed of WARDA rice lines produced at Kilasilo in 2005.

| Rice line | Seed produced (kg) | Comments |
|---|---|---|
| WAB 928-22-2-1-1-B | 40.0 | Low *Striga* numbers; early maturing. |
| WAB 935-5-1-1-1-B | 13.5 | Low *Striga* numbers; early maturing. |
| WAB 935-5-1-2-1-B | 50.0 | Not very palatable, but grown for sale. |
| Total | 103.3 | |

All of the seed produced has been bought by the project for distribution for wide scale evaluation for adaptation, yield performance, resistance to *Striga* and testing for cooking qualities. This will be supervised by DALDOs office. Uyole Agricultural Research Institute will plant all lines for multiplication at Kikusya research site in Kyela in 2006.

## Output 2. Strategies up-scaling promotion of legume rotations by district councils developed

**Review of promotion activities since 2002:**
Discussions during the mid-season evaluation visits with district council, ward and village level extension staff, teachers and leaders were used to collect views on the progress made with pilot promotion since 2002. Key issues to emerge were:

- Demonstration plots and farmer exchange visits are important components of accelerating the testing of green manures – farmers prefer to learn from other farmers;
- Both Kyela and Matombo District councils and their agricultural extension staff have provided consistent support to the project programme since inception and are committed to up-scaling promotion. In Matombo, Ward level staff were also keen to see expansion of activities to all 33 villages in the division – this consists of 6 wards;
- Good working partnerships had developed between DALDOs office and District Education Officers in both districts. DEOs had taken considerable effort to ensure the success of the primary school component of the project and had always backed attendance of teachers at project workshops and other meetings. When individual teachers had transferred DEOs and ward primary school co-ordinators had played an important back-stopping role to ensure suitable replacements were identified;
- Agreed that the way forward is to first increase awareness in ward leadership prior to formation of farmer groups. Experienced farmers from existing villages with groups could assist with training in new villages so that the groups formed by the project become a training resource and source of seed for future scaling-up.
- The project in collaboration with extension staff had initially formed farmer groups for validation of soil fertility and *Striga* management practices. It was recognised that additional capacity already exists in some communities. An example is the NGO CARE International that undertakes community based work in the Uluguru Mountains. CARE aims to work in 32 villages in the southern sector of the mountains by 2009 and has initiated an agricultural component in three pilot villages including at one site in Matombo ward. Their diagnostic study in these communities identified soil fertility and *Striga* among farmer priorities. The CARE programme provides a clear opportunity for promoting outputs of the CPP project.

A stakeholder workshop was convened in Kyela in June 2005 to explore these issues in detail and to discuss options for up-scaling promotion throughout Kyela, Matombo and beyond. Workshop participants included senior District Council Extension managers, research managers from Eastern and Southern Highlands Zones, ward and village extension officers, district and ward education managers, NGOs (including CARE) and lead farmers. A full list of participants, the workshop programme, summary of presentations and discussions are shown in the proceedings (Mbwaga *et al.* 2005d – Annex.1). The project process and achievements were presented by research, extension, farmer group and education department partners. Group sessions focused on how to promote knowledge of legume-cereal rotations, how the process should be incorporated into the daily responsibilities of district council, ward and NGO staff, leadership for the process, materials and sources of funds. It was agreed that the promotion process should be led by district councils and incorporated into District Agricultural Development Plans. This strategy was accepted by the policy makers present who considered that funding should be available within district budgets or Agriculture Sector Development Programme projects e.g. PADEP (Participatory Agricultural Development Programme) in Morogoro Rural. Subsequent to the workshop three initiatives were designed to expand promotion activities beyond the life of the project.

**Kyela:**
The following work programme was developed by the DALDO's office. The district council voted Sh. 8 million (US $7300) to support the initiative with activities to begin in the 2006 season. Funds are included for technical back-stopping by research staff.

**Enhancing productivity in Striga infested and non-infested upland rice and maize through rotation with *Crotalaria* (MAREJEA) in Kyela District – Proposal for scaling up.**

**1. Introduction:**

Kyela is a very small district, with a big problem of land scarcity. Rice and maize are the main food crops in the district. Out of the 50000ha available for agriculture in the district, less than 20000ha are used for growing both rice and maize. Worse still, some of these areas have low soil fertility for the crops and/or are highly infested by notorious witch weeds. All these reduce the productivity of the small land available.

The use of different types of green manure has demonstrated to be suitable and simple way of combating both problems. Farm trials conducted by Dr. A. Mbwaga* in different villages in the district using sunhemp *Crotalaria spp* (Marejea) have shown that the technology apart from being effective and efficient in both improving soil fertility and controlling *Striga*, it is cheap and affordable to many of the have-nots in the district.

**2. Objective**

Realizing that Marejea can control the witch weed and improve soil fertility, the objectives of this activity:-

- ►To increase productivity of paddy and maize in farmers field
- ►To increase peasant household income thus poverty alleviation
- ►To reduce the number and burden of weeding
- ►Reduction of *Striga* infestation in the farm and improvement of soil fertility
- ►Sustaining the technology of using *Crotalaria* already put in place

**3. Activities**

To train 210 key farmers in 21 villages (10 farmers from each village) how to minimize the effect of the witch weed by improving the soil status in infected and exhausted fields by using Marejea hence increasing productivity and incomes.
Each participant will be required to establish Marejea demonstration plot (to be followed by paddy/maize) in order to create awareness of the technology among the village members.
Conducting close supervision of the demonstration plot so that they perform as expected.

**4. Outcomes**

As a result of the project,

1) At least 210 key farmers will be trained on how best one can apply Marejea in improving soil fertility and fighting against witch weed (the *Striga*).
2) At least there will be ten demonstration plots on how Marejea is improving soil fertility and reducing Striga infestation in rice and maize field in each of the ten villages.
3) There will be a routing supervision of the technology to induce sustainability.

5. **Impact**

The anticipated positive impacts from this project are:-

a) Dissemination of the Marejea technology to even a larger population in the district.
b) Reduction in the infestation of the Striga and improved soil fertility in the farms.
c) Improved farm management and production per unit area
d) Sustainable use of Marejea and other green manure in daily agricultural activities.

**6. Locations**

**Wards** – Ipande, Busale, Ngana, Mwaya, Ikolo, Ikama, K/Songwe and Ipinda.
***Villages*** – Mbula Sinyanga, Konjula, Itope, Kandete, Ibanda, Lema, Ngana, Ushirika, Kasumulu, Kapamisya, Malungo, Kasala, Kilasilo, Ibungu, Lupembe, Fubu, Lutusyo, Ikulu, Talatala and Njisi.

**Matombo:**
Morogoro Rural developed the following programme to expand promotion to four other wards beginning in 2005-06 short rains season.

**STRATEGIES FOR PROMOTION OF MAREJEA AND PIGEON PEA MATOMBO-MOROGORO RURAL DISTRICT 2005/06**

**Introduction:**
The project on the enhancing soil fertility and control of *Striga* by using Crotalaria or pigeon pea started 2002 in Matombo ward Morogoro rural district in villages Kibangile and Matombo
Through the project period farmers have accepted the green manure technology and they have shown a lot of interest of expansion. Indicators for this is the number of community farmers using the technology from initial 2 villages to 11 villages, the number of farmers requesting Marejea seed, the crop yield increase per acre and the reduction in Striga infestation.

**The future plan after the end of the project**:

►To expand the project areas from Matombo ward to other wards e.g.Tawa, Kibungo Juu, Lundi and Mtombozi

►To use the existing farmer groups to produce Marejea seed to be distributed to more farmers within and outside Matombo

►The district will make a routine of making a follow up on the activities and to hold seminars for new farmers groups

►To collaborate with other institutions working in the area like CARE International, UMADEP, and DAI PESA, being also involved in farmer group organization /strengthening, empowerment and environmental conservation.

►Through village/ward meetings and schools information on the use of green manure will be advocated.

►The policy of the country is to work farmers who have formed farmer groups and this will be priority agenda in this project

►There is a committee which has been formed to perform monitoring and evaluation

All these activities will be continuing starting this season

In addition contact between the project and CARE staff in Morogoro has led to the NGO incorporating promotion of the legume-cereal rotations into a community programme in the Uluguru Mountains.

**Activities with CARE International in Morogoro**

**Introduction**

CARE is aiming to work in 32 villages in Uluguru south area. From a diagnostic study undertaken by CARE, and one of the priority problems identified was low soil fertility and *Striga*. Emphasis for soil fertility improvement is to use organic fertilizers of which CPP outputs will have been adopted. The organisation will concentrate by using Crotalaria on the promotion of enhancing soil fertility and controlling *Striga* in the following villages Kibungo Juu, Lanzi, Nyingwa, and Mlono. Some of these villages like Kibungo Juu will be shared by the district council.

**Resources**

Resource set aside for this activity by CARE in the 2005/2006 season is Sh. 2.0 million. (US $1800) They have already bought 40kg of *Crotalaria* seed from Peramiho-Songea and they are planning to buy more seed from farmers who have been in the CPP project.

**From the CPP projects (R8136 and R84560) CARE requested and given the following teaching materials for teaching farmers in farmer groups.**

| **Type of material** | **Quantity** |
|---|---|
| *Striga* manual on maize | 20 |
| *Striga* manual on rice | 20 |
| *Striga* manual on *Striga* species found Tanzania | 20 |
| **Leaflets:** | |
| Leaflet on Marejea in maize in rotation | 100pc |
| Leaflet on Marejea in rice rotation | 40pc |
| Leaflet on Stem borers | 100pc |
| **Posters:** | |
| Effect of Marejea on maize yield and *Striga* control | 20pc |
| Effect of Marejea on rice yield and *Striga* control | 20pc |
| *Striga* biology | 20pc |
| Integrated *Striga* control | 20pc |
| **Video tapes** | |
| *Striga* control in rice | 1 |
| *Striga* control in rice/maize Matombo | 1 |
| Drama on *Striga* control in rice - Matombo | 1 |
| Poems about control of *Striga* in Kyela | 1 |
| Songs on *Striga* control in rice Kyela | 1 |
| Traditional dance on *Striga* control in rice-Kyela | 1 |

All these materials are used for training of farmers in farmer groups, starting from 2005.

**Monitoring of the primary schools programme:**

There were 21 schools involved in the project, 15 from Kyela and 6 from Matombo. These were involved in various activities for the promotion of the project outputs. This included setting up of demos and developing poems, songs, local dances and drama as tools to relay messages to the community (Figures 7 & 8).

Kyela primary schools involved with the project and their activities 2005.

| Activity | Lema | Kandete | Ngamanga | Nduka | Nkuyu | Lema | kisale | Mbogela | Lugombo | Lukwego | Kyela | KCM | Lusungo | Kasumulu | Mbula |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Choir | | | | | | | | √ | | | | | | √ | √ |
| Poems | √ | | | √ | √ | √ | √ | | | √ | | √ | | | |
| Drama | | | | √ | | | | | | | | | | | |
| Dance | | √ | | | | | | | | | √ | | √ | | |
| Demo plots | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |

Matombo Primary schools involved with the project and their activities 2005.

| | Kibangile | Konde | Mlono | Matombo | Mkumbo | Gozo |
|---|---|---|---|---|---|---|
| Choir | √ | - | - | √ | √ | - |
| Poems | √ | √ | √ | √ | √ | √ |
| Drama | √ | √ | - | - | - | - |
| Dance | √ | - | √ | - | - | - |
| Demo plots | √ | √ | √ | √ | √ | √ |

To make sure that these activities were implemented a monitoring committee consisting of ward executive secretary, ward education officer, ward agricultural officer and ward secretary was formed in Matombo. It was led by ward education officer. The committee monitored school activities at the beginning of, at mid- and end of the season. Reports were sent to project leader and a copy to the district headquarters. During monitoring they made recommendations for improvement and even to change some of the teachers who were not performing well. They also solved some of the disputes for getting enough land to plant demonstration plots and recommended schools with good performance to attend and take messages to the communities in the form of songs, poems, local dance at Government officials' visits and during festivals. At Kyela, the committee has recently been formed and it is expected to start its monitoring of activities this coming season.

While participating with the project the demonstration plots located near and run by schools have increase from 5x10m to more than half an acre. Examples of some of the schools visited during monitoring and evaluation are shown below. A major reason for increasing the school plot size has been to produce seed to be sold to farmers and other schools, as well as to enhance soil fertility and control *Striga* on the school fields.

Kyela

| **School** | **Plot size *Crotalaria*** |
|---|---|
| Mbako | 62x42m early planted, 15x40m late planted |
| Kandete | 14x40m |
| Nkuyu | 2.5 acres |
| Kasumulu | 10x10m |

Matombo

| **Primary School** | **Plot size** |
|---|---|
| Kibangile | 30x40m |
| Matombo | 15x20m |
| Konde | 20x20m |

**Figure 7:** Mbako primary school students perform a drama about the problems of *Striga*

**Figure 8:** Kandete primary school choir perform songs about the control of *Striga*

**Training of Trainers:** Lead farmers, district and village extension officers, teachers, ward secretaries, ward executive officers and NGO staff participated. Full details of participants and the content of training sessions are provided in Mbwaga *et al*. (2005b) in Annex. 1. The workshop lasted four days in each district with 16 trainees in Matombo and 26 in Kyela. Information was presented on *Striga* biology, soil fertility improvement, economic considerations of legume-cereal rotations, rain water harvesting and, improved rice cultivars (for Kyela) and improved maize cultivars (for Matombo). Following the teaching sessions, trainees undertook group work to prepare and present topics to simulate training that they will undertake in the communities that they serve. Extension leaflets, a poster, a trainer's manual and a series of videos produced by the project were used to support the training.

**Extension materials:** The project produced and printed a range of "learning tools" that can support future promotion programmes. A poster and extension leaflet describing the use of *Crotalaria* had been completed and distributed during 2004. During the extension the project team focused on a training manual, contributed to radio programmes and produced a series of videos (see Annex. 3, 4 and 5). The training manual and pictorial training guide that it supports covers practices for the management of *Striga* infested land with an emphasis on rice production. This was adapted from a manual and training aid developed for the maize-based system in Muheza District (N.E. Tanzania) by CPP project R8215. The set of images in the pictorial guide is for use when training farmer groups. Seven programmes were aired nationally by Radio Tanzania and aimed to raise awareness of the *Striga*-soil fertility issue, management practices and the role of schools in increasing knowledge in the community. Assistance with video production was provided by Mr J Mika, (Central Agricultural Zone Communication Officer). He had previously received training on video production and editing as a partner in the CPP project R8428 (Crop Protection communication and research promotional strategies for semi-arid East Africa). The videos cover practical aspects of using legumes to improve soil fertility where *Striga* is a problem, and document cultural activities used by school children to illustrate these issues. These have already proved very popular when screened at the training courses.

**Other promotion activity:** Displays were mounted at the National Agricultural Show (*Nane nane*) in Mbeya (Southern Highlands Zone) and at the regional show in Morogoro (for Morogoro, Tanga, Dar es Salaam and Coast regions). At the Mbeya show extension and farmers contributed leaflets, posters, *Striga* manuals and Crotalaria seedlings grown in pots. Farmers sold 68 kg of *Crotalaria* seed to different people who after listening to the explanation given decided to try the legume. In addition to the display of literature a small plot of *Crotalaria* was established for the public to view.

The Kyela DEO office attended an adult education day organised by the Ministry of Education in Chunya district, Mbeya region. This area is also severely infested with *Striga*. Seed and pots planted with *Crotalaria* and *Canavalia* seedlings, leaflets, the training manual and pictorial guide produced by the projects were on show. The display was inspected by various officials of the region and other districts including Regional Commissioner of Mbeya, Hon. Matheo Quares, They were given leaflets, posters, manuals for further reading. Seed of *Crotalaria* and *Canavalia* was given to farmers who showed interest in trying these species in their own fields.

**Farmer group strengthening:** The farmer group strengthening workshops for Kyela were held in seven villages. In each workshop participants included farmers, the ward agricultural extension officer, two village extension officers and the Crops specialist from the District office. Three teachers from two schools also attended (Kandete and Mbako respectively). In Matombo, workshops were held in four villages and participants included farmers accompanied by the ward secretary, village extension officer and District office Crops Specialist. A full list of participants and a summary of the content of the training course are described in Mbwaga *et al.* (2005c) in Annex. 1. The objective was to provide an understanding of group dynamics, leadership responsibilities and group analysis to ensure continued group sustainability after the project has ended. The groups that have worked with the project are an essential resource on which promotion of outputs across each district will be built. The workshops were held in an attempt to ensure that the groups continue to be a

success. Each group analysed its performance to date and was facilitated to set targets for future activities.

### Output 3. Lessons from evaluation and promotion of legume rotations for *Striga* infested land documented

The draft of a paper "Factors affecting Farmers' Adoption of Green Manure for Promoting Crop Production in Selected Regions of Tanzania: Past experience, current status and future perspectives", summarising a study of previous attempts to promote the use of green manures, and specifically *Crotalaria* in Tanzania appears in Appendix 1. The main findings and policy lessons were also presented at the Stakeholder workshop in Kyela in June 2005 (see Mbwaga *et al*. 2005d). The main findings from this study were:

- Earlier research on green manures was largely on-station but when on-farm lacked farmer-participation. Results were not communicated to farmers or followed-up so these initiatives achieved little impact;
- Promotion of *Crotalaria* has previously been un-co-ordinated and lacked a clear process for providing farmers with seed and knowledge on how it could be used to increase farm productivity and household income. In many cases seed was distributed as far as district offices around the country but did not reach farmers;
- Little attention has previously been given to the advantages and disadvantages of using green manure in smallholder systems and of economic costs or benefits;
- The adoption of legume-cereal rotations, now beginning in Kyela and Matombo, results from a farmer participatory approach involving farmers at all stages of the validation and promotion process, empowerment of farmer groups to manage the process at village level, commitment from the district councils, capacity building in district extension teams, availability of appropriate learning tools.

Clear policy implications and recommendations emerged from the study:

- Concerted effort should be made by all stakeholders (farmers, researchers, NGOs, and particularly local government officials) to ensure that the technology is scaled up to as many farmers, in many locations as possible;
- Farmer group learning approaches including exchange visits and demonstration plots are key to successful promotion;
- Partnership between district council agricultural extension and education teams to involve primary schools in promotion of agricultural knowledge should be expanded;
- Now that the economic value of rotations has been established with farmers, more research on the best options to increase returns and or reduce cost (labour demand, drudgery and financial) should continue in a range of environments. Methods that allow an economic grain yield in the season when the green manure is grown e.g. relay cropping or other grain legumes need further investigation.

### Contribution of Outputs to developmental impact

This report describes the outputs from a 10 month extension to work initiated in 2002 with the objectives of validating and promoting practices to reverse the trend of 30 and 70% decline in upland rice yields over the past 20 years as soil fertility levels have fallen and witch weed levels have increased. Additional monitoring of yields of both rice and maize at demonstrations undertaken during the extension confirmed the potential for legume-cereal rotations to reverse the yield decline. Rice is the second most important cereal crop in Tanzania with an average of 359,000 ha planted per year to the crop in the period 1993 to 2003. However there was still a need to import an additional 135,000 MTs per year during the same period (FAOSTAT, 2005[5]). Yields of continuous, unfertilised rice observed at many

[5] FAOSTAT 2005. Food and Agricultural Organisation Statistical Databases. FAO, Rome, Italy. URL http://faostat.fao.org (accessed January 2006)

demonstration sites in both Kyela and Matombo districts were considerably below national average yields of 1.6 t $ha^{-1}$. There is strong market demand for quality aromatic rice in Tanzania. Farmers participating with the project in 13 villages in two districts have realised the importance of improving the fertility of *Striga* infested and other lands to increase productivity to improve both food security and household incomes. Over the 3 year 10 month period that the project has been operational activities have demonstrated how dissemination of knowledge of the link between low soil fertility, *Striga* and poor crop yields and of how to improve crop management is the key to farmer adoption of legume/cereal rotations. The project has demonstrated how a combination of knowledge sources and learning opportunities including a partnership between agricultural extension and primary schools can support this process. Members of farmer groups working with the project have achieved increased yields of rice and maize and increasing numbers of growers are adopting the practice of rotation beyond the groups. The direct involvement of farmers through empowerment of groups to lead the demonstration process is leading to farmer to farmer extension and dissemination of *Crotalaria* seed. After initial experimentation individual farmers are increasing the area planted to the green manure year-on-year. This is in contrast to the failure of previous top down approaches taken by authorities and NGOs in Tanzania to promote green manure-based rotations of which there has previously been little sustained up-take. The value of the technology AND the appropriateness of the dissemination processes and extension materials developed by the project have been acknowledged in the project area leading to the allocation of locally available funds to scale-up the dissemination process beyond the life of the project. This includes training lead farmers in all villages of Kyela District with district council funding and work in the Uluguru Mountains funded by CARE International.

## Follow-up indicated/planned

Agreed, funded programmes for up-scaling promotion activities in both Kyela and Matombo have been described under output 2. The farmer groups participating in the project have indicated that there has already been considerable farmer to farmer spread of green manure seed. To document the extent of this and to learn additional lessons will need careful follow-up of the farmers involved. Visits will be needed to seek out farmers who group members have passed seed to in order to ascertain if they have sustained adoption and if so what impact this has had on their income. The Department of Agricultural Economics and Agribusiness at Sokoine University of Agriculture has suggested that two MSc. students be allocated to undertake such a study in both Kyela and Matombo for their thesis research. Funding is available from the university and supervision will be provided by Dr Hella, a partner in the CPP project. Responsibility for evaluation the *Striga* tolerant rice lines, introduced by the project from West Africa, have been taken on by Uyole Agricultural Research Institute.

**PUBLICATIONS SUMMARISING RESULTS FROM R8436**

**Annex 1: Working Papers and workshop proceedings**

1. **Mbwaga A. M., Riches, C.R. and Hella J. (2005a):** Mid-season Evaluation of on-farm verification and promotion of green manure for enhancing upland rice productivity on Striga infested fields; Matombo-Kyela 2005, Working paper No. 9, Ilonga Agricultural Research Institute, Kilosa, Tanzania 28pp
2. **Mbwaga, A. M. Ley, G. Hella, J. Kayeke, J. (2005b):** Workshops for Training of Trainers on the enhancement of soil fertility and control of Striga in rice/maize., Working paper No. 11, Ilonga Agricultural Research Institute, Kilosa, Tanzania, 32pp
3. **Mbwaga, A. M., Kayeke, J. and Lameck, P. (2005c)** Workshops on farmer group Strengthening; held in Kyela and Matombo 28th November – 15th December 2005 Respectively, Working paper No.10, Ilonga Agricultural Research Institute, Kilosa, Tanzania 16pp.
4. **A. Mbwaga, C. Riches, J. Hella and J. Kayeke (2005d),** Proceedings of the Stakeholder's workshop held at TAFRI Hall Kyela, Mbeya Tanzania, 20th-21st June 2005, Ilonga Agricultural Research Institute, Kilosa, Tanzania, 57pp

**ANNEX 2: Conference Papers**

Riches, C.R., Mbwaga, A.M., Mbapila, J., Ahmed, G.J. (2005). Improved weed management delivers increased productivity and farm incomes from rice in Bangladesh and Tanzania. Aspects of Applied Biology 75: Pathways out of Poverty. 127-138

**ANNEX 3: Extension materials**

1. Njia bora za udhibiti husishi wa viduha (Integrated *Striga* control manual for trainers), (2005). Ilonga Agricultural research Institute, Kilosa, Tanzania.
2. Njia bora za Udhibiti viduha (Pictorial guide for Integrated Striga control – A training tool to use with farmers), (2005). Ilonga Agricultural research Institute, Kilosa, Tanzania.

**ANNEX 4: Radio programmes**

1. Three radio interview programmes with (National Radio Tanzania) farmers (Itope, Kilasilo and Kiswira), 2005
2. Two radio programme with primary school children in Kyela on the importance of using Crotalaria to enhance soil fertility and control Striga (Mbako and Nkuyu), 2005
3. Two radio interview with researchers on the magnitude of the Striga and soil fertility problem in Kyela and farmer group formation (A. Mbwaga and G. Ley), 2005

**ANNEX 5; Video tapes**

1. *Striga* control in rice, Kyela 2005
2. *Striga* control in rice/maize, Matombo 2005
3. Drama on *Striga* control in rice, Kyela 2005
4. Songs on the control of *Striga* using *Crotalaria,* Kyela 2005
5. Traditional dance about the control of *Striga* using *Crotalaria* in rice, Kyela 2005
6. Drama on *Striga* control in rice by Matombo farmers, Matombo 2005
7. Poems about control of *Striga* in rice, Kyela 2005

**Biometricians Signature**

*The projects named biometrician must sign off the Final Technical Report before it is submitted to CPP. This can either be done by the projects named biometrician signing in the space provided below, or by a letter or email from the named biometrician accompanying the Final Technical Report submitted to CPP. (Please note that NR International reserves the right to retain the final quarter's payment pending NR International's receipt and approval of the Final Technical Report, duly signed by the project's biometrician)*

***This was a promotional project, which from the beginning it was agreed with CPP that a biometrician was not needed in this project, however the few analysis using GENSTAT***

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

Signature:
Name (typed):
Position:
Date:

## PROJECT LOGICAL-FRAME WORK

| Narrative Summary | Objectively Verifiable Indicators | Means of Verification | Important Assumptions |
|---|---|---|---|
| **Goal** | | | |
| **Livelihoods of poor people improved through sustainably enhanced production and productivity of RNR systems..** | To be completed by CPP Programme Manager | To be completed by CPP Programme Manager | To be completed by CPP Programme Manager |
| **Purpose** | | | |
| Promotion of strategies to minimise impact of target pests in rice-based Land-Water interface cropping systems, for benefit of poor people. | To be completed by CPP Programme Manager | To be completed by CPP Programme Manager | To be completed by CPP Programme Manager |
| **Outputs** | | | |
| 1. Participatory evaluation and promotion of *Striga* management practices | 1.1 By 01/06 impact of legumes on production of *Striga* susceptible cereals assessed in 6 villages of 2 districts<br>1.2 By 01/06 5 rice lines tested in 15 on-farm trials across 2 districts | Final project working paper describing yields under up-scaling of use of legumes and extent of adoption in target villages<br>Project report | Weather favourable in 2005 crop season; Extension officers remain allocated to work by districts. |
| 2. Strategies up-scaling promotion of legume rotations by district councils developed | 2.1 Stakeholder review of process an future opportunities complete by 07/05. Strategies planned with districts by 10/04.<br>2.2 TOT in extension and schools completed by 11/05 and new farmer groups formed and run by Kyela and Matombo districts by 01/06<br>2.3 Radio programme aired | Project working paper.<br>Budgeted strategies submitted to district councils<br>Project report<br>Radio Tanzania schedule | Weather favourable in 2006 crop season; Extension officers remain allocated to work by district and education officials continue to support promotion via schools<br>District councils agree to allocate funds |
| 3. Lessons from evaluation and promotion of legume rotations for *Striga* infested land documented | 3.1 Review of lessons and implications of use of legume-cereal rotations in other environments completed by 01/06 | Policy brief circulated to extension and MAFS management in Tanzania and lessons incorporated into a journal paper | |

| Activities | Inputs | Means of Verification | Important Assumptions |
|---|---|---|---|
| 1.1 Monitoring of performance of rice or maize crops following large scale planting of legumes | 1.1.1 Participatory assessment of crop performance at 81 sites in 2 districts in 05/05 including crop budgets.<br>1.1.2 Adoption survey in 6 villages by 06/05 | Project working paper | |
| 1.2 On-farm trials of rice lines | 1.2 15 PVS trials established and assessed by 07/05 | Project report | |
| 2.1. Review of promotion activities since 2002 and planning strategy | 2.1 Stakeholder workshops in Kyela and Matombo by 07/05<br>2.1.2 Meetings with district to plan future promotion strategy | Project working paper.<br>Strategy ad budget submitted to 2 district councils | |
| 2.2. Training of extension trainers | 2.2.1 TOT Manual finalised and training sessions given for 15 extension officers<br>2.2.2 Radio programme prepared and aired in April/May 2005 | 1000 manual printed<br>Project reports | |
| 2.3. Training of teachers | 2.3 Training provided to teachers from 20 | Project reports | |
| 3.1. Lesson learning review of evaluation and promotion of *Striga* practices in Kyela and Matombo. | 3.1 Consultations with stakeholders within 2.1. Review of literature on green manure in Tanzania and region, discussion with MAFS policy makers. | Policy brief and journal paper | |

**Appendix 1: Factors affecting Farmers' Adoption of Green Manure for Promoting Crop Production in Selected Regions of Tanzania: Past experience, current status and future perspectives**

J P Hella
Sokione University of Agriculture, Morogoro

**Abstract**

*Depletion of soils through loss of soil nutrients is a major problem affection a majority of the smallholder farmers in Tanzania. Since 2002, research on the use of leguminous plants to increase soil fertility was reintroduced in Morogoro and Kyela districts respectively. This paper presents a brief account on the factors affecting adoption of green manure (Marejea) technology for soil fertility improvement and Striga control. The main objective of the study was to assess the current reason for changing trend in the adoption when compared with poor uptake despite concerted extension efforts in the 1980s. Both primary and secondary data used in this were gathered from farmers, NGOs including Roman Catholic missions and Government officials in Ruvuma, Mbeya and Morogoro region. Results show that Marejea as a plants in not new in Tanzania and has been used since 1940s. Past failure to fully utilized potentials of Marejea was recorded and evidence from the study associated this with the research and extension approaches used in delivering the technology to farmers. The participatory and on-farm approach explains reasons for the current success. The paper concludes that use of Marejea as a panacea for improving soil fertility in Striga prone low income farm families offers a more sustainable solution for improving land and labour productivity. The paper recommends for researchers and relevant stakeholders to come up with location specific rational strategies.*

**Introduction**

Depletion of soils through loss of soil nutrients is a world-wide problem affection 135 million ha mostly in South America and Africa (Waithaka *et al*, 2004). This is particularly so for rice producing areas in Tanzania where soil depletion is a common feature of food crop oriented small-scale farms and has led to low labour and land productivity. Rapid population growth has aggravated the problem and resulted in an increase in continuous cropping of farmers' fields, while there has been little effort to replenish nutrient mainly because of two reasons. First, due to removal of subsidies on fertilizers in late 1990s the prices have become prohibitive to smallholder farmers. The second reason is linked to a problem of timely availability especially in villages located in remote areas for which no practical solution has been devised.

Another problem associated to declining soil fertility is increasing *Striga* infestation. Evidence from several studies (e.g. Shamkupa, 1994; Gerold, 1984; Mbwaga *et al*,) poor yields of *Striga* infested upland rice are associated with low and declining soil fertility. A context analysis undertaken with farmers in four villages close to Lake Nyasa, in Kyela district (Mbeya Region) has indicated that as infestations by *S. asiatica* have increased as rice yields have declined from approximately 20 bags per acre 20 years ago to little more than 2 bags per acre today. A similar situation has been reported by farmer groups in two villages in the Uluguru Mountains of Morogoro Rural District (Morogoro Region). Here, *Striga* is also a serious problem in maize, also an important food crop in the district.

An alternative strategy is to improve the fertility of *Striga* infested fields by growing legumes in rotation with susceptible cereals. On-farm trials undertaken by farmer groups collaborating with CPP funded project R7564 in Kyela district in Mbeya region and Matombo in Morogoro region, demonstrated how rice yields can be increased by 25-50% by application of 25-50 kg Nitrogen $ha^{-1}$, while the infestation level of *Striga* decreased. The majority of farmers are not however prepared to invest their limited cash in fertilizer. The key project activity became a series of on-farm demonstrations of legume-cereal rotations using Marejea or pigeon pea, managed by farmers following training and with support from district extension staff and the

project team. Evidence from mid-term reports in 2004 in both study areas (see Mbaga et. al., 2004) showed that the uptake of the technology by smallholder farmers within and outside the study villages was very impressive.

There was a promotion of Marejea in 1996 - 2000 under the Nguvu-kazi programme. The purpose of Marejea was to improve soil fertility by green manure in order to increase productivity and use as fodder for diary cattle. Farmers were advised to plant Marejea during short rains (Vuli) and ploughed under during long rains (Masika) before planting food crops. The response was good because political leaders were involved - This was a political move. The method of dissemination of information was the use of seminars, Bw. Shamba (Village extension officers) and distribution of seed. It was taken to some villages (names were not given) and prisons. On the Prisons farms Marejea seed is still being used and they have seed. Elsewhere the programme collapsed.

At Uyole Agricultural Research Institute in Mbeya (the research was conducted by Mr A.E.Temu) work on green manure was conducted in 1980-1983 by the maize programme. Application was done by removing the above ground biomass (yield of maize obtained was equivalent to 80 kg N /ha) and another by incorporating the biomass in the soil (gave yield equivalent to 120 kg N/ha). Although a recommendation to use Marejea was given there has been no documented progress about the promotion of Marejea to address smallholder farmers declining soil fertility problems.

**The problem**

Sun hemp (*Crotalaria spp*) or Marejea in Kiswahili is a plant native to tropical region where rainfall is high. Although some literature show evidence of using Marejea in Tanzania as long ago as in 1898, it was only in 1942 when some documented use was reported in Peramiho in Songea District of Southern Highlands (Gerold, 1986) mainly as livestock feed and for soil fertility improvement. Due to potential of Marejea for fertility improvement, in early 1980, Peramiho received some money from Swiss Government to promote Marejea throughout the country. The practice involved production of seed by farmers on contractual base and distribution to all Districts agricultural offices in Tanzania. The expectation was that use of Marejea could be promoted to as many farmers possible.

On the research side, there was some attempt on research on Marejea use at Uyole Agriculture Centre and Sokoine University of Agriculture in 1983 (Lupanaga et al, 1986). It is also reported that the Arusha based Tropical Pesticide Research Institute (TPRI) had some interest in the subject. Despite these effort especially that of Father Gerold and Peramiho, the extension service was not significantly involved (Lupanga et al, 1986). For example evidence gathered during this study in many district offices showed that the seed received from Peramiho under the Swiss funded scheme rotted at the office without reaching the end users. This observation is contrary to what has been observed during implementation of the CPP project in Kyela and Matombo where farmer to farmer spread of the green manure and adoption is occurring. It was with this background that many questions on the reasons for past failure emerged.

**Methodology**

Both primary and secondary data were used in this study. Secondary data were collected from various sources (see Table 1) while primary data was generated by use of a standardized questionnaire and checklist directed to farmers and key informants.

**Table 1: Sources of data**

| Region | Secondary data | | Primary data | |
|---|---|---|---|---|
| | *Sources of data* | *Methodology* | *Sources of data* | *Methodology* |
| **Mbeya** | *Uyole ARI, Mbeya (R)* Kyela (DALDO) | Review of available literature | 40 farmers at Kyela district<br><br>Key informants | Structured Questionnaire<br><br>Check list |
| **Morogoro** | SUA, Morogoro (DALDO) | Review of available literature | 40 farmers at Kyela district<br><br>Key informants | Structured Questionnaire<br><br>Check list |
| **Ruvuma** | Peramiho mission Songea (DALDO) | Review of available literature | -- | --- |

**Results**

### 4.1 History

------: A native plant found in the wild & considered poisonous by natives
1898: Evidence of use for fertility improvement
1942: Marejea was brought to Peramiho mainly for livestock feed and soil fertility improvement
1963: Peramiho started experiments to control weeds (Couch grass) using Marejea.
1983: Sunnhemp seed bank started at Peramiho with generous support from Switzerland. By 1990, about 64.5 tons of Marejea was distributed to all districts in the country to kick start the farm-level the production and utilization of Marejea for fertility improvement and weed control
1980-84: Extensive research at Uyole (Mr Mkurasi) & SUA (Drs Tucker and B. Ndunguru). Results were no communicated to farmers
1987: Mradi wa Kurutubisaha Ardhi kwa Kutumia Marejea[6] (MRUMA) centre started at Peramiho. The object of the project was to maintain seed production for local use and export. Between 1996 and 2002 the centre has exported 1,710.5kg of seed to different countries all over the world
2002: O-farm trials on the use of Marejea to improve soil fertility and control weeds in upland rice at Kyela initiated by CPP project to replace use of Urea as farmers were unable to afford to purchase fertilizer.

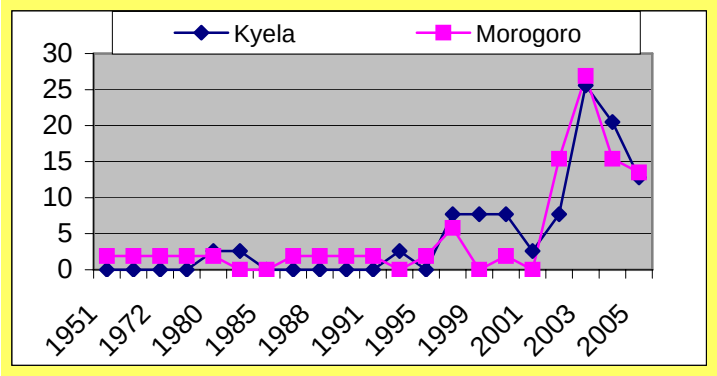
### 4.2 Extension methods use

#### 4.2.1 Knowledge about Marejea

- Scanty or no information exists about the plant (Marejea) in all 7 districts visited except Songea rural as a result of extensive promotion by Roman catholic priests at Peramiho;
- Native plant is known to farmers especially among the old ladies as the pods were used for decorations at young age;
- Many farmers considered Marejea plants as poisonous if eaten by chickens;
- In all CPP project villages, farmer knowledge about the plant mostly came in recently as indicated in Figure 1..

[6] Project for improving soil fertility using Marejea

**Figure 1:** Proportion of respondents by the year when they heard about the use value of Marejea (Note: Number increase with CCP project period)




### 4.2.2 Extension method used

- Generally no specific extension method was used for promotion of Marejea in the past. All District Livestock and Agricultural Development Offices (DALDO) visited during this study remembered receiving seeds of Marejea between 1989 – 1990. In some offices the seed got spoiled while at the office. Others had no records about how the seed had been used;
- Spread based on individual farmers, NGO, and interests: Roman Catholic missionaries, Late President Nyerere, MRUMA centre at Peramiho. There was no concerted promotion by government agencies;
- Research: On station research at Uyole , SUA and TPRI were conducted apparently with limited on-farm research
- In some case where on-farm research was conducted, there was no organized farmer representation or no feedback to farmers about the results.

Results of the promotion were a total failure of the technology to impart any significant contribution to increase land and labour productivity. Based on the information below, some hypothesis on the reasons for the reported failure includes:

- Limited extension input;
- Research approach i.e. on station work without full participation of the farmers in research process;
- Low population, which allowed continuation of shifting cultivation thus allowing fertility build-up through fallow;
- Lack of immediate and direct economic benefit(s); producing Marejea in rotation means using labour on production of plants which has no immediate economic value to the farmers (grain yield in season of production);
- Availability of chemical fertilizer at subsidized prices?

## 4.3 Current status

### 4.3.1 Pilot village – participatory and multidisciplinary research and extension approach

The use of *Crotalaria* or pigeon pea in rotation with rice to combat *Striga* and low soil fertility had been introduced in Kilasilo and Itope villages in Kyela prior to the 2001/02 crop season when farmers were provided with seed for on-farm trials. During discussions with farmers it was subsequently agreed to incorporate these into the demonstration programme in each village. Plots previously planted to *Crotalaria* or pigeon pea in 2001/02 were planted with rice in 2002/03. Village seminars were held in Sinyanga and Konjula in Kyela and in Kiswira and Kibangile in Morogoro Rural in September to November 2002 to introduce farmers to the potential benefits of the legume/rice rotations. Farmer groups were then formed within each

village to undertake demonstrations at a number of sites. It was agreed that at each site there would be single plots, side by side, of *Crotalaria,* disease resistant pigeon pea and rice. All plots would be planted to rice in the following season.

The farmer group accompanied by a multi-disciplinary project team in their respective villages visited all sites. At each site the host farmer described the demonstration, provided information on dates of field activities. Farmers were encouraged to discuss what they had observed so far during the season. Following the field visit findings were summarized and a group discussion held to confirm aims and objectives of the on-going program and future work. A multidisciplinary project team comprising following members conducted field

Dr A M Mbwaga - Plant Pathologist/*Striga* specialist, ARI Ilonga (Project Leader)
Mr C Massawe – Plant protectionist/Agronomist, ARI Ilonga
Dr G Ley – Soil Scientist, ARI Mlingano
Dr J Hella – Agricultural Economist – department of Agricultural Economics and Agribusiness SUA.
Mr P Lameck – Social scientist – INADES
Dr J Kayeke – Weed scientist/Agronomist, ARI Uyole
Dr C Riches – weed scientist/Agronomist, Natural Resources Institute, UK
Mr Mwambungu – District Agricultural and Livestock Development Officer (Kyela district)
Mrs Masangya - District Agricultural and Livestock Development Officer (Morogoro District)

### 4.3.2 Scaling up

- On farm experimentation - Multi disciplinary (see above);
- Farmer as a researcher – are involved in experiment layout and making assessment of their experiment treatment from planting to harvesting;
- Farmer researchers' working in group;
- Periodic joint evaluation of experimental plots by both researchers and farmers;
- Farmer exchange visits to sites where farmers are experience with use of the rotation – farmers learning from farmers;
- Primary school involvement to impart knowledge on farmers of tomorrow and spreading same information to parents who are not members of research groups (songs & poems);
- Leaflets and posters distributed and posted at most advantaged point within and outside project villages;
-

Evidence from mid-term review and final technical reports shows that number of participating villages increased from 1 in 1998 to more that 15 in 2005. Similarly in each village an average of 10 new farmers have acquired Marejea seeds from participating farmers. Compared to the 1990s period this is the most successful achievement recorded in terms of adoption of the technology

**Conclusion and policy recommendations**

In Tanzania and elsewhere in sub-Saharan Africa, increasing food production is a huge challenge, constrained by limited opportunities to increase arable land area and the declining yields due to continuous cultivation and declining soil fertility. With the increase in prices of chemical fertilizer and its limited availability in rural areas, use Marejea and other green manures offers a low-cost solution. Use of Marejea will not only increase land productivity, control weeds but concur with the current requirement for increased demand for organic products in both local and international market. Based on this conclusion the following recommendations are suggested:

- Since economic value has been established, more research on the best rotational method that will increase return and or reduce cost (time, drudgery and financial) should continue;
- Concerted effort by all stakeholders (farmers, researchers, NGOs, and Government officials) to ensure that the technology is scaled up to as many farmers, in many locations as possible;

- Government should improve availability of other facilitating or supporting services such as roads so farmers can benefit from the increased in production levels due to use of green manure;
- Facilitate group approach in learning.

**List of people contacted**

| | |
|---|---|
| Mwambola, L.J. | DALDO office Kyela (0748 772292) |
| Faya (Dr.) | DALDO Rungwe – Tukuyu |
| Mwaselela, S.J. | Agro-mechanization officer, DALDO office Mbeya |
| Sophia Msemwa | District Extension Officer – Mbeya rural |
| Isubira Yosefa (Sister) | Mlowo mission, Box 179 Mbeya |
| Nakalengo Crensia (Sister) | Mlowo mission, Box 179 Mbeya |
| Mawongo, Adolfu | Farmer – Kiswila village |
| Dallo, Deodatus | Village chairman – Kiswila village |
| George Shomari Mkami | Retired teacher – Mtombozi village |