

***Striga* management in Uganda.**

Report on a visit to Serere for CPP project R7564.

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January 2000

Summary

Striga species have been identified by needs assessments to be widespread constraints to cereal production in the Lango and Teso farming systems of north and eastern Uganda. During a visit to the Serere Agricultural and Animal Production Research Institute (SAARI) research gaps and opportunities were explored with institute staff. Following a brief review of previous relevant work, and of the facilities available at SAARI, a set of research outputs with associated activities were developed. These cover the identification of tolerant/resistant cultivars of sorghum, finger millet and upland rice and, the identification and farmer evaluation of cultural *Striga* management strategies. Following previous work in Uganda and Tanzania a number of promising sorghum lines are available and it is recommended that these are tested in participatory variety selection trials on-farmers fields in districts adjacent to Serere. On-farm work should also be initiated on rotations and inter-cropping systems including cotton, once an important crop in local systems. These on-farm studies should be proposed for support by the DFID funded Client Oriented Agricultural Research Fund, based at SAARI. Other more strategic work on the identification of resistant finger millet and rice lines and the use of the weed *Celosia argentia* for *Striga* suppression would have benefits for Tanzania also and it is recommended that the DFID Crop Protection Programme considers funding this. Opportunities for collaboration between scientists in Tanzania and Uganda are discussed and proposals for future interaction are made.

1. Background

1. The DFID Crop Protection Programme is currently funding work in Tanzania focusing on the development of practices which will lead to the alleviation of cereal crop yield loss due to infestation by witchweeds - parasitic weeds in the genus *Striga*. During the development of the current project memorandum for R7564 the programme management team included a budget line to provide for an assessment of the need for similar or complimentary studies in Uganda. This work, to be completed during a brief visit to Uganda, would be included in the following **Activity**:

“By end December 2000 Dr Riches visits Dr Oryokot in Uganda to assess *Striga* research needs and develop research activities, possible milestones and outputs to be proposed, if appropriate, to CPP for funding”.

The funding was to allow work to be undertaken towards the following **Output**:

“Proposal for CPP funding and/or revision of existing project memorandum form and budget, to demonstrate functional linkages with new work in Uganda, if justified”

2. The required visit took place from 10th to 14th December 2000. During this time Dr Riches met staff at Serere Agricultural Research and Animal Production Research Institute (SAARI) and made a field visit to the adjacent districts of Kumi and Pallisa.
3. SAARI has the mandate to develop agricultural production technologies for the predominately semi-arid north and eastern districts of Uganda. Major staple crops in this bi-modal rainfall area are sorghum, finger millet, cassava and grain legumes. Pearl millet is also grown in some districts while maize is planted where ever conditions allow. Rice production in valley swamps has increased in recent years and the crop is also important in the dry uplands in some districts, particularly Gulu. Cotton, traditionally the principle cash crop of the zone, has been through a period of steep decline due to a variety of reasons including a reduction in draught power associated with cattle rustling, an unstable economic environment caused by rebel insurgency and, low producer prices. Other cash crops grown include sweet potato, sesame and sunflower.
4. DFID is supporting R & D activities leading to sustainable improvements in agricultural production in the Teso and Lango farming systems through competitive research fund managed by the Client-oriented Agricultural Research and Dissemination Project, based at Serere. These systems, the former predominantly based on animal draught power and the latter on hand labour, are found mainly in Soroti, Kumi, Katakwi, Pallisa (Teso), Lira and Apac districts (Lango). Within this project, set to run for five years until 2004, the Client-oriented Research Fund (CORF) will support on-farm, participatory research that contributes to sustainable improvements in rural livelihoods. The first projects to be selected for support by the fund are currently at the project memorandum stage

and the next deadline for new concept notes is in February 2001. Research at Serere has also received support from DFID research programmes. Some weed work is currently underway as part of a draught animal power (DAP) project aimed at the re-establishment of the use of DAP weeders in the Teso system.

5. During the visit discussions were held with the following:

Dr J Oryokot	Director, SAARI
Dr P Elobu	Cotton Agronomist
Mr J Ebiyau	Sorghum and millet breeder
Mr P Obuo	Legume Agronomist
Mr R Olupot	MSc. Student (Makerere University) working on <i>Striga</i> in association with Serere
Dr DJ Rees	Co-ordinator, DFID funded Client Oriented Research Support Unit

2. The *Striga* problem

6. Demand for research on *Striga* in Uganda is well documented. Following a request by the CPP management the author reviewed available literature on *Striga* in Uganda and prepared an annotated bibliography in early 1998¹. Witchweed has been recognised as a constraint to the production of finger millet, maize and sorghum in the country since at least the early 1940s. The first systematic survey of *Striga* distribution was reported in 1971 and indicated that *S. hermonthica* was a particular problem and the cause of serious cereal crop loss in the Teso system. Greathead and Milner (1971) reported that in affected areas “fields of maize or sorghum often appear bright purple from the abundance of *Striga* flowers”. *S. asiatica* was also reported to be widespread. Subsequently a national *Striga* survey undertaken in 1993 (Baguma, 1996) confirmed the widespread occurrence of witchweeds in most northern districts including Gulu and Lira, and in eastern Uganda in Soroti, Kumi, Tororo and Pallisa. During a study on the impact of weeds in selected cropping systems, Webb *et al.* (1993) also reported that farmers in Soroti considered *Striga* to be an increasing problem in both finger millet and sorghum crops. By 1995 the parasite was found in 83% and 50% of fields surveyed in Pallisa and Tororo districts respectively, causing yield losses estimated at 60 to 85% (NARO, 1997).
7. Agricultural research priorities for Uganda were set by the National Agricultural Research Organisation (NARO) in 1994. The published NARO research priority rankings, quoted by Brown and Poulter, (1997) indicate that, at the time, *Striga* was the highest ranked research priority for both finger millet and for sorghum. As part of the process of developing a client-led farmer participatory research agenda

¹ Riches, C.R. 1998 *Striga* in Uganda: a survey of the literature and opportunities for collaborative research.. A review undertaken for the DFID Crop Protection Programme. Chatham, UK: Natural Resources Institute, 13 pp.

- SAARI staff subsequently participated in needs assessments by Rapid Rural Appraisals in both Teso and Lango farming systems (Akwang *et al.*, 1998; 1999).
8. Sorghum and finger millet were confirmed as crops of major importance and in both systems the needs assessment revealed the importance of *Striga* and, the need for future work on its' control in these crops. For Teso, *Striga* was identified as a "Priority Agricultural system-wide issue". The report suggested that this should be addressed through the development of an IPM strategy and regional collaboration in Eastern Africa. For Lango areas the report similarly listed *Striga* in cereals as a "High Priority Agro-ecology-based crop and post-harvest issue". For sorghum, the development of resistant varieties and IPM packages were suggested as research activities.
 9. During the current visit the author made a brief tour through Kumi (Mukura, Ongino, Malera and Bukedia sub-counties) and Pallisa Districts (including Kaderuna, Boulaka and Kibole sub-counties). At this time of the year, approaching the end of the second rain season, the sorghum crop was approaching maturity. *S. hermonthica* was apparent in the crop almost everywhere – areas close to Pallisa town, where cotton is still widely grown, were perhaps an exception although peri-urban maize plots were highly infested. Relatively few sorghum fields had been sown to Sekado an improved cultivar released in 1995. This appeared as susceptible as any other lines seen. Serado, previously recommended for the area, was said to have some tolerance to the parasite. The most dominant cultivar seen was the local brown sorghum called "Elodir". This is clearly extremely susceptible and many sites were seen where the parasite appeared as a purple "carpet" with the crop little taller than the *Striga* itself.
 10. *S. asiatica* was also seen, generally a few plants here and there among dense stands of *S. hermonthica*. However, according to both farmers and researchers this species is more prevalent during the first rains when finger millet is an important crop – it is apparently common to see finger millet fields appearing red with *S. asiatica*.
 11. Rice was first introduced into the northern and eastern districts of Uganda around 1900 (Ochollah *et al.* 1997). By 1993 it occupied some 80,000 ha but is now rapidly gaining in importance – upland plantings are particularly significant in Gulu district (Lango system) and also in Kitgum, Arua, Lira, Apac, Mbale and Soroti. According to Dr Oryokot, *Striga* has become a serious problem in upland rice. Indeed, a delegation of members of parliament from northern districts recently appealed to the NARO through the Minister of Agriculture for assistance with dealing with this constraint. In response Mr Ebiyau recently travelled to Gulu where he heard from the extension staff that *Striga* is a serious problem in upland rice. Unfortunately the insurgency problem continues in Gulu so field visits were not feasible.

3. What previous work has been done on *Striga* in Uganda?

12. Research on the *Striga* problem has been undertaken in the Serere mandate area at various times in the past. This is summarised below.
13. *Surveys*: As discussed above a number of surveys of *Striga* distribution have been undertaken in Uganda. In addition to the Needs Assessments, the results of recent surveys of *Striga* in Pallisa, and Tororo have also been reported (Ebiyau, 1999). From the information already available the location of communities affected by the problem, where on-farm research could be initiated, is clear and it does not seem a priority at present to undertake further wide scale surveys.
14. *Germplasm evaluation - Sorghum*: Most effort in the past has been devoted to the development of parasite resistant or tolerant sorghum lines. This work dates back to the studies undertaken at Serere by Hugh Doggett during the 1950's. He continued to study the *Striga* problem here following earlier work at Ukiriguru Tanzania where he had demonstrated that the line Dobbs was resistant to the parasite (Doggett, 1965). This did not prove to be an acceptable type to farmers and did not become widely grown. Serado, selected as an improved sorghum at Serere by Doggett, was introduced and is said to have been somewhat tolerant. However, according to Mr Ebiyau, the sorghum breeder at Serere, this has now been replaced as a recommended and released line by Sekado. During the field visit to Kumi and Pallisa we saw relatively few fields of this cultivar and those were heavily infested by *Striga*. No information about its tolerance is available.
15. Mr Ebiyau has received sorghum nurseries from ICRISAT. These were screened at Pallisa and Tororo during 1996/7 when the SAR lines 1, 16, 34, and 38 were identified as potentially useful. The so called "Purdue lines" developed at Purdue University USA have also been found to have useful levels of resistance (Ebiyau *et al.*, 1999) – similar results have been obtained by the CPP *Striga* project in Tanzania. The SAR and Purdue materials are short duration sorghums with bold white seed. Farmers in the Serere area produce brown seeded sorghums. Efforts have therefore been made to incorporate resistance into local lines via breeding. Parents used include Framida, Sekado (most recently released line with brown seed), Gambela (white) and SARs. This has resulted in 10 progenies which are mostly brown. The F5 generation is available for field testing. With the range of resistant lines (i.e. the SARs and Purdue materials) available too there are some 34 lines to look at. To provide acceptable to farmers *Striga* resistance needs to be incorporated into cultivars with low shoot fly and stem borer susceptibility, bold brown seed, and good storage characteristics.
16. *Germplasm evaluation - Finger millet*: There has been no specific activity on *Striga* to date. 1000 local lines have been collected and characterised for height, maturity length and yield. Some of these have been included in a blast screening programme. On-farm evaluation of 5 promising lines has been undertaken for one season so far in Kumi district (5 sites).
17. *Germplasm evaluation – Rice*: No work has been conducted on this crop.

18. *Trap and rotation crops*: Mr Olupot is currently writing up studies on the interaction between *Striga* and the weed *Celosia argentia*. Inter-planting of *Celosia* in sorghum is an indigenous *Striga* control practice, still used by a few older farmers. In on-farm trials, for 3 seasons at 5 sites, Mr Olupot has observed consistently higher sorghum yields associated with lower *Striga* populations when this is practiced. This approach should clearly be investigated further.
19. Cotton was an important rotational crop in Teso along with finger millet, cowpea and sorghum. Work elsewhere has shown that cotton is a trap-crop for *Striga* and it has been suggested in Uganda that *Striga* has increased in severity as the area planted to cotton has declined. Inter-cropping other income generating crops in cotton has been investigated by Mr Eloubu as a way of encouraging more cotton production through more efficient use of limited land and labour. Mixtures including cotton/cowpea and cotton/soybean have been tested for three seasons on-farm. Other options are cotton/beans (some farmers are adopting this in Lango system) and cotton/groundnuts.
20. Cowpea is also a well known trap-crop for *Striga*. Some local types are available - farmers prefer semi-erect plants. Leaf production for spinach is an important aspect of cowpea production. Of many types under test for yield and leaf palatability, two have been released. Two lines of soybean have also been released. These are compatible with cotton but no work has been done on their efficacy as trap crops. Cotton/cowpea or cotton/soybean, with high *Striga* stimulant producing cultivars could provide a “double trap-crop” system.
21. Sim sim (sesame), sunflower, bambara and pigeon pea are also common crops in Teso and are good candidates for trap crop work. Any work on pigeon pea could be associated with ICRISAT promotion of new cultivars suitable for processing and export.
22. *Soil fertility*: Mr Olupot has also studied the use of fertiliser and weeding as part of his Mphil thesis project. Currently very few farmers use fertiliser and it's use as a component of soil fertility management would be constrained by the usual economic and institutional problems encountered in many smallholder systems in the region. CAN and urea were tested at 80 kg ha in combination with use of Serado and weeding at 4 and 6 weeks. CAN plus two weedings increased yield and reduced *Striga*. However, CAN alone increased *Striga*.
23. Some work was done with *Crotalaria* as a green manure some time ago but no one was aware of the location of the findings. This approach may fit in some areas where farmers prepare land on the 2nd rain but then leave it fallow until the following first rain season. Labour issues will be important.
24. Elsewhere useful sorghum yield increases have been demonstrated (e.g. in Tanzania) following the application of cattle manures. It is however very difficult to see much being used in the Teso system at this point in time because the cattle herd is still at low base although restocking is under way.

4. Research Gaps and Opportunities

25. Following this review of previous work future research opportunities were identified.

Germplasm:

- Sorghum – Participatory Variety Selection (PVS) on-farm with imported lines and progeny from crosses made in the breeding programme at Serere with resistant parents.
- Finger millet - initiate pot or field screening of local collection to select lines for inclusion in PVS.
- Rice: Initiate screening in pots or field to include potentially *Striga* resistant lines recently bred at WARDA.

Trap crops

- Screenhouse and lab work on stimulant production to identify of varieties of candidate crops for field testing
- Rotation trials on-farm with monitoring of seed banks. Associated socio-economic studies would be conducted.

Soil fertility:

- Important socio-economic questions need first to be considered through focus groups etc. Is fertiliser likely to be adopted and if so what will assist this process?
- Can green manure have a place in the systems?

5. Facilities and resources:

26. With the assistance of SAARI staff a brief review was undertaken of the facilities and resources which are currently available.

- *Staff:* Mr Ebiyau and Dr Oryokot have been involved in surveys of *Striga* incidence and in screening sorghum for susceptibility in the field. Mr Olupot is currently a student at Makerere but it is expected that he will join SAARI once he has completed his thesis. He has experience with a number of *Striga* research techniques including monitoring of the soil seed bank, for which he built his own equipment, and studies with crop root exudates. Other staff have a broad range of experience with agronomic trials both on and off station, including participatory studies. Technicians are also available. Socio-economists are on the staff of SAARI and at district level based in Kumi. They are likely to have extensive work programmes given the structure of projects funded by CORF.

- *Screenhouse:* Two modest glasshouses are available as is the frame for a screenhouse. Re-sited and clad this would be useful for pot screening.
- *Laboratory equipment:* Microscopes and an incubator are available. Computing facilities are available in a pool but there are a number of breakdowns and printing is a particular constraint. Any new work coming in would benefit from provision of a computer and printer.
- *Research sites:* The SAARI farm does not have fields infested by *Striga* and the management would like to keep it that way. This would restrict work at the site to pot and laboratory trials from which infested soils would be dumped in a pit and buried. The institute does however maintain research plots at Tororo District Farm Institute (DFI), approx. 100 km by all weather road from Soroti. The land here is infested and suitable for screening work or the study of *Striga* management technologies. Infested on-farm sites are abundant in the districts surrounding the Institute.
- *Vehicles:* Available at SAARI but in competition with other sections. Transport seems to be a contentious issue. The CORF is intended to be an on-farm programme so availability of transport is key to timely implementation of activities. The DFID project bought 6 vehicles but these are not only for use by SAARI. Any institution awarded a project can hire transport from the project. The DFID Draught Animal Power project is also largely working on-farm and resolved the situation by importing a second hand vehicle for £12,000. Funds would be needed for running costs, fuel and maintenance in any case. Vehicles can be hired in Soroti as an alternative.

6. Proposed work on *Striga* management for the Teso and Lango farming systems in Uganda.

27. The needs assessments conducted in Teso and Lango farming systems, review of previous work and discussions with staff at Serere indicate clearly that *Striga* on cereals is a widespread constraint to smallholder crop productivity in the SAARI mandate area. The following therefore outlines the project outputs and suggested activities which would be needed to address this issue. At this stage the outline has been prepared on the basis of what needs to be done, rather than in response to any particular funding opportunity.

Project Purpose: To develop and promote technically viable and cost effective integrated *Striga* management strategies for sorghum, finger millet and upland rice in the Teso and Lango farming systems.

Output 1. Tolerant/resistant sorghum cultivars identified and made available for promotion.

Activity 1.1: Pot evaluation of sorghum lines under screenhouse conditions at SAARI. Previous work has identified useful levels of resistance to *S. hermonthica* in a number

of lines and these have been used in crosses at SAARI from which F5 progenies are now available for testing.

Activity 1.2: Farmer participatory variety selection at *Striga* infested sites among 34 promising sorghum lines in Teso (3 sites) and Lango (3 sites) farming systems. Work through extension and NGOs as appropriate.

Activity 1.3: Replicated researcher managed trial of potential *Striga* resistant lines at Tororo DFI.

Activity 1.4: Laboratory evaluation at SAARI of promising lines identified by activities 1.1-1.3. to determine resistance mechanism.

Activity 1.5: Collection of local lines which appear to show tolerance in farmers fields. Also collect associated information on farmer perception of *Striga* problem and indigenous technical knowledge of possible control options.

Activity 1.6: Purify and multiply collected lines by selfing at SAARI.

Activity 1.7: Undertake P.V.S. with local potentially tolerant lines in Teso and Lango farming systems.

Activity 1.8: Seed multiplication of sorghum germplasm for trials.

Output 2: Tolerant/resistant finger millet cultivars identified and made available for promotion.

Activity 2.1: Pot screening, at Serere, of collection of local finger millet lines for susceptibility to *Striga*.

Activity 2.2: P.V.S. of selected lines in Teso and Lango farming systems. Work to involve extension and NGOs as appropriate.

Activity 2.3: Replicated trials of selected lines at Tororo DFI.

Activity 2.4: Seed multiplication of finger millet germplasm for trials.

Activity 2.5: Laboratory evaluation of promising lines to determine resistance mechanisms.

Output 3: Cultural *Striga* management strategies identified and, evaluated by farmers.

Activity 3.1: Laboratory screening of potential rotation or inter-crop cultivars for *Striga* stimulant production. To include available lines of cowpea, soybean, bambara, pigeon pea, sim sim and the widely grown cotton cultivar.

Activity 3.2: Rotation trial on farmers fields in Teso and Lango farming systems of appropriate rotations, including cotton with associated monitoring of *Striga* seed

banks, cereal crop yields and farmers perceptions. Would include cotton/legume inter-crops followed by cereal.

Activity 3.3: Inter-cropping trials on farmers fields in Teso and Lango farming systems to include evaluation of cereal/*Celosia argentia* mixtures, cereal legume (sorghum/cowpea or beans or soybean) and cereal/*Desmodium* options. Economic and farmer perceptions would be analysed.

Activity 3.4: Visit Tororo district to learn from farmers (and support services) who have adopted use of green manures for restoration of soil fertility.

Activity 3.5: On-farm participatory evaluation of green manure species sown in the second season for impact on yield of cereal crops in first season at *Striga* infested sites in Kumi, Pallisa and Katakwi.

Activity 3.6: Assess potential for use of fertiliser as a *Striga* management option through discussion with farmers and analysis of secondary literature.

Output 4: Tolerant/resistant upland rice cultivars identified and made available for promotion.

Activity 4.1: Evaluate susceptibility and yield of local and introduced rice lines (including materials from WARDA, West Africa) at Tororo DFI.

Activity 4.2: On-farm P.V.S. of promising rice lines at *Striga* infested sites in Pallisa and Katakwi. If security permits this work would also be undertaken in gulu in collaboration with local agencies.

Activity 4.3: Seed multiplication of upland rice lines for use in trials.

7. A strategy for the development of project concept notes for funding

28. Prioritisation of the above activities and a strategy for attracting DFID funding were discussed with Dr Oryokot and his staff. Opportunities with in the CORF were also discussed with Dr Rees who co-ordinates the Client Oriented Research Support Unit. CORF funds are targeted at on-farm adaptive work. As *Striga* was identified as a very clear research need by the studies leading to the establishment of CORF it would seem that an application for financial support to the fund is a priority. SAARI staff had submitted a concept note to the first call for projects but this was not successful. Following this visit and the development of the outputs listed above Dr Oryokot agreed that a new well targeted concept note will be developed to cover on-farm aspects of Outputs 1 and 3. This proposal will be designed to take forward to PVS on-farm evaluation of sorghum lines and to incorporate these into rotations and inter-crops for trap-cropping. Ebiyu, Elobu and Obuo agreed to collaborate in the development of the concept note and preparation of the budget in the format required by CORF, if possible by the February 2001 deadline. Dr Oryokot requested that I assist with the development of the concept note and hope that funding can be found to allow for my involvement in the field work if the application is successful.

29. Some aspects of the research identified in paragraph 7 also appear suitable for funding by the DFID CPP. These include outputs 2 and 4 aimed at identification of resistance in finger millet and rice. Work on both crops would compliment activities being undertaken in Tanzania. Some work was done in Tanzania on finger millet by project R6654. Limited screening did not reveal resistance but only 32 lines were assessed. Both laboratory and pot screening techniques were found to be suitable for this species. During discussions in Tanzania leading to the development of the project memorandum for current work in Tanzania² (R7564), it was agreed that finger millet was not a priority for funding. Although the crop is locally important in Serengeti District, where *Striga* is a major problem on the crop, it is not widely grown elsewhere in Tanzania. Any outputs from research on finger millet in Uganda would therefore benefit farmers in Serengeti. In particular less susceptible cultivars would be welcomed and could be provided to the district extension office for on-farm testing. A *Striga* programme for finger millet would be new in Uganda and the first task would be to screen a large number of local accessions. This would require screenhouse or on-station trials (at Totoro). Such work is not likely to attract support from CORF. Similarly work on rice would initially need on-station screening of lines. A limited number of lines have been tested in southern Tanzania and it would be important to exchange materials between the two locations. Recent breeding work at WARDA developed some *O. sativa* lines incorporating resistance to *Striga* following on from work done in UK and Cote d'Ivoire by the earlier CPP project R5228. At a pot level the resistance is expressed in the new lines (Johnson *et al*, 1999). These are currently being multiplied and could be requested for future work in East Africa. It is suggested that on-station work with both finger millet and rice would be need for two seasons to select lines to include in subsequent on-farm PVS.
30. In addition to the research activities suggested for CPP funding it would be extremely valuable to find funds to allow exchange visits between scientists working on *Striga* in Tanzania and Uganda. It is to be hoped that greater regional collaboration on *Striga* may stem from recently established East Africa Sorghum and millets network co-ordinated by ICRISAT. This needs further investigation.
31. Collaboration between Uganda and Tanzanian scientists should also facilitate the development of sorghum *Striga* management strategies in Uganda. Data on cultivar trials in Tanzania has already been made available although it has to be recognised that white sorghums are preferred in Tanzania while brown seeded types are needed in Uganda so exchange of seed may be limited. Research techniques developed at Sheffield University as part of R7564 will also be of use in Uganda for assessing sorghum tolerance. Other aspects of work in Tanzania will be useful in Uganda however, including the developing studies on soil fertility x cultivar interactions and assessment of learning tools for farmer training. Similarly work in Uganda may provide future ideas for on-farm testing of technology in Tanzania. The use of *Celosia* for *Striga* suppression in particular, after further development work in Uganda, could be tested. This aspect of proposed Output 3 would also benefit from CPP support.

² Riches, C.R. (Ed.) 2000 *Striga distribution and management in Tanzania*: Proceedings of a Stakeholder workshop, held 8-9 September 1999 in Dar es Salaam. Chatham, UK: Natural Resources Institute.

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Itinerary

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| 10 th December | Arrived Entebbe from Zimbabwe |
| 11 th December | Travel from Kampala to Soroti – briefing meeting with Dr Oryokot (SAARI) and Dr Rees (DFID CORF) |
| 12 th December | Discussions with SAARI staff |
| 13 th December | Field visit to Kumi and Pallisa districts |
| 14 th December | Round-up meetings at Serere; travel to Entebbe and depart for UK |