DFID CROP PROTECTION PROGRAMME

Integrated control of *Striga* in Tanzania

R6654 (ZA0004)

FINAL TECHNICAL REPORT

March 2000

C R RICHES, NATURAL RESOURCES INSTITUTE, UNIVERSITY OF GREENWICH

RNRKS PROJECT FINAL TECHNICAL REPORT

Integrated control of *Striga* in Tanzania – R6654

NRIL Contract numbers: 1. ZA0004

Programme Manager: Natural Resources International

RNRKS Programme: Crop Protection

RNRKS Production System: Semi-arid

Commodity Base: Finger millet, Sorghum, Rice

Project Leader/Institution: C R Riches, Natural Resources Institute

	Planned	**Actual**
START DATE:	1-4-96	1-4-96
FINISH DATE:	31-3-99	30-9-99[1]
TOTAL COST:	£150,768	

[1] Following an agreed 6 month extension

CONTENTS

Executive Summary

i) A series of on-station and on-farm trials were undertaken to investigate components of an integrated system of *Striga* management for sorghum, finger millet and rice in Tanzania. This work was supported by glasshouse work conducted in UK.

ii) Sorghum lines were selected on the basis of low susceptibility and farmer preference in on-farm trials in the Lake Zone (*S. hermonthica* infested) and Central Zone (*S. asiatica* infested). Farmers showed particular interest in the early maturing line P9405, obtained from Purdue University USA which also performed well at a site infested by *S. forbesii*. This was also tested in combination with application of animal manure or a legume inter-crop. Efforts are now needed to multiply selected lines for wider testing prior to registration. Studies of farmers perceptions of the *Striga* problem indicated that they have little understanding of the life cycle or biology of the parasite – this is a considerable constraint to the process of farmer evaluation of control options. Posters were produced to inform both extension workers and farmers about key aspects of *Striga* biology and control.

iii) *S. hermonthica* is a problem on finger miller in the Mara Region. Pot screening of local landrace lines did not reveal any resistance. Laboratory and greenhouse systems for screening this crop were demonstrated as suitable.

iv) *S. asiatica* is associated with declining soil fertility and falling yields of upland rice in Kyela district in southern Tanzania. Work was undertaken with farmer groups formed by district extension staff to evaluate rice cultivars and practices for improving soil fertility. Lines which had shown partial resistance to other *Striga* species in West Africa were susceptible. Farmers indicated a clear preference for tall vigorous rice lines with aromatic grains and have requested the opportunity to evaluate a number of lines further on larger plots. Application of urea at 25 to 50 kg N ha^{-1} reduced parasite number in rice and improved yields. The parasitic weed *Ramphicarpa fistulosa* was identified as a constraint to lowland rice production in Kyela.

Background

1. Parasitic weeds in the genus *Striga* species are widespread constraints to the production of staple cereal crops in semi-arid areas of Eastern and Southern Africa, including finger millet, sorghum and upland rice. They have been estimated to infest some 40% of the cereal producing areas of sub-Saharan Africa; *S. hermonthica* alone may now infest over 10 million hectares. Semi-arid areas of Tanzania lie in a zone where the three most significant *Striga* species which infest cereals i.e. *S. asiatica, S. forbesii* and *S. hermonthica* occur. Most of the districts in semi-arid areas of Tanzania have been surveyed and the distribution of *Striga*, found throughout these areas, is broadly known (Mbwaga 1994; Mbwaga 1996). Grain yield loss from parasitised cereal crops is difficult to estimate with any reliability due to variations in soil fertility, infestation levels and tolerance of local varieties. Reports of 5-30% loss of potential yield, with crop failure at heavily infested sites are common in the literature for various parts of Africa. Other consequences of *Striga* infestation include farm abandonment, now difficult in the face of a shortage of productive arable land, or a change of cropping pattern to less favoured, albeit resistant crop species. Reichmann, *et al* (1995) reported that 75% of farmers interviewed in Shinyanga region of Tanzania considered *Striga* an increasing problem on sorghum, on which they were unable to obtain satisfactory advice from extension on effective control strategies.

2. Prior to 1996 work on the development of *Striga* management strategies had been undertaken at research station locations in Tanzania by Dr Mbwaga, the plant pathologist at Ilonga Agricultural Research and Training Institute. Funding from the Swedish Aid Programme had supported a number of surveys and the production of a colour leaflet and video aimed at raising awareness of the problem within the research and extension services. There had also been links with the SADCC/ICRISAT Sorghum and Millet Programme. This had resulted in the production of a number of breeding lines in an attempt to introduce parasite resistance into lines adapted to Tanzanian conditions. However, due to limited local funding these had not been screened and findings from on-station trials had not been followed up on-farm within affected farming communities.

3. Project R6654 was therefore designed to support national programme efforts to develop integrated methods for the management of *Striga* in Tanzania by introducing a farmer participatory research component. A much wider group of potentially resistant sorghum lines was obtained for screening and investigations began on the problems of *Striga* in finger millet and upland rice. A second CPP project on *Striga* (R6921), undertaken at the same time by Dr Mbwaga in collaboration with the University of Sheffield, investigated the effect of nitrogen on parasitism of maize by *Striga.* This project also collaborated with R6654 to undertake detailed laboratory studies to describe mechanisms of tolerance to *Striga* in the sorghum lines tested in the field.

Project Purpose

4. The project was designed to contribute to the RNRKS programme purpose “Improved methods for the control of *Alectra* and *Striga* in cowpea, groundnut and cereals developed and promoted”. The specific objectives of the project were to develop and evaluate practices for the control of *Striga* species in cereal based cropping systems in Tanzania through the integration of techniques appropriate to smallholder farmers.

Research Activities

5. Research activities were implemented in Tanzania by research staff from Hombolo, Ilonga, Ukiriguru and Uyole Agricultural Research Institutes led by Dr Mbwaga. On-station trials were planted in the Lake Zone at Ukiriguru (infested by *S. asiatica* and *S. hermonthica*) and in Central Zone at Hombolo (*S. asiatica*). A farmers field infested by *S. asiatica* and *S. forbesii* was also used for replicated research trials at Melela near Morogoro, Eastern Zone. Collaboration was developed with district agricultural extension staff to implement on-farm studies involving sorghum in Misungwi District (Lake Zone), Dodoma Urban and Dodoma Rural Districts (Central Zone) and upland rice in Kyela District (Southern Highlands Zone) where the crop is infested by *S. asiatica*.

6. Contact with farmers in Dodoma was initiated via a Rapid Rural Appraisal study in three villages where trials were subsequently planted. The RRA was used to gain an understanding of the existing farming system and farmers understanding of the *Striga* problem. For Misungwi the project worked with existing farmer research groups which had been established for on-farm sorghum and millet studies by the Lake Zone Farming systems team. This had conducted research in the area for some time including farming systems characterisation studies e.g. Enserink and Kaitaba (1996). Extension staff in Kyela district had identified that *S. asiatia* was a constraint to upland rice production. They facilitated the formation of farmer research groups in two villages. Focus group discussion was used to collect information on the farming system. An earlier study also provided a useful baseline (ICRA, 1994). Two short visits were also made to Mara Region (Lake Zone) to examine the current importance of the finger millet crop and to assess the importance of *striga* on the crop.

7. In order to ensure adequate supplies of crop seed for both on-station and on-farm studies it was necessary for the project to maintain seed multiplication plots at Ilonga. This required a significant investment of resources and time to maintain the purity of lines. Up to 1 ha was planted each year. Ilonga was supplied with a Land Rover and computer for use on the project.

8. Supporting glasshouse and laboratory trials were undertaken at Long Ashton Research Station, UK. These concentrated on characterising resistance to *Striga* in sorghum and finger millet. The following have made inputs to the project:

NRI

C R Riches	Project leader, greenhouse studies at LARS
R I Lamboll	Co-ordination of socio-economic studies

Ilonga Agricultural Research Institute, Kilosa

A M Mbwaga	Co-ordination of field work in Tanzania
J Kaswende	Studies at Melela

Hombolo Research Station, Dodoma

Mr Letayo	On-station studies

Ukiriguru Agricultural Research Institute, Mwanza

E B Kapinga Studies on-station and in Misungwi District

Uyole Agricultural Research Institute

J Kayeke On-farm studies in Kyela District

District Extension, Dodoma

J V Semwaiko District Crops Officer Dodoma Rural
R Matary District Extension Officer Dodoma Rural

Outputs

Output 1: Validation of sources of resistance to sorghum under smallholder farmer conditions.

9. When the project started sorghum lines which had shown promising levels of resistance elsewhere in Africa were obtained from a number of sources. These included the INTSORMIL programme at Purdue University and ICRISAT. During previous collaboration with Dr Mbwaga and the sorghum breeder at Ilonga, the SADCC/ICRISAT sorghum and Millet Improvement Programme (SMIP) had hybridised their so called *Striga* resistant source lines (SAR lines) with sorghum lines adapted to Tanzanian conditions. This produced more than 100 progenies. The sorghum breeder in Tanzania had also crossed the local tolerant line Wijeta with elite lines in an attempt to improve agronomic characteristics. These materials were all made available to the project and were evaluated in pot trials, in replicated trials at on-station hot spots, Ukiriguru for *S. hermonthica,* and Hombolo for *S. asiatica*, and on-farm. These on-farm trials were undertaken in two villages in Lake Zone (*S. hermonthica* infested) and in three villages in Dodoma Rural (*S. asiatica* infested). Low-susceptibility, in term of numbers of emerged *Striga* was confirmed for a number of lines including P9405 ex-Purdue University, SAR29 and SRN39. This partial resistance was less pronounced at low fertility sites, particularly infested by *S. hermonthica* in the Lake Zone. Summaries of results of the field trials have been included in the proceedings of the project stakeholder workshop, held in Dar es Salaam in September, 1999 – Annex 1 (see papers by Mbwaga, 2000 p 34; and Kapinga, 2000 p 42). During field days and group discussions, farmers selected lines for further testing on the basis of low susceptibility, plant and grain type (see Lamboll, 2000). A late and variable start to the rains in 1999 resulted in delayed sowing and the need for replanting at many sites. Under these conditions farmers in Dodoma were particularly impressed with not only the reduced density of *Striga*, but also with the early maturity of P9405 and SAR 29. These produced a grain harvest in about 70 days when local landraces were still flowering. Parallel work was also undertaken at Melela (Eastern Zone) at a site infested by *S. forbesii* and *S. asiatica* infested site. A number of the Purdue lines supported low numbers of emerged parasite (see Massawe, 2000 p 47). Farmers at a field day here also selected Purdue materials, including P9405, for further testing.

10. Supporting work in the glasshouse at LARS UK confirmed that these lines are less susceptible to the parasite than Pato, the most recently released cultivar in Tanzania (Table 1.) There is evidence that the emergence of two *Striga* species is delayed on P9405 compared to Pato. The number of emerged *Striga* by 83 days after sowing was considerably less on P9405 and SRN39 compared to the other lines tested. Interestingly the height of parasite stems, of both species, supported by P9405 was also less than those on Pato, and the susceptible check Combine Shallu (ex India)

11. The response of *Striga* on the Purdue lines was also examined in detail by use of an *in vitro* system. Sorghum seedlings were raised on filter paper placed on plastic trays, using a hydropoinc system. This allows pre-germinated parasite seeds to be placed on the host root and the subsequent course of infection to be monitored by use of a microscope. Compared to Combine shallu, a known susceptible line regularly used for this assay at LARS, the success of *S. hermonthica* attaching to the Purdue lines was similar (Table 2). However subsequent development was slower as indicted by parasite shoot height.

12. The tray system was also used to examine the response of four other lines to *S. hermonthica* from three locations in Tanzania (Table 3). Once again Combine shallu was used as a standard susceptible check. There was a low success rate of attachment of the parasite on the roots of SRN39 compared to on the check and subsequent development on SRN39 was also slow. This mirrored the situation seen in the pot trial. Ochuti is a landrace sorghum from Kenya. This had been selected as tolerant to the parasite by Sheffield University. In this trial it supported slower *Striga* development than the check in the first 20 days after placing parasite seed onto its roots. Framida and IS777 also appeared to support slower parasite development. IS777 had been previously reported to be resistant to *S. hermonthica* in West Africa. It was tested at the *Striga* hot spot at Ukiriguru but proved to be susceptible.

Table 1. Summary of pot trial data for evaluation of response of sorghum lines to *S. hermonthica* ex Shinyanga and *S. asiatica* ex Hombolo. One host plant per pot with soil containing approx. 500 viable parasite seeds.

Line		*Striga* parameters	
S. herminthica	Days to 50% emergence	Number per pot	Mean height mm
SAR 29	61	20 (4-20)	322
SRN 39	67	8 (0-18)	353
P9405	75	10 (5-13)	163
Pato	72	31 (20-38)	331
Combine shallu	57	24 (22-27)	656
S. asiatica			
SAR 29	72	67 (58-75)	231
SRN 39	83	4 (5)	76
P9405	77	18 (4-39)	91
Pato	72	62 (48-81)	238
Combine shallu	62	46 (22-82)	314

Table 2. Development of *S. hermonthica* ex Shinyanga on the roots of 18 day old sorghum seedlings maintained on trays in hydroponic culture. *Striga* development at 20 days after placing pre-germinated seed on host roots. Combine shallu results indicate check for preceding test lines in three separate tests of 5 replicate trays.

Sorghum line	% success infestations	Mean shoot height[1]
P9405	20	59
P9402	23	82
Combine shallu	**20**	**306**
P9403	15	62
P9404	30	83
P9405	22	52
P9406	27	71
Combine shallu	**33**	**95**
P9407	20	58
P9408	34	71
Combine shallu	**55**	**128**

[1] As microscope eyepiece units.

Table 3. Development of *S. hermonthica* from three areas of Tanzania on the roots of 18 day old sorghum seedlings maintained on trays in hydroponic culture. *Striga* development at 20 days after placing pre-germinated seed on host roots. Combine shallu results indicate check for preceding test lines in three separate tests of 5 replicate trays.

Striga		Ex shinyanga			Ex Ukiriguru			Ex Kuruyu	
Line	% success	Mean height[1]	Tallest shoot	% success	Mean height	Tallest shoot	% success	Mean height	Tallest shoot
SRN39	6	51	230						
C. shallu	43	160	400						
Ochuti	18	78	310	20	107	340	20	36	120
C. shallu	35	156	500	43	146	440	26	103	400
Framida	35	32	120				24	29	60
C. shallu	16	95	400				10	93	370
IS 777	27	59	280	17	74	210	21	50	120
C. shallu	25	134	580	32	223	380	30	202	380

[1] As microscope eyepiece units

13. From more than one hundred progenies supplied by ICRISAT, 13 were retained for further analysis in 1999 at Ukiriguru. All lines supported emergence of both *S. hermonthica* and *S. asiatica* (Table 4). At this heavily infested site Macia x SAR 29 supported least *Striga* emergence and should be tested further. Yields were low due to sorghum midge attack.

Table 4. Striga count (per 7.5 m^2) at 9 WAP, 12 WAP, at crop harvest, stover and grain weight (kg/ha) obtained from Sorghum Population Screening for *Striga* resistance at Ukiriguru – 1999.

Treatment	9 WAP	12 WAP		Crop harvest		Stover	Grain yield
	S. herm.	*S. herm.*	*S. asia.*	*S. herm.*	*S. asia.*	weight (kg/ha)	(kg/ha)
SV-1 x SAR 19	3	119	1	147	2	943.00	133.78
Macia x SAR 39	1	29	2	34	7	3340.00	107.33
SAR 19 x NL-229	1	45	0	110	1	667.00	134.89
SV-2 x SAR 29	10	216	3	284	8	1320.00	298.67
SV-2 x SAR 35	7	196	11	173	10	700.00	4.67
SAR33 x SV-2	7	201	2	215	1	597.00	90.22
SAR35 x SV-1	0	34	0	71	0	540.00	15.56
SAR33 x LARS-19	2	185	5	221	2	483.00	84.00
SDSL 87019 x SAR 29	1	58	0	115	0	757.00	99.56
Weigita	2	207	4	218	10	700.00	68.13
SDS 2293-6 X SAR 16	8	137	1	181	3	867.00	77.47
SAR 29 x SDSL 87019	4	303	12	274	10	553.00	79.33
Macia x SAR 35	13	292	11	261	7	863.00	140.00
P9405	0	61	1	100	4	867.00	202.22
SAR 16 x LARS-46-85		85	2	107	9	717.00	140.00
Tegemeo	0	52	1	124	5	303.00	0
Grand Mean	3.79	138.00	3.60	164.70	4.50	713.54	112.40
S.E.	13.83	24.13	9.74	22.46	1.16	45.15	13.04

14. Crosses based on the tolerant line Weijta as a parent all supported emergence of both *S. asiatica* and *S. forbesii* at Melela (Table 5). Yields were high, particularly for 85-IL-208 x Weijita and a selection of these progenies should now be tested on larger plots for tolerance under farmer conditions, and to assess farmer acceptance of the grain type.

Table 5. Evaluation of Weijita Crosses for *Striga* Resistance at Melela 1999 *Striga* count/7.5 m^2

Variety	Stand Count	12 WAP		AT HARVEST		Grain yield
		S. asiatica	S. forbesii	S. asiatica	S. orbesii	(kg/ha)
Weijita x Tegemeo	57	50.5	76.0	61.0	78.0	1366.7
Weijita x Pato	65	105.0	123.0	389.5	216.5	633.3
Tegemeo x Weijita	57	99.5	95.5	228.5	223.0	1400.0
Weijita x Serena	53	100.0	68.0	370.0	116.0	1833.3
Weijita x SAR 29	65	84.0	32.0	257.0	103.5	1400.0
Weijita x 85-IL-208	60	61.5	93.5	135.5	47.5	933.0
85-IL-208 x Weijita	49	22.0	16.0	45.5	58.5	1833.3
SV- 1 x SAR 29	60	25.0	208.0	153.0	285.0	1000.0
Weijita x SV-1	57	40.0	146.5	153.5	507.0	716.7
Grand Mean		65.27	95.44	199.27	181.67	1235.18
S.E.		13.21	17.59	39.48	41.46	174.86

15. Seed multiplication was undertaken for three seasons at Ilonga to provide sufficient seed for collaborating farmers. This aspect of the project included improvement of the purity of seed stocks by removing off types in multiplication plots and preventing cross-pollination.

Output 2: Selection of sources of resistance to *Striga* in finger millet for subsequent field testing.

16. During development of the project memorandum *Striga* had been identified, by Tanzania National Programme staff as one of the constraints to finger millet production. In Tanzania the crop is concentrated in mid-altitude areas of Mara Region to the east of Lake Victoria. Reports of priority setting studies undertaken by Ukiriguru for the IFAD funded "Mara Regional Agricultural Development Project" describe a serious *Striga* problem on sorghum at low and mid-altitudes in Bunda and Tarime districts (FAO, 1995). The original plan to undertake an RRA here in 1997 had to be abandoned due to the 1996/97 season drought – few farmers were able to plant. Subsequently a two day reconnaissance survey was undertaken in May 1998, targeted on mid-altitude areas (1,200 to 1,400 m) of Masoma, Tarime and Serengeti Districts where, according to extension staff, finger millet is an important crop. Travel in Mara, particularly in Serengeti, is difficult during the rainy season and at the time of the survey access was restricted due to swollen rivers and broken bridges following prolonged rains. However, through contacts with village extension officers and farmers a representative picture of the situation was gained.

17. In summary, the area planted to finger millet has been in decline since about 1990, largely due to reluctance of younger people to plant what they perceive to be a labour intensive crop. Weeding is particularly time consuming in finger millet. The drought of 1997 and floods of 1998 had resulted in relatively small areas being planted but farmers and extension officers indicated that in more favourable years many farmers plant small portions of their fields to finger millet in all three district visited, particularly Serengeti. Farmers and extension officers were unanimous in their assessment that *S. hermonthica* is a major pest of the crop and dense infestations of this, in places mixed with *S. asiatica,* were observed in finger millet fields. Farmers described the familiar situation of an increase in *Striga* associated with a reduced opportunity to fallow due to increased population pressure. There has been an increase in "cassava fallow" and in Serengeti, for example, cassava is now an important food. Sorghum is the main cereal here with finger millet an important cash crop - according to farmers it is of more importance than maize. A number of land-races of finger millet are planted. Resistance would be of interest to households who wish to continue producing the crop as S*triga* is perceived as an increasing problem.

18. An attempt to screen the national finger-millet germplasm collection in 1996/97 failed due to the drought at Ukiriguru. A smaller collection of 32 lines was screened in pots and in the field in 1997/98 but all were found to be susceptible (Table 6). The trial was repeated with essentially the same results.

19. The "soil box" technique was tested for screening finger millet at LARS. Eleven day old finger millet seedlings were transferred on to compost in an opaque black plastic box from which light is excluded by a lid. The plant shoots are maintained in the light with the plant growing through a hole in the side of the box. After a further 15 days pre-germinated seed of *S. hermonthica* was placed on to the finger millet roots which ramify over the surface of the compost in the box. The seed was stimulated to germinate by maize root exudate. Between 20 and 25 seeds were placed on each of 5 plants per cultivar tested. Subsequently *Striga* development can be monitored on the host roots by use of a microscope. Striga attached and developed successfully on the roots of the four cultivars selected for study (Table 7). These included the most and one of the least susceptible lines in the pot trial in terms of emerged *Striga* number. Kasanda, on which just 2 parasites per pot had emerged supported the least proportion of successful attachments in the box system. Nameka (4.5 shoots per pot) supported somewhat slower development of *S. hermonthica* in terms of mean and tallest shoot height by 30 days after seed transfer. From the pot trial it had been observed that the parasite emerged somewhat later on Nameka than other lines tested. This study demonstrated that a combination of pot trials and use of the "soil box" system would be suitable for screening finger millet.

Table 6. Susceptibility of 32 finger millet lines to *S. hermonthica*. Emerged parasite number per pot of three millet plants at 12 weeks after planting – Ukiriguru 1998.

Finger millet entry	Mean parasite number per pot
Mangayo	14.5
Katila	11.5
Usausha	10.5
Ndele	10
SDFM 1143	8
Karuna	7.5
Kivuntui	7.5
Kalae	7
Meru local	7
P388	7
Chikwelekwele	7
L516	6.5
Makazi	6.5
Mantila	6.5
Kahurunge Kadogo	6.5
Usango local	6
Makuru	6
Nyamweri	6
Gulu	6
SDFM 1352	5.5
Ntiswe	5.5
SSDFM 217	5.5
Mpiti	5
Serere Composite	5
Mangombe	4.5
Kahungenkulu	4.5
Kasasangwe	4.5
Naweka	4.5
Brikongo	3
Barikongo	3
Kasanda	2
Katilama	1.5
S.E.	0.52

Table 7. *S. hermonthica* (ex Shinyanga)development on the roots of finger millet cultivars maintained in soil boxes. Data taken at 30 days after transferring pre-germinated *Striga* seed.

Entry	% Successful		Mean shoot height	Tallest shoot
	Mean	Range		
Nameka	24	2-10	44	140
Kasanda	18	6-15	72	440
Kahurunge Kadogo	27	2-13	83	500
Meru Local	37	2-15	126	530

Output 3: Field validation of sources of resistance to *Striga* in upland rice.

20. An initial screening trial was undertaken with limited seed supplies in 1997/98 at an on-farm location in Kyela. Farmers evaluated the trial of 27 local and imported lines grown in 2 row plots. Ten lines were selected for further testing on basis of low susceptibility to *S. asiatica* and vigour. The farmers indicated a preference for tall varieties with vigorous vegetative growth. Results are summarised in Mbwaga, 2000 p 65, in the stakeholder workshop proceedings. *O. sativa* lines, including IR 47255-B-B-5-4 selected with partial resistance in West Africa, by previous CPP funded work, were not favoured by farmers in Kyela who considered them to be too short. Makasa and AC102196, two partially resistant *O. glaberrima* lines obtained from WARDA, were among the most infested lines in the trial, lodged prior to harvest and were not favoured by farmers. Yields on these four row plots used in the trial ranged from 0.7 to 1.5 tons per ha. Farmers requested that the lines are made available for testing on larger plots in the future. Some 27 farmers in two villages in Kyela have become involved in trials which are examining *Striga* management practices. They are interested in testing rice lines which can be productive on parasite infested soils and it is clear that suitable varieties could play an important role in Kyela and other upland rice growing areas of southern Tanzania.

21. Farmers in Kylea also pointed out to the project that another parasitic weed, *Ramphicarpa fistulosa* is a problem weed in rain fed lowland rice fields to the extent that some fields have been abandoned. District extension staff requested assistance to investigate the problem and were provided with herbicide samples in 1999 season. Observation plots were sprayed with 2.4-D which killed the parasite. However by the time of application the rice was already severely stunted and further trials will be needed to determine the most appropriate time of herbicide application.

Output 4: Development of integrated approach to *Striga* management for subsequent on-farm testing.

Potential trap-crop effects

22. Non-cereal species grown as either inter-crops or in rotation with *Striga* susceptible staples may act as trap-crops i.e. produce the germination stimulant in their root exudates without being hosts themselves. Work was undertaken at LARS to assess the trap-crop potential of a range of alternative crops which are grown in Tanzania. Root exudates were prepared by growing three ten day old crop seedlings in 25 ml distilled for 24 hours. The resulting root solution was then used to moisten pre-conditioned *Striga* seed held on glass fibre filter paper in petri-dishes. The final germination % of the parasite seed – three replicate batches of at least 25 seeds – was assessed after maintaining the seed at 30^0C. The resulting germination levels are shown, with the range of values for the replicates in Table 8.

Table 8. Effect of root exudates of various crops on the germination of *S. asiatica* (ex Hombolo) and *S. hermonthica* (ex Shinyanga).

Species	Cultivar	% germination			
		S. asiatica		*S. hermonthica*	
Cowpea	Fahari	7	0-15	76	68-89
	Vuli 1	12	2-25	49	40-58
	85F42020	8	0-15	37	14-51
	Tumaini	11	0-23	24	10-42
Maize (check)	R210	51	34-75	54	44-62
Sesame	Local “ex Hombolo”	4	0-13	46	22-53
Sunflower	P1162453	22	8-39	31	11-46
Pigeon Pea	ICP9145	8	0-38	27	18-43
	ICP0040	8	0-20	32	13-76
Crotalaria		34	24-52	41	25-65
Maize (check)	R210	57	46-73	65	50-92

23. Cowpea, particularly the cultivar Fahari, is a potent source of *S. hermonthica* germination stimulant and appeared to be more effective that the maize check. The cultivars of cowpea which were available for testing were however considerably less effective at stimulating germination of *S. asiatica*. These results suggest that provided it is acceptable to farmers, Fahari is a useful cultivar to use as an inter-crop at *S. hermonthica* infested sites in the Lake Zone. For the other crops a similar pattern emerged with greater effectiveness being observed on *S. hermonthica.* Where there is a market for sunflower and pigeon pea both crops are likely to have an impact on the *Striga* seed bank, particularly where *S. hermonthica* is a problem. The result for *Crotalaria* is particularly promising and suggests that, when grown at a high density as a green manure, the species will also act as a trap-crop to reduce parasite infestation.

24. During mid-1999 an MSc student from Malawi, undertook thesis research in association with the project at LARS (Mainjeni, 1999). This study confirmed that the cowpea line B359, originating from Botswana, is completely resistant to *Alectra vogelii*. B359 is a late maturing landrace with an indeterminate habit and is not suitable for immediate use by famers in East Africa. It does, however, provide a likely source of resistance to use in cowpea improvement in Tanzania. *Alectra* resistant cowpea would be useful for deployment in inter-cropping systems, particularly in Central region where *Alectra* is a problem. An *Alectra* resistant line which produces the *Striga* germination stimulant could be used for trap-cropping.

25. Work to asses components of an integrated approach to *Striga* management was undertaken on-farm to ensure farmer participation in system development, linked to output 5. In 1997/98 trials on six farms in Iteja (Lake Zone) became water-logged and failed but sorghum work was completed successfully in Mwagala (Lake Zone), Mvumi, Hombolo and Chipanga (Dodoma). Reduced *Striga* attack was associated with application of cattle manure or inter-cropping with cowpea or groundnut. *Striga* resistance of P9405 and SAR 29 was more pronounced when these lines were grown in combination with an inter-crop or following application of manure. In 1999 the use of legume inter-crops and manure were assessed in crops of P9405 and local sorghum selected by participating farmers. Some suppression of *Striga* was observed in the Lake Zone in the inter-cropping system and manure application improved yields in Dodoma. However the trials are difficult to evaluate in the absence of a consistent series of yield data. Yields were reduced by poor rainfall distribution and sorghum midge attack in 1999. Results are summarised in Mbwaga, 2000 (p 56) and Kapinga 2000 (p 42). Although manure application is a useful option in *Striga* management the general lack of transport in the rural areas of Tanzania restricts the amount that is likely to be used. Most households can only move manure from cattle kraals to their fields by basket. It will therefore only be used on fields that are close to house sites and on limited areas of land.

26. Reduced *Striga* emergence shown to be associated with enhanced yields following application of urea, at affordable rates, to rice. Mean *S. asiatica* counts following application of 0, 25 or 50 kg ha^{-1} urea were 10.6, 6.7 and 3.0 plants m^{-1} while associated yields were 1756, 2474 and 3051 kg ha^{-1} respectively The rsults are summarised in Kayeke, 2000. Rice is an important cash crop in Kyela so fertiliser is a feasible technology for target use on *Striga* infested sites. *Crotalaria* for soil fertility improvement has also been introduced in trials at 27 sites in Kyela as part of 1998/99 programme. There were trials with the green manure on a few farms in the area some years ago and farmers are keen to have access to more seed. The effect on subsequent rice yield is to be evaluated in 1999/2000.

Output5: Assessment of farmer acceptability of *Striga* management options.

27. In July 1997 RRA activities were undertaken in three villages in Dodoma Rural district. These led to an understanding of the farming system; generation of research priorities, initiation of farmer interest and planning of trials programme (Mbwaga, 1998 – See apendix). Discussions focusing on farmers perceptions of the *Striga* problem revealed that they have little knowledge of the biology of the pest, beyond a link with declining soil fertility, and have no existing control measures. *Striga* control practices are knowledge based and it is difficult for farmers to critically assess their likely long term value without some basic knowledge of the life-cysle of the parasite. This was provided by the project at focus group sessions at various times during each crop season. Throughout the project extension staff managing on-farm trials in Lake Zone, Dodoma and Kyela

involved farmers in the evaluation of resistant varieties and other *Striga* control practices. Farmer group discussion at trial sites led to the selection of sorghum and rice lines for more extensive testing. Farmers indicated preferences for choice of cultivars and comment on practicability of other parasite management technologies. Information from these studies was summarised in two presentations made at the Stakeholder workshop (Lamboll, 2000. p 22 and p 61).

Output 6: Reports and publications at regional conferences and in international journals.

28. The project report on the *Striga* problem in Dodoma Region and the Lake Zone was distributed in Tanzania. Dissemination emphasis has been to focus on local institutions within Tanzania. Hence Dr Mbwaga and other collaborators have made presentations at extension meetings and within the ministry in Tanzania. This was necessary to raise the profile of the *Striga* problem in Tanzania. Even now it is not clearly understood by some extension officers. He has also contributed information on *Striga* to a leaflet, written in Swahili, distributed to extension officers and farmers in parts of Dodoma by the CPP funded Sorghum Smut project. Following two seasons of field trials under conditions of drought and excessive rainfall, when few crops went through to yield, it would have been inappropriate to have offered papers for international publication. Project results were summarised and discussed at a national stakeholder meeting in Dar es Salaam in September, 1999. The proceedings of this meeting, supported by CPP dissemination funding, is attached in the appendix.

Contribution of Outputs to Project Goal:

29. This project has addressed the production system purpose of " Impact of weeds in the production cycle minimised". The work undertaken has targeted *Striga*, one important weed in East African cereal-based systems. The most resistant sorghum lines which are currently available have been selected with farmers, and a start has been made to assess the productivity of these when used in combination with other *Striga* control measures (trials in four villages of two Zones in Tanzania). The project has demonstrated that the resistance is less pronounced at sites with low fertility but it can be enhanced by applications of manure or by inter-cropping. No resistance has been found among the finger millet lines made available to the project for screening. Partially resistant *O. glaberrima* and *O. sativa* rice lines from West Africa were tested but were not favoured by farmers and did not show high levels of resistance. The value of low application rates of urea in rice cash crops has been demonstrated. A critical assessment of the economic value of the *Striga* management practices investigated by the project was compromised by the difficult weather conditions, and associated pest infestations experience during the life of the project. It therefore proved difficult to take crops to yield in on-farm trials. Indeed in the villages of Dodoma Rural and Urban districts food became particularly short during early 1999 and a number of participating farmers were forced to leave their farms in search of work and food. By harvest farmers at some sites were unable to leave plots until the crop matured and removed and consumed sorghum heads as these ripened.

30. Involving farming communities in the assessment of *Striga* management options has required the introduction of new methodologies in some of the areas of Tanzania where the project has been working. Although the use of farmer research groups is well established in the Lake Zone, these are not well known in other areas including Dodoma. It therefore took some time for research and extension staff to fully embrace this way of working. By the end of the project the group approach had become well established in the study villages and these will provide ideal locations for further studies. As the project developed there was increasing interest in Tanzania in addressing the *Striga* problem. With the establishment of Zonal Research Programmes, *Striga* has now been identified as a priority issue via zonal internal programme reviews in Eastern, Central, Lake, Southern Highlands and Southern Zones. Expertise on *Striga* research remains concentrated at Ilonga, the Eastern Zone research centre. As other zones have begun to develop their programmes it was requested, at the stakeholder workshop, that any follow on project to R6654 should help back-stop efforts to develop and promote *Striga* management recommendations at zonal level. In Kyela the district council decided to allocate funds so that district and village extension staff can continue to work with *Striga* researchers from outside the district until 2002.

Project Publications:

A.M. Mbwaga R. Lamboll and C R Riches 1998 *The Striga Problem in Dodoma Region and the Lake Zone of Tanzania: Analysis of the Problem and Research Priorities*. Natural Resources Institute, University of Greenwich, Chatham Maritime, Kent, UK pp 29

Riches, C.R. (Ed.) 2000 *Striga* distribution and management in Tanzania. Proceedings of a Stakeholder Workshop 8th to 9th September 1999 Dar es Salaam. Natural Resources Institute, University of Greenwich, Chatham Maritime, Kent, UK pp 87.

Internal Reports:

Visit reports to Project A0533 – Tanzania. Natural Resources Institute, University of Greenwich.

July 1996 (Riches and Lamboll)
March 1997 (Lamboll
May 1997 (Riches and Lamboll)
March 1998 (Lamboll)
May 1998 (Riches)
November 1998 (Riches)
May 1999 (Riches and Lamboll)
September 1999 (Riches and Lamboll)

Other Dissemination of Results:

Posters
Two colour posters printed in Tanzania for use by extension officers. One shows aspects of the life cycle and biology of *Striga* and should help increase awareness in the farming community about *Striga*. The second shows options for the control of *Striga* in a series of diagrams.

MSc. Thesis
Mainjeni, C.E. 1999 *The host range of Alectra vogelii* Benth. From Malawi and resistance in common bean and cowpea. MSc. Thesis, University of Bath, pp 83.

Other references cited

Enserink, H.J. and Kaitaba, E. 1996 *Farming systems zonation Lake Zone , Tanzania*. Ukiriguru, Tanzania: Lake Zone Agricultural Research and Training Institute.

FAO, 1995 *Mara Region Agricultural Development Project: socio-economic and Production Systems Study*.

ICRA 1994 *A dynamic farming system: The case of Kyela District Tanzania*. Working Document Series 37. Wageningen, The Netherlands: International Centre For Development Oriented Research in Agriculture.

Mbwaga, A.M. 1994 *Striga* and *Alectra* survey of the occurrence, distribution and on-farm verification of *Striga* control practices for small-scale farmers in Tanzania. Report for Plant Protection Improvement Project, ARTI Ilonga, Tanzania.

Mbwaga, A.M. 1996 Status of *Striga* species in Tanzania: Occurrence, Distribution, and on-farm control packages. Pages 195-299 In: *Drought-tolerant crops for southern Africa*, Proceedings of the SADCC/ICRISAT Regional sorghum and Pearl millet workshop, 25-29 Jul 1994, Gaborone, Botswana. Patancheru, AP, India: ICRISAT.

Reichmann, S., Kroschel, J, and Sauerborn, J. 1995 Distribution and infestation of *Striga* species in Shinyanga region of Tanzania and evaluation of control measures. *Brighton Crop Protection Conference - Weeds*, 151-156.