CROP PROTECTION PROGRAMME

Facilitating the promotion of improved and blast resistant finger millet varieties to enhance production

R8445 (ZA0670 & ZA0734)

FINAL TECHNICAL REPORT

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List of Acronyms

ACU	Agricultural Council of Uganda
AT (U)	Appropriate Technologies, Uganda
CBOs	Community based organizations
CPP	Crop Protection Programme
CPHP	Crop Post-Harvest Programme
DFID	Department for International Development
ECAPAPA	East and Central Africa Agricultural Policy Analysis
ECARSAM	East and Central Africa Sorghum and Millet Network
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
IPM	Integrated pest management
KACE	Kenya Agricultural Commodities Exchange
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspectorate Service
MoA	Ministry of Agriculture
NAADS	National Agricultural Advisory Service
NGOs	Non-governmental organizations
NR Int	Natural Resources International
NARO	National Agricultural Research Organisation
R & D/E	Research & Development/Extension
RUFORUM	Regional Universities Forum
SAARI	Serere Agricultural and Animal Production Research Institute
SG2000	Sasakawa Global 2000
UIA	Uganda Investment Authority
Warwick HRI	Department of Warwick HRI, University of Warwick, UK

Acknowledgements

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We would like to thank Dr. F. M. Kimmins and Dr. A. Ward for their help and support. We are grateful to the Department for International Development (DFID) – Crop Protection Programme (CPP) for funding this project.

Our primary recognition is to the farmers who cooperated in the on-farm activities for no direct reward.

Biometrician certification

For the on farm varietal demonstration and promotion work, the standard design and methodologies followed by ICRISAT for mother and baby trial system were adopted in Kenya as well as Uganda.

Dr. Mary A. Mgonja
ICRISAT-N.

Executive Summary

Finger millet has not received the attention it deserves from the international and national scientific R & D communities, although it is one of the most nutritious among all major cereals and is a major staple food for millions of people in East and Central Africa and Southern India. Moreover, the grain tastes very good, the plant is productive in a range of conditions and the seeds can be stored for long periods – lifesaver for famine-prone areas. The high nutritional value of finger millet could also help sustain the health of HIV positive and malnourished people; hence its production should be encouraged throughout Africa. However, a number of constraints are faced by farmers as outlined in other sections and current finger millet production practices demand extreme hard work.

Building on R8030 outputs, in project R8445, mother and baby trial system was adopted to successfully demonstrate and promote improved and blast resistant finger millet varieties to farmers and farming communities in different district covering key finger millet producing areas in Kenya and Uganda. Farmers field days conducted linked to these trials and in close interaction with local extension staff provided excellent opportunities to interact with the farming community and enhance their awareness of the blast disease and various farm level management options including row planting which would reduce drudgery, particularly of women farmers and help in more efficient weed management. These activities also enabled the farmers to evaluate the attributes of the improved varieties and to express their preferences. The close linkages with farmer groups and the communities and also local extension and service providing organizations (e.g. staff of the Kenyan and Ugandan MoA, NARO, NAADS, SG2000 and TechnoServe) established by the project coalition lay the foundations for continued work on finger millet building on the knowledge and technologies developed.

The project also developed close interaction and linkages with the grain processing industry (e.g. Maganjo Grian Millers and Family diet, Uganda and Unga and Proctor and Allan, Kenya). Private sector representatives from Uganda and Kenya participated in the stakeholder workshop in Narobi and this led to the successful organisation of an industry co-sponsored and led finger millet awareness day in Kampala. The project, through the industrial links (e.g. Maganjo Grian Millers and Family diet) has engaged with the investment (e.g. Uganda Investment Authority), health (e.g. Mulago Hospital, Kampala) and education sectors (e.g. RUFORUM, Rockefeller) as well as policy makers (NARO, NAADS and Dr. J.J. Otim, President, ACU and Senior Advisor on Agric. & Vet. to the President of Uganda) and raised the opportunities and challenges in improving finger millet production and utilisation.

Project R8030 started as a strategic science-based collaboration project among 4 R & D organisations on blast pathogen biology, epidemiology and host resistance. Within a four year funding period (including R8445) a project coalition of nearly 20 different partners across the finger millet production-marketing chain has been established and the following areas have been identified as demand-led priorities: 1) Improved seed systems through community based multiplication and distribution of farmer and industry preferred varieties, 2) Improved crop management (row planting, draught animal power, reduced labour for weeding, host resistance development), 3) Improved post-harvest handling and grain quality through producer marketing groups, 4) Improvement in the production – supply chain, particularly through market access and 5) Product diversification, value addition, and consumer awareness through industry-led campaigns (see e. mail transcript in next page)

Thus the project coalition is poised for taking an innovations systems based approach to improving the production and utilization of finger millet in East Africa through local, national, regional and international linkages. Interactions with the DFID-CPP groundnut and potato seed systems and the bean IPM project teams as well as the collective marketing initiatives developed by DFID-CPHP, through the recent DFID-programmes research showcase event, offer opportunities for future systems wide approaches.

E.Mail transcript received on 27.02.2006 from
Mrs. Mary Tamale, MD, Maganjo Grain Miller, Kampala, Uganda

Dear Prasad

Thank you for the communication and I will patiently wait for the settlement of the expenses.

We have started working with the consumers, the local farmers, and the distributors on having a promotional day(proposed for July 2006) involving the above three groups and all the stake holders that were involved in the previous millet awareness day BUT this time, the main objective is to involve the Local consumer, and the local farmers (the local community in general).

We shall keep you informed about the whole programme(s).

Thanking you once again,

Yours,

Mrs.Mary Tamale

Background

In the semi-arid tropics of East Africa, finger millet (*Eleusine coracana* L.) is a staple food for millions of people. This cereal plays an important role in the dietary habits and economy of subsistence farmers in the region and is especially important for pregnant women, nursing mothers and children. Blast caused by *Magnaporthe grisea* (anamorph *Pyricularia grisea*) has been identified as one of the highest priority constraints to finger millet production by the East African National Agricultural Research Systems. Blast affects finger millet at all stages of growth and most of the land-races and a number of other genotypes are highly susceptible and certain forms of blast can cause failure of the grain to set and seeds to shrivel resulting in major yield losses. R8030 delivered various outputs to address these issues. Blast genotypes based on a collection of 350 characterised isolates was established and these show limited genetic diversity. Some genotypes were common to Uganda and Kenya whilst others were restricted to one country. Considerable variation in pathogen aggressiveness was observed. This provides a framework for identification, deployment and development of host resistance. Weed blast isolates were capable of infecting finger millet; particularly blast isolates from wild Eleusine were as aggressive as some of the finger millet blast isolates. Seed-borne pathogen appears to contribute to disease development, with higher blast levels in seed lots of susceptible finger millet varieties. This enables identification and development of disease intervention and management strategies. An assemblage of finger millet varieties likely to be suitable for East Africa was screened and a range of varieties with resistance to blast has been identified with the potential for immediate promotion or incorporation into breeding programmes. Baseline information on East African finger millet cropping systems and prevalence of blast, constraints to production and farmers' perception of the blast disease and its management has been generated, identifying the needs of the farmers. Capability strengthening and dissemination of project outputs achieved through shuttle visits to Uganda and the UK for project review and planning meetings and presentations at major international conferences. SAARI pathologist Mr. John P. Takan is on target to complete his PhD research programme. This contributes to local and regional capacity to develop sustainable disease/crop management. Promotion of these outputs - new knowledge generated and resources identified would lay the basis for disease intervention and efficient utilisation of host resistance leading to improved blast management and enhanced finger millet production benefiting poor people.

Project Purpose

R8030 achieved a number of key outputs – strategic knowledge on pathogen diversity, epidemiology, identification of farmers' needs, capability strengthening and identification of promising varieties. However, the PRA work carried out in the project with farmer groups and communities in Uganda and Kenya as well as wider consultations with research, development and extension groups and interaction with industry clearly showed the need for further work to promote the potential of the improved and blast resistant varieties to bridge the huge gap between local supply and demand. Also the need to enhance farmer awareness of the disease problems, pathogen spread, collection and use of clean seed, improved post-harvest handling/grain quality as well as the potential of the improved and blast resistant varieties. Similarly, NARO and at a higher level, the Ugandan Govt recognise the need to promote crops such as finger millet and provide R & D/E support. However, there is a lack of connectivity in the production and supply chain and the research-extension-farmer-industry continuum. The proposed project is set out with specific outputs and associated activities to address these needs.

The primary beneficiaries are finger millet growers, consumers and millet processors/industry. The project activities are also aimed at providing opportunities for close interaction between the researcher-extension-farmer-industry continuum through the field demonstrations, farmer field days, industry consultation days, regional workshop and the availability of a leaflet on finger millet and blast management and the workshop proceedings outlining the constraints to millet production, needs of the industry and pathways to improve the overall needs of this whole group thus benefiting National organisations such as NARO/SAARI and KARI and also regional

organisations/networks such as ICRISAT and ECARSAM and the network of CBOs and NGOs associated with these organisations and the national Agricultural Extension Departments. Although the on-ground project activities are planned in Uganda and Kenya, building on R8030 outputs, involvement of ECARSAM in the regional workshop and associated knowledge dissemination activities would benefit farmer communities and researchers in other East African countries such as Tanzania.

Targeted outputs:
1. Potential of improved and blast resistant finger millet varieties demonstrated/promoted.

2. Farmer community awareness about blast problems and management issues enhanced through direct interaction and wider dissemination through leaflet/pamphlet distribution.

3. Connectivity in the finger millet production - supply chain (R & D/E workers – farmers – industry continuum) improved through a regional workshop.

Research Activities & Outputs

Activities

1. Promotion/demonstration of the potential of improved and blast resistant varieties

Mother and baby trials, based on standard biometric designs followed by ICRISAT, were used in Kenya as well as Uganda, at various locations, for the demonstration and promotion of the improved and blast resistant varieties identified in R8030. This approach has been extensively used to test a range of technology options suited to a heterogeneous community (Snapp, 2002). Demonstration plots with these varieties were set up on farm along with locally grown varieties. The gross plot size recommended was six rows each 5 meters long with a row spacing of 30 cm and thinned to 10 cm between plants in a row. No fertilizer was applied at all sites. Linking with local extension workers, project staff made periodic visits to the sites to work with the farmers for maintenance of the crop. In the mother and baby trials, data were collected both by researchers and farmers working with research and extension staff on leaf, neck and finger blast, days to 50% flowering, agronomic scores, plant height, lodging, panicle weight, threshing percentage, 100-seed mass and grain yield. Data were analyzed for each mother trial and also combined across sites. A comparison was also made between researcher-managed versus farmer-managed mother trials. To obtain data in uniform manner over the locations, cooperators were supplied with a set of guidelines and recording pro-forma. Data was analyzed using SAS statistical system (SAS, 1992). Data based on counts and percentages was transformed using the square root transformation before analysis.

SAS Institute Inc., 1992. Software changes and enhancements, release 6.07. Technical report P-229, SAS/STAT; NC: SAS Institute Inc., 620 pp.

Snapp S. 2002. Quantifying farmer evaluation of technologies: the mother and baby trial design. In *Quantitative analysis of data from participatory methods in plant breeding* (Bellon MR and Reeves J, eds). Mexico, DF: CIMMYT.

2. Increasing farmer awareness of the blast disease problems and management, harvest and use of clean seed and improving grain quality

PRA work done in R8030 revealed that farmers in Kenya and Uganda did not know the cause, modes of transmission and control measures for blast disease although farmers mentioned some general contact with and role by the community, radio bulletins and extension workers. This dearth of information has been addressed through farmer field days conducted at key stages of

the crop. The role of leaf and neck blast in the infections appearing on heads/fingers was explained during the farmer field days at the demonstration farms using practical examples from the local or susceptible varieties. Also the need to improve post-harvest handling of finger millet seeds to improve grain quality issues raised by millet processors and using clean seed to avoid blast were explained. Feasibility of improved seed sowing methods notably row planting to manage weeds and reduce labour has been demonstrated and discussed with farmers. Extension staff as well as local CBOs and NGOs were also involved in these activities.

3. Regional workshop to improve connectivity in finger millet production - supply chain (R & D/E workers – farmers – industry continuum

A regional workshop was organised at Nairobi during 13-14 Sep 2006 working in partnership with ECARSAM with a view to promote and improve communication and understanding of the mutual needs of the growers and the industry as well as to disseminate the knowledge generated and technologies identified and to raise awareness of the potential to enhance finger millet production and utilisation.

4. Industry led finger millet awareness day and other dissemination activities for fostering finger millet production and utilization in Uganda and the East African region
In view of the enormous stakeholder interest in the Nairobi workshop, a finger millet awareness day was organised funded by DFID-CPP and co-sponsored by Maganjo Grain Millers to generate further discussion among representatives of various sectors involved in finger millet production and utilisation including researchers, representatives from farmers' groups, representatives of the health and education sectors, processors, investment authorities and micro-credit schemes, as well as the media and policy makers. This also provided an opportunity to link up with parallel CPP projects, and DFID programmes through the Research Showcase event. These activities took place during 9-10 Feb 2006.

Outputs & Lessons:

1. Building on the contacts developed with the farming community and local agricultural extension staff during R8030, variety demonstration and promotion work was carried out with participation from farmers and farmer group leaders. The Mother-Baby (MB) approach was used to demonstrate the potential of improved, blast-resistant varieties involving mother trials and baby trials. Mother trials were researcher-designed, researcher-managed and completely randomized, with two to four replications per site. They were designed to directly compare different 'best bet' technologies in the same field, allowing farmers to choose technologies most appropriate to their needs. Baby trials were located around mother trials, and consisted of a few treatments chosen from the mother trial, by the farmer. Baby trials allowed farmers to see for themselves the performance of treatments at different trial sites, and allow for faster, larger-scale testing at different locations under different management conditions.

In Kenya, demonstration plots were established in selected villages in four districts – Kisii and Gucha districts in Nyanza province, Busia and Teso districts in Western province. The demonstrations were hosted by a total of 81 farmers managing either mother or baby trials. Mother trials were planted at Busia (Alupe, Nambale and Butula divisions); Teso (Amagoro and Amukura); Kisii (Masimba) and Gucha (Nyacheki). A total of 5 mother trials and 81 baby trials were planted; each mother trial was typically 'surrounded' by 12-15 baby trials. Each mother trial consisted of one local and seven improved varieties: KNE688, ACC32, KNE 814, P224 (commercial variety), KNE1149, ACC14 and ACC29. Each baby trial was managed by a farmer and consisted of four of the above varieties, including a farmers' local check variety and the commercial variety P224.

In the mother trials, data were recorded on grain yield, blast incidence (leaf, neck, finger, and overall blast reaction), days to 50% flowering, agronomic score, plant height and lodging score. Grain yields ranged from 1.07 to 1.85 t ha^{-1} (trial mean 1.58, local control 1.34). Varieties KNE 688 and ACC 32, KNE 814, KNE 1149 and P224 gave yields above the trial mean (Appendix 1). All the varieties had a low blast reaction with incidence scores of $\leq$ 3.0 for leaf, neck, finger, and overall blast. KNE 688 and KNE 814 had the lowest blast incidences of <2.0. ACC 32 was the earliest to flower (68 days) but also had the highest blast incidence scores of 3.0. This reflects the susceptibility of early maturing varieties, as reported in previous finger blast screening research. Plant height varied from 104 to 119 cm. ACC 32, although the shortest, had a relatively high lodging score of 3.8, indicating that it has a weak stem. KNE 1149 had the best overall agronomic score (1.8) and ACC 32 and the local variety had the poorest (3.0). In the baby trials, data on grain yield from 4 sites in Alupe showed that the yields were generally comparable. Variety P 224 gave the highest grain yield, 1.73 t ha^{-1} averaged across the four farmers (Appendix 1). Some varietal differences were notable. For example, P 224 yielded 1.67 t ha^{-1} in mother trials, and 1.73 t in baby trials. KNE 688 gave the lowest grain ield in baby trials (1.37) and the highest in mother trials (1.85 t ha^{-1}). This suggests that P 224 can yield fairly well under good or poor management, whereas KNE 688 responds sharply to management conditions or environment. In general, the most popular farmer preferred varieties were P 224, KNE 688, KNE 814, KNE 1149, ACC 14, ACC 29 and ACC 32 based on blast resistance, panicle size, grain color and grain yield. Farmers preferred brown grain color and this clearly shows that researchers need to identify varieties with high yield potentials together with the farmer and industry desired attributes.

Considerable differences between farms with regard to blast incidence on some varieties were observed, whereas the difference was small between treatments. This might be a result of different farmer practices in each farm, especially in planting date and/or due to the prevailing pathogen populations and their interaction with the host genotype and the environment. Varieties KNE 814 and KNE 1149 – both late-maturing – showed the lowest blast incidence, 1.9 and 2.2 respectively (Table 6). The trial mean was 2.4, while the local variety was as high as 2.9. ACC 14, P 224 and the local – all early maturing –had the highest blast incidence. This relationship between earliness and susceptibility confirms results from earlier work on blast screening. Thus there is need to take into account the relative risk of blast incidence versus susceptibility to terminal drought in late maturing varieties.

In Uganda, the varieties used in included Gulu E, Pese1/P224, Seremi 1, Sermi 2/U15, Sx 8, Sec 915 and local variety specific for each site. These varieties have various attributes such as blast resistance, high yield, good grain quality and early maturity. Farmer group leaders and established groups participated in the varietal demonstration activities and promotional work at five sites. These included villages in Kaberamaido, Katakwi and Soroti districts.

Farmers recorded blast disease incidence using the standard scale with the assistance of project staff and also other attributes of the varieties particularly yield (Appendix 2). The mean plant height for the trial over four sites was 69.3 cm. Maximum height for the trial was recorded at Kikota village (77.8 cm) and minimum at Oselel (59.1 cm). There were highly significant differences for plant height ($p < .001$) for sites and varieties. The mean grain yield over locations was 2.39 t/ha (Appendix 2). The highest mean of the trial was recorded at Kikota village (3.09 t/ha) and lowest at Oselel (1.59 t/ha). The highest yielding variety was Gulu E (3.02 t/ha) and lowest were the local varieties (1.44 t/ha). Blast is widespread and important in all millet growing areas, particularly head blast which can directly affect the yield and the varieties with least overall incidence of head blast were Seremi 1 and SX 8. Seremi 2, the earliest maturing variety, showed least resistance to blast (33.9%) at various locations.

In Uganda, overall, improved varieties Gulu E, SX 8, Pese 1, SEC 915, Seremi 1 and Seremi 2 showed good performance in blast resistance and yields which impressed the farming community. Seremi 1 and SX 8 particularly showed high levels resistance to blast. Farmers have selected Seremi 2 for earliness. SX 8 and Seremi 1 were selected for yield and cleanliness (free from blast attack) in te field and were found to have a relatively stable resistance across

locations. However, as observed in Kenya, some finger millet genotypes exhibited contrasting reactions to blast incidence at different sites. It is essential to utilise the knowledge of the pathogen biology developed and the varieties identified in this programme as well as the germplasm resources to further develop stable and durable resistance and also monitor the longterm genetic interactions between the pathogen, the host and the environment. The tools, resources and the wider linkages established with parallel national, regional and international projects/programmes and the comparative knowledge from the rice-blast system lay the foundation for developing this area of work. The project has established partnership with the industry particularly various grain processors such as Maganjo Grain Millers Ltd., Family Diet, SESACO and East African Basic Foods Ltd. in Uganda as well as Unga and Proctor and Allan in Kenya. An interesting model to emerge from these linkages is the farmers co-operative with 300 members established in Western Uganda by Family diet. Mr. Issa Wamala has been hugely enthusiastic about the prospect of linking up the co-operative with the varietal promotion work and plans of the project and participated in the stakeholder events in Nairobi as well as Kampala and is now viewed as a key member of the project coalition. With the participation of the project coalition in the recent research showcase and parallel project-specific events (more details in outputs 3and 4) in Kampala, interaction and contact with AT-Uganda and SG2000 have been established with a view to further developing community based multiplication and distribution system of seeds of finger millet varieties preferred by farmers and the industry.

2. Farmers' field days were held linked to the mother and baby varietal demonstration trials for farmers participating in the demonstrations, as well as those in the neighborhood to see the performance of new blast resistant varieties and improved crop husbandry techniques (Appendices 3 and 4). Project staff periodically visited the sites to work with farmers on plot management, and to discuss varietal performance under biotic stresses, especially blast. Farmer field days were conducted at physiological maturity to demonstrate the potential of the improved varieties in terms of blast resistance, yield and other attributes. Extension staff as well local community-based organizations and NGOs worked with project staff to increase farmer awareness of blast management and encourage adoption of the new varieties. During field days, farmers visited the mother and baby trials and discussed the full range of issues from finger millet production to consumption and marketing. Feasibility of improved sowing methods (notably row planting) to manage weeds and reduce labor, as adopted by farmers in Busia, were discussed. During the field days, farmers also participated in selecting the best performers based on a number of criteria. Farmers' rankings of varieties were analyzed to better understand their needs and preferences. For example, a farmers' field day was held on 3 Sep 2005, at one of the mother trial sites planted by Bulindo group in Butula Division. The field day was organized by the Ministry of Agriculture staff involved in the on-farm activities, KARI and ICRISAT and 72 people attended. The participants included Agricultural Extension Officers from the neighboring Divisions/Districts, NGOs, community-based organizations, farmer groups, and a representative from Technoserve-Nairobi (an NGO specializing in building market linkages). The field day proved a good forum for exchange of ideas between extensionists, farmers, researchers and marketing experts. Key issues that emerged from this interaction were:

- Farmers appreciated row planting as it reduces drudgery
- Farmers appreciated the yield and bird resistance potential of some of the test varieties
- They valued the storability of finger millet grain
- Both producers and consumers (market demand) attach a high value to finger millet
- Farmers appreciated that improved grain quality and higher volumes (more production) would enhance market prospects
- They agreed on the need to enhance soil fertility for increased productivity
- Farmers recognized the need to form marketing groups to facilitate market access.

At the field day, farmers were divided into four groups and asked to assess the test varieties (agronomic evaluation). Each group evaluated one replication and selected the top three varieties

from the replication. Scores were pooled to determine the best varieties overall. The top four were, in order of preference, KNE 1149, KNE 814, P 224 and ACC29. The reasons for preference were similar for all varieties: high yield, good grain color (brown), blast resistance and low bird damage. Dissemination materials prepared on blast management and finger millet production are being translated into local languages for wider dissemination.

Focused consultations with representatives of farmer groups and industry prior to the workshop were also made and the issues arising from this exercise were highlighted through a presentation by Mr. Julius Okwadi at the stakeholder meetings organized by the project in Nairobi and Kampala. In addition, farmer group representatives from both Uganda and Kenya participated in the Nairobi workshop and were actively involved in identifying constraints and opportunities during the breakout sessions. Linkages have been established with AT-Uganda, SG-2000 and NAADS and also TechnoServe with a view to utilising the network of farmer groups as well for developing producer marketing groups and market access mechanisms. Interactions with the DFID-CPHP programme during the research showcase were very useful for future development of the knowledge and the framework essential for addressing these critical issues. This is an excellent opportunity to utilise and build on the tools, manuals and resources developed by CPP and CPHP programmes based on groundnut, potato, beans, maize and other commodities providing cross-project and -programme perspectives in future activities on finger millet as well as the farming systems in East Africa.

3. A regional workshop on finger millet production and utilisation was organised with a view to bring together a wide range of stakeholders to provide an up date on the outputs of the DFID-CPP funded finger millet blast management work within the context of finger millet production and processing needs in the east African region. More than 40 participants representing the production to processing continuum participated, in what was hailed by many as the first of its kind on finger millet with the widest representation possible, including ECARSAM, represented by the regional co-ordinator Prof. Barnabas Mitaru (Appendices 5 and 6). The major objective was to initiate the process of connectivity among these stakeholders. This successful workshop also received excellent media coverage with the Kenyan Television Network, KTN showing the exhibits and a short interview as well as detailed two page write up by the science correspondent in The Standard, EA, 28th Sep 2005 (Appendix 7).

The workshop started with a speech by Dr. E. A. Mukisira, Deputy Director (Research), Kenya Agricultural Research Institute who highlighted the importance of finger millet and KARI's research strategy and observed - this workshop is the first of its kind in Kenya, and possibly anywhere in the region – focusing exclusively on finger millet, not clubbing together various millet species that may have different research needs and opportunities. Every stakeholder group – researchers from within and outside East Africa, extension, farmers, industry, NGOs, donors – is represented here. That is a good sign. Clearly, there is broad interest in the crop, strong support for what we aim to do, and commitment from the national research programs in all three countries. For many years, finger millet in East Africa has suffered from lack of attention and policy support. I am convinced this is the beginning of a new era.

Various presentations made in the following technical sessions covered the outputs of the DFID-CPP project R8030, progress made in R8445 and national, regional, producer and industry perspectives on finger millet. The presentations highlighted progress made on: improved knowledge of disease and pathogen, improved blast-resistant FM varieties, improved disease management options at farm level, on-farm participatory testing of technologies and development of promotional tools.

Tremendous potential for increasing finger millet productivity in East and Central Africa was recognised and a number of outstanding issues and constraints affecting various stakeholders - farmers (weeds, labor, low prices, knowledge, marketing), researchers (knowledge, methodologies, funds) and processors (supply, quality, knowledge, linkages), were raised. These

create mistrust, lack of awareness, misconceptions, lack of connectivity and ultimately inefficient supply chain, despite the potential for ECARSAM to work at regional level.

The following opportunities were also highlighted in various presentations - new tools to exploit diversity, improved breeding methodologies, improved agronomic practices, improved blast-resistant varieties, improved mgmt methods for blast, potential for pelleting, use of herbicide, row planting, draft animal power, improved processing technologies, eg destoner, high and increasing demand for products, pro-active processors seeking new products and markets, growing regional trade, income generating opportunities for the poor, conducive macro-policy environment, opportunities for product diversity (malt, commercial beer production, fodder, baked products).

Promotion of Finger Millet: Stakeholder Perspectives Constraints and Opportunities
Participants formed three groups representing, farmers, researchers and industry and each group discussed constraints and opportunities to/for finger millet development from their particular perspective, also taking into account the issues from the presentations (Appendix 6). These findings were later presented and discussed in plenary sessions. This process allowed the meeting to consider a wide variety of views in detail, and provided a strong base for discussions on an innovation systems approach.

The three groups independently reached broadly similar conclusions on the following issues -

- What are the major constraints to the promotion of finger millet in East Africa?
- What are the opportunities to resolve these constraints?
- Which stakeholders should be involved?
- Who should pay?

CONSTRAINTS

Policy

- Low government priority for finger millet (except in Uganda), extremely low funding for research and extension, hence poor technology development and dissemination.
- Different countries have different tax regimes, import/export procedures, certification and phytosanitary standards etc. This reduces trade opportunities and hinders the creation of a single regional market large enough to attract private investment.
- No policy efforts to encourage utilization in specific areas where potential exists, e.g. baking, brewing

Awareness

- Lack of awareness among all stakeholders, including policy makers.
- Most rural communities are unaware of its nutritive value, and consider it inferior to maize, rice or wheat.

Production

- Producers are scattered widely across rural areas; not organized into larger, more effective groups. Hence highly variable production, fluctuations in grain supplies, quality and price
- Poor linkages between farmers and processors
- Lack of quality control systems, or standards/prices based on crop quality
- Lack of credit facilities to enable farmers to expand production
- Lack of seed of improved varieties

Marketing

- Long and inefficient marketing chain with numerous middlemen; no formal, organized marketing structures
- Poor infrastructure (roads, communications)

- Farmers lack market information, market access; simultaneously, traders and processors lack information on crop availability, quality and price
- Limited product range, especially convenience foods, hence poor sales in urban areas despite potential demand

OPPORTUNITIES

Policy
- Detailed analyses have been or can be conducted on policy issues; opportunity for regional bodies like ECARSAM, ECAPAPA to lobby for favorable legislation
- Influence policy makers to harmonize tax regimes at local and regional levels
- Include finger millet in strategic grain reserves, also in school feeding programs, prisons, food relief
- Review policy on specific products, e.g. use of finger millet in bread, opaque beer
- Establish finger millet committee within ECARSAM, to coordinate and lead promotional and lobbying efforts

Awareness
- Technical information is available on many aspects, including utilization, nutrition, value-added products. Package and disseminate this information to different stakeholder groups: policy makers, consumers and other potential users e.g. schools, prisons
- Raise profile of the crop through local media: radio, TV, press. This will improve public awareness of the importance of the crop, and eventually result in more funding for research and extension.
- Spread nutrition awareness by working with Ministries of Health, Education
- Build on and exploit linkages already established, to eventually develop a coalition/platform to promote finger millet. ECARSAM could help increase the profile of the crop, and establish its individual identity, rather than referring to it collectively with pearl millet

Production
- Appropriate, low-cost technologies are available in Asia and elsewhere, to improve production and processing. ICRISAT could act as a conduit to promote these technologies in East Africa
- Examine successful models used for other crops in the region, for (i) quality control system, price/grading standards, (ii) mechanisms to intensify production, e.g. contract farming
- NGOs, community-based and church organizations could provide resources (including staff and local experience) to supplement government extension services
- Facilitate formation of Producer Marketing Groups (PMGs), strengthen existing groups, to increase production and marketing
- Establish collection centers, encourage farmer groups to bulk up produce
- Provide credit through micro-finance institutions, which are available in many areas
- Promote finger millet in non-traditional areas, i.e. outside high-rainfall or cooler zones.

Marketing
- Use PMGs as the focus for intensified marketing efforts; PMGs can also manage collection centers and disseminate market information to group members
- Disseminate market information (price, location) through farming radio programs and government extension channels
- Include finger millet in existing market information channels, eg KACE in Kenya, Foodnet in Uganda
- Good business opportunities for the private sector, e.g. demand for value-added (e.g. fortified) finger millet products; high-value niche market for finger millet as an organic product, exported to Europe

Price fluctuations
Price fluctuations harm both producers and buyers (traders and processors). Fluctuations can be reduced by schemes that will enable farmers to wait until prices rise, not sell immediately at harvest. They can be implemented at PMG level. Options include:

- Micro-finance credit, i.e. loan from a financial institution against stocks
- Inventory credit, where farmers place crop in joint storage and receive credit from an NGO.

Seed availability
Appropriate high-yielding, disease-resistant varieties are available for multiplication. Seed shortages can be resolved by:

- Promoting alternative models for seed production and delivery, e.g. community based production
- Linking seed producers to the private sector, e.g. seed company contracts small-scale farmers to produce 'certified' seed
- Farmer training on seed production techniques and seed quality control
- Liberalizing the seed sector, particularly for subsistence food crops such as finger millet; harmonizing seed policies across region, e.g. phytosanitary, registration, certification.

STAKEHOLDERS AND POTENTIAL DONORS/CONTRIBUTORS FOR PROMOTING FINGER MILLET

- Farmers, Researchers, Extension, NGOs, Community-based organizations, churches
- Policy makers, National governments, ministries: planning, education, food, health, industry
- Private sector – small traders to large processing or trading firms, Media, Consumer bodies
- Market information agencies such as KACE, Foodnet, Financial institutions, e.g. micro-credit and banks
- National bureau of standards in each country, Seed companies, Seed regulatory bodies,

All stakeholders must be willing to contribute resources, in cash or kind. For example, national extension staff provide time, vehicles. Farmers provide land and labor. Industry provides facilities, use of equipment.

- Regional bodies (ECAPAPA, ECARSAM, ASARECA), especially for harmonization efforts
- DFID, FAO, UN agencies, Gates Foundation (nutrition, AIDS aspects), McKnight foundation (plant breeding, crop management), Rockefeller Foundation, DANIDA, Sasakawa Global 2000
- Industry, Farmers, Artisans (*jua kali*) for fabricating household or village-level processing equipment

Plenary discussion

The following points were further highlighted in the plenary discussion session:

Traits for end uses. Finger millet is not suitable for confectionery (baked) products because of its low gluten content. However, the national programs will not be able to screen accessions for high gluten, in view of the large number of accessions and the limited resources available. In addition, low gluten is an advantage in some ways, eg #### It is important to identify a few priority traits where screening and breeding efforts can be concentrated.

Status of variety development. Most of the 'improved' varieties in Uganda are only selections made from local germplasm collections. In Tanzania, germplasm and improved material developed by ICRISAT, was supplied to the national program through EARSAM. However, this material was not screened because of lack of funds; and the finger millet research program has

essentially been closed since 1994. Similarly in ICRISAT, the breeding program ended in the early 1990s, although ICRISAT continued to maintain the germplasm collection. In this situation, a first priority should be to transfer blast resistance into popularly grown varieties (whether landraces or improved).

Genetic resources. Tanzania is poorly represented in the global germplasm collections. Additional collection missions need to be organized, especially since East Africa is the center of origin. There is considerable potential for identifying sources of blast resistance; and also for enlarging collections of the races Africana and Spontanea (wild relatives), which are severely under-represented in all collections and are being genetically eroded. Both NARS and IARCs must increase their investments in germplasm collection and maintenance in Tanzania.

Variety release procedures and dissemination of new varieties. In Kenya, the national variety release system has not functioned effectively for nearly 15 years; releases were not always based on data, and were mostly restricted to maize and wheat. However, the committee has now been resuscitated, and the following procedure established:

- A prospective new variety is tested for 2 years in KARI trials. If performance is good, it can be advanced to national trials conducted by the Kenya Plant Health Inspectorate (KEPHIS). The breeder/institution is required to pay a fee of Ksh 40 000 per variety for these trials
- KEPHIS trials last for four seasons: 2 long rains and 2 short rains
- Subject to good performance, the variety is then considered for release by the national variety release committee
- These procedures are for Scheduled Crops only, and do not cover finger millet (and most non-commercial crops)

Throughout the region, official release procedures are too slow, especially for minor crops such as finger millet, where the returns may not justify the expense and effort needed to fast-track release of a new variety. However, on-farm trials offer the opportunity for rapid dissemination. Varieties at this stage are considered 'pre-release' and informal exchange or sale at community level is permitted (although commercial sale of branded or labeled seed is illegal). Seed harvested from on-farm trials can be distributed to other farmers in the community. Within 3 seasons after the first trials, sufficient seed of cereals can be multiplied and exchanged to meet local requirements, and even produce a surplus for sale to neighboring communities.

For this to happen, farmers must cooperate with each other, freely sharing seed and agronomic knowledge about the new varieties. Unfortunately, farmers who host trials are often reluctant. Researchers must make it clear to trial participants that seed must be shared; and the community must help enforce this.

Other semi-formal channels are also available. Under a DFID-funded project in Kenya, kale seed is produced at community level, inspected by KEPHIS (through special arrangement), and successfully sold to neighboring communities. In Tanzania, the government allows "quality declared seed", i.e. seed produced by farmers for sale to the community, and labeled as such. This does not require formal inspection or certification.

The participants noted that in many cases the key issue is not slow variety release procedures but unavailability of seed – even of varieties released several years previously. This is a major reason for poor adoption of improved varieties.

Processing. Processors are the key to expanding cultivation, and must be involved more closely in R&D. National and international research institutes must give processors samples of all new varieties, for testing grain quality, traits, and suitability for industrial use.

Adaptation. Finger millet area in the major production zones is declining or stagnating. However, if widely adapted varieties can be developed, there is a huge potential for a huge increase in

area. For example, the crop is now restricted to high-rainfall areas. Availability of drought-tolerant varieties would lead to significant expansion. Likewise, frost tolerance would enable expansion into highland areas, and even into Europe (as a forage crop).

ICRISAT intends to map zones of adaptation of specific finger millet varieties using GIS tools (as it has done for sorghum and pearl millet). Mapping – mainly on the basis of rainfall, min/max temperatures and length of growing season – will help target new varieties to areas where they are best adapted, and identify non-traditional areas with suitable environments, where finger millet can be introduced.

Fodder and stover. Finger millet is rarely used for stover or silage in East Africa. The reason: in smallholder systems, harvested fields are traditionally considered a common resource, and animals are allowed to graze freely on residues. However, good genetic material is available, identified or developed at ICRISAT-Zimbabwe in the 1990s. Two finger millet lines have been released for forage use in Zimbabwe, and are being successfully promoted as a source of dry-season fodder.

Grades and standards. Contamination can be reduced by a grading system with differential prices. This is being done to a limited extent by millers in Kenya and Uganda. For some traits (eg presence of foreign matter), the miller may stipulate a progressive reduction in price. For other traits (eg moisture) there may be no price differential, but the consignment is completely rejected if found beyond acceptable limits.

One difficulty is poor communication. Grades, standards and prices can be clearly established between millers and their suppliers, but this information is not being passed on to farmers, or to all traders in the bulking-up chain.

Post-harvest operations. The milling industry is concerned about grain cleanliness. This may be caused by adulteration and/or poor post-harvest handling. Several participants felt that grain from the farm was fairly clean – stones, sand and small quantities of cheaper sorghum grain – were largely introduced by middlemen and traders, to increase weight of the product when delivered to millers. However, farm-level handling methods also need to be improved. Finger millet is threshed, and later sun-dried, on the ground. Use of cemented threshing and drying floors would greatly reduce contamination. So would mechanized threshing: inexpensive machines are available, suitable for community use.

Producer marketing groups (PMGs). Farmers organized in groups have numerous advantages over individuals. They can negotiate better prices for both inputs and outputs; and enforce quality and grading standards (eg contamination) among their members, and thus obtain higher farmgate prices. PMGs are also a good entry point for development interventions, eg new varieties or mechanized threshing. Pay-offs from innovations will be higher with a PMG, compared to individual farmers. Market linkages are also easier to develop. For example, successful technology adoption by a PMG will attract interest from – and subsequently investment by – a private firm, especially when a third party such as an NGO, facilitates the process. PMGs also improve financial viability. For example, a group – but not an individual – could afford to pay for transport (direct to miller, higher prices); if NGO support is still required, it is easier to administer and recover loans through the group.

Middlemen and traders. Traders are often accused of exploiting small-scale farmers. However, in most outlying communities, and for many crops, the trader is the only link to the market. He buys small quantities from many scattered producers, incurring the risk and cost involved in bulking up quantities to sell to larger traders. At least in the middle term, smallholder farmers in Africa cannot survive without traders and middlemen. It would be useful to bring them into the development partnership through training, awareness, and technical and/or financial support. This process, if well managed, will lead to a win-win situation. Traders can maintain their profits while system efficiency, quality, and farmgate prices can all improve.

Policy environment. The key issue is low government priority for the crop in Kenya and Tanzania, although finger millet has a higher priority in Uganda. This affects production and marketing. Some legislation that apparently 'discriminates' against finger millet also needs to be changed. For example, the national Bureau of Standards specifies that bread can only be made from wheat. Another important policy change would be to legalize opaque beer – this would unlock a large market for finger millet. Interestingly, in Kenya opaque beer powder is legal, and at least one brand has been certified by the Bureau of Standards – but beer made from the powder is liable to be confiscated by the police.

Information and lobbying. Policymakers should be lobbied to enact more supportive policies; but lobbyists will require hard information to strengthen their case. Stakeholders must aim to collect and provide such information. This will include

- Use of finger millet in composite flours; demonstrate technical and financial viability
- Costs and benefits of regional (as opposed to national) registration/release of new finger millet varieties
- Adoption data; consumption levels, especially among the rural poor.

Distinct identity for finger millet. It is important to establish a distinct identity for finger millet – and information on crop production, utilization and market trends etc, is an important prerequisite. But such information is scarce. In published statistical data, millets are usually presented as one commodity; in some cases, all small-grained cereals – i.e. sorghum and millets are published as a 'single' commodity. Stakeholders must work together to ensure that crop-specific information is collected in the future.

However, it is already possible to obtain some crop-specific data. Most millet data from Uganda refer to finger millet; almost all data from Tanzania and Sudan refer to pearl millet. In Kenya, differentiation is possible, from 1995 onwards. Millet data from Western Province is entirely finger millet; data from other provinces is mainly pearl millet.

Donor funding. In the future, an increasing proportion of donor funds will be channeled through governments; direct funding to NGOs and district or community-level projects will fall. This is likely to reduce funding for finger millet, since donor funds will be spent on areas or crops that enjoy government priority. It is therefore important to disseminate information and sensitize policy makers quickly, in order to increase funding support for finger millet.

Role of ECARSAM. The East and Central Africa Research Network for Sorghum and Millet (ECARSAM) can play a key role in promoting finger millet. Various possibilities were suggested:

- ECARSAM has committees for specific crops. A new committee should be established for finger millet, to facilitate research and promotion. Based on the research priorities identified at this meeting, the committee could develop a proposal seeking donor funding specifically for the crop, e.g. establishing competitive research grants system for finger millet in the region. This was agreed in principle, but the modalities need to be worked out
- ECARSAM has a system of competitive grants for various crops; adding finger millet to this list would allow funding for small research projects
- ECARSAM will call for research proposals on drought; participants at the meeting could develop proposals on finger millet, to compete with other crops for this funding

Stakeholder perspectives from the Nairobi finger millet workshop:

Mary Tamale
Managing Director, Maganjo Grain Millers Ltd, Uganda

My thanks to everyone: the workshop organizers, participants, and the sponsors DFID. I am sure we are all encouraged by KARI's strong support for finger millet, as shown by the opening

address by their Deputy Director (Research). With this kind of commitment from the national research program, we will be able to move forward quickly.

I am glad that three large processing firms are represented here. The industry now knows about the DFID project, and the research findings. This meeting has given us other valuable information that we did not have – the background and priorities of various stakeholders (research, extension, NGOs, donors), major areas of concern, and future plans. As industry representatives, we will now sensitize other processors, and work with farmers to promote both cultivation and utilization of finger millet.

Our common goal is to promote finger millet across the region. To achieve this, we must work together. For example, industry could organize a workshop highlighting its nutritional qualities; researchers must participate and provide support. Researchers might work on developing new products – for which industry can provide equipment, facilities and skills.

The workshop lasted only two days, but we were able to successfully complete the agenda without skimping on the quality of debate – the discussions were exhaustive, comprehensive, and led to clear conclusions and recommendations.

Ambrose Agona
Head, National Post-harvest Research Program, Uganda

The workshop title was 'Blast disease of finger millet', followed by a scientific name… I was somewhat intimidated. But the discussions have been more wide-ranging, and more relevant to many of us, than a purely technical discussion on plant pathology. We have shared experiences about profitability and income of finger millet cultivation, about socio-economic aspects, post-harvest issues, marketing, etc.

The discussions led to clear priorities and recommendations. The next step is to translate this to concrete action. How best do we operationalize the promotion of finger millet? What time frame do we give ourselves? We must work fast enough to gain the confidence of all stakeholders; farmers, extension, processors, donors. Business as usual will not do.

This is the first workshop of its kind in East Africa, focusing exclusively on finger millet. We are starting out to build on a new regional initiative, sharing knowledge, experience and resources. We have all been involved in this initiative together, from Day One. Our success will be ours, our failures will be ours – we will have no excuses.

Let us give finger millet a chance. We need to show devotion and commitment to what has been agreed at this meeting. We need to work together; if you have a problem, talk to another stakeholder, and solve it together.

I was weaned on *wimbi* porridge. If you want to look like me, eat finger millet.[1]

Ben Kanyenji
Coordinator, National Sorghum and Pearl Millet Program, Kenya

This is the First Regional Finger Millet Workshop for the region. When was the First Regional Maize Workshop held? In other words, a great deal of work on cereals has been done, and

[1]The speaker is 185 cm tall and weighs 105 kg. We believe this is mainly due to finger millet, with a little help from conference cuisine.

substantial investments made in research, training, and field and laboratory facilities. Many of the resulting advances can be directly or indirectly applied to finger millet.

Consider the finger millet farmer who is unable to make enough profits to pay his children's school fees... or the processor who has to close his plant because he cannot compete with maize millers… their future depends on how well we work, and how seriously we take the commitments made at this meeting.

We are not 'challenging' maize or wheat, but simply remembering a traditional but partly forgotten crop that has much to offer. We are in a historic position – the first ever, best ever collection of skills and expertise on finger millet.

Between us, we have enough skills and experience with small-grain production. We need to develop research proposals to resolve technical constraints, and interventions to promote finger millet more aggressively. If we clearly assign responsibilities and work together, we can make the finger millet industry a success. The future is within reach.

Issa Wamala
Managing Director, Family Diet Ltd, PO Box 5179, Kampala, Uganda

Family Diet Ltd is a relatively young firm in Uganda, specializing in grain products including millet, maize, soya, rice and cassava flour. We commenced production in 2001. Our vision is to provide a ready market to small-scale farmers, and to process and sell the grain to domestic and export markets.

With particular reference to finger millet we also aim to

- Start up model 'Farmers Pilot Projects' in the major finger millet growing districts in Uganda
- Increase public awareness of the high iron content in finger millet.

Finger millet production and processing in Uganda is still at a very low level of commercialization, and caters only for the domestic market. Rarely do you find a farm with more than 10 ha under millet. The largest processing plant handles less than 20 tons per day.

Issues and constraints

Processors in Uganda face a range of constraints: economic, biophysical, cultural (these three are the most serious), and issues related to administration, infrastructure, policy and technology. These are summarized below.

***Economic constraints*.** Finger millet is grown as a food crop, not a cash crop. Farmers are not very interested in scaling-up production. Thus, processors are unable to procure a steady supply of grain. The marketing chain depends on exploitative middlemen who often add dust and stones to increase weight of grain; hoard supplies to create artificial shortages; or inflate transport costs from farm gate to processor. Small-scale processors lack capital: they are rarely able to access government grants or soft loans. Instead, they pay bank interest rates as high as 35%. Electricity supply is irregular, while generators and fuel are expensive, thus increasing production costs. Land factory construction is expensive. Because printing is expensive, processors are forced to use cheap, unattractive packaging. Finally, consumers lack purchasing power and buy cheaper but poor quality products. All these problems have led reduction in the size of the market for quality products.

***Biophysical constraints*.** Variable climatic conditions cause numerous problems, e.g. delayed maturity causes farmers to harvest too early, and deliver immature grain to processors. Rains can make roads impassable, disrupting transport and production. Another problem is that difference in soil type leads to differences in taste of the milled product.

***Cultural constraints*.** Literacy levels are low, hampering extension efforts and adoption of modern technology – and also leading to poor awareness of the nutritional benefits of finger millet. There are popular misconceptions about finger millet, e.g. that it is a food only for certain tribes, which greatly reduces the size of the market.

***Administrative issues*.** Many processing firms are badly managed. For example, use of untrained staff to reduce costs, lack of basic office equipment (computers, internet, email etc), lack of proper administrative structure, nepotism and dependency on relatives and family members as managers, and poor record keeping.
There are no research or technology upgrading programs. Instead, companies use trial-and-error methods of processing. They produce the same products year in, year out, with no product diversification. Staff working conditions are often poor, e.g. no insurance, no proper working gear (face masks, gloves, gumboots) etc.

***Infrastructure and policy issues*.** Processors receive no protection from government, and are vulnerable to imports of high-quality, well-packaged foreign brands. There is no association of finger millet growers or processors, hence capacity to lobby for policy change, is limited. Agricultural infrastructure is poor, e.g. lack of affordable trucks/tractors at district level as well as bad roads and no rail system, reducing the opportunities for commercial production. In general, the threat of war or political instability has discouraged investors. There is a lack of educational programs about health and nutrition, whether from government or NGOs; people remain unaware of the health benefits of finger millet.

***Technology issues*.** Many processors have no access to modern processing technology, using primitive methods that are inefficient and ultimately costly. Storage facilities are poor, exacerbating contamination by dust and stones. Companies lack access to information on new research findings, newly developed finger millet varieties, and new food products. A recent problem is the use of certain weed control chemicals which damage soil productivity, eventually reducing production and supply.

Despite these problems, experience has shown that a large potential market exists. If consumers and producers are sensitised about the health benefits of finger millet, production and processing can expand rapidly.

4. Finger millet awareness day in Uganda and follow-up interactions and linkages, 9-10 Feb 2006, led by Maganjo Grain Millers, Kampala

Mary Tamale, the Managing Director of Maganjo, the largest flour miller in Uganda, enthusiastically agreed to the project coalitions' suggestion of organising a finger millet day in Kampala, following discussions at the Nairobi workshop. This was then followed up with DFID-CPP by the project leader Dr. Sreenivasaprasad and the programme management agreed to fund this activity with cash/in-kind support from Maganjo. She jointly organised and co-funded a "Finger Millet Awareness Day" in Kampala in February, 2006. This was enthusiastically attended by 50 participants including researchers, representatives from farmers' groups, representatives of the health and education sectors, processors, the Uganda Investment Authority and micro-credit schemes, as well as the media and policy makers. This event provided an opportunity to further discuss and identify the major demand-led priorities building on the outcomes of the Nairobi workshop -

Improved seed systems

Improved crop management (row planting, draught animal power, reduced labour for weeding)

Post-harvest handling and grain quality issues

Improvement in the production – supply chain

Product diversification, value addition and consumer awareness

and seek the perspectives of various stakeholders including policy makers and develop wider linkages.

A few examples of the support expressed for improving the finger millet sector include:

Dr. Komawombi Dulegiya, Director and Head, Food Science Department, Ministry of Agriculture, Government of Uganda, highlighted “the need for Government support for finger millet product diversification and value addition”.

Mr. John Wakikona, Representative, National Agricultural Advisory Services (NAADS) was keen for the finger millet partnership coalition “to work with the many thousand farmer groups in Uganda for enterprise development”

Dr. Maggie Kigozi, Executive Director, Uganda Investment Authority (UIA), was excited about “the potential offered by finger millet as an investment opportunity” and

Mr. Charles Sembatya of SG2000-Uganda expressed keen interest in seed systems and post-harvest quality work.

The finger millet partnership coalition is now poised to direct the progress already made towards significant increases in finger millet production and utilization in East Africa to the benefit of farmers, processors and consumers. Among the demand-led priorities listed above, two critical areas especially need further donor investment to achieve our objectives. Firstly, we need to facilitate the development of seed systems in order to ensure that farmers have access to the improved, blast resistant and farmer-preferred finger millet varieties. There are a number of successful models in East Africa with other crops that we already looking at. Links with SG2000 will be important. Secondly, we need to improve the production-supply chain, especially farmer access to efficient markets and farmer links with processors. Excitingly, one Ugandan processor, Family Diet, has already formally linked with a cooperative of 300 farmers to supply finger millet. Again, there are some successful examples in East Africa with other commodities that we are considering. A strengthened production-supply chain is also likely to expand regional trade in finger millet, already very active. Attractive aspects to any donor are the fact that some of the members of the coalition are willing to contribute funds and/or in kind support to further donor investment; agencies such as Uganda Investment authority see the potential in finger millet and the industry are keen in production and procurement of improved and blast resistant varieties.

Contribution of Outputs to Developmental Impact

Finger millet has not received the attention it deserves from the international R & D communities, although it is one of the most nutritious among all major cereals. Moreover, the grain tastes very good, the plant is productive in a range of conditions and the seeds can be stored for long periods – lifesaver for famine-prone areas. The high nutritional value of finger millet could also help sustain the health of HIV positive and malnourished people; hence its production should be encouraged throughout Africa. However, current finger millet production practices demand extreme hard work. Technologies for more efficient crop management and improving post-harvest grain quality have been identified. Potential of improved and blast resistant varieties and knowledge of blast disease and management has been promoted to the farmer groups as well as the industry and other sectors including policy makers and health and education sectors through farmers field days, the regional workshop in Nairobi and the finger millet awareness day in Kampala (Dr. Maggie Kigozi, Executive Director, Uganda Investment Authority was excited about

"the potential offered by finger millet as an investment opportunity) and also through interactions during the Research Showcase of DFID Programmes. Direct interactions with finger millet processing industry representatives have clearly identified that the demand for millet far exceeds supply and that there are also problems with grain quality. This has led to enhanced connectivity among the wide range of stakeholders involved. Farmers as well as the industry are keen for the production and procurement of improved and blast resistant varieties identified. Consequently, the component technologies identified and developed through these DFID-CPP projects linked with the parallel efforts by partner organizations have the potential for improving finger millet production and utilisation that contributing to poverty reduction as well as the creation of employment opportunities in wider sectors.

NARO team working with Lango farmers recommended more research and technology transfer to improve crop management practices in millet among other crops (The New Vision, Uganda Daily/Website, 25th Feb 2004). Ugandan government is embarking on plans to promote agriculture particularly for the benefit of internally displaced people and millet is identified as one of the priority crops to promote to improve their livelihoods (The New Vision, 16th June 2004). The outputs generated and the future priorities listed below are fully in alignment with the strategies of the ECARSAM network. On a wider level, McKnight foundation and USAID have funded projects linking University of Georgia and scientists in India, Kenya and Uganda on blast resistance mapping and characterisation of finger millet germplasm. Rockefeller has funded a PhD programme for a Kenyan scientist Chirspus Odouri in finger millet breeding and blast resistance and Chrispus has been involved with the project activities linked to KARI, Kakamega via ICRISAT-Nairobi. This underlines the fact that further R & D and promotional work on finger millet is essential and will make a real difference to urban and rural poor.

The project coalition has identified the following demand-led priorities -

Improved seed systems

Improved crop management (row planting, draught animal power, reduced

labour for weeding)

Post-harvest handling and grain quality issues

Improvement in the production – supply chain

Product diversification, value addition and consumer awareness,

and plans to develop further work addressing these issues for 'improvement in finger millet production and utilisation for the benefit of farmers, processors and consumers in East Africa' to seek support from the new DFID Research into Use Programme and also other sources such as Rockefeller and Gates foundations, particularly in view of health and nutritional benefits of finger millet.

Strong links forged among the international, regional, national research and development and local extension organisations and the ECARSAM network as well as farmer groups, CBOs, NGOs and industry will form the basis for continued use of the knowledge and resources generated. Outputs will also have indirect links and contribute to the millet mapping/characterisation work funded by other international agencies such as USAID and McKnight foundation and national and regional projects.

Publications/Dissemination list

SREENIVASAPRASAD, S. 2004. Fungal molecular diversity, development and interactions. Invited lecture, School of Biotechnology, 9th August 2004, Madurai Kamaraj University, India.

SREENIVASAPRASAD, S., TAKAN, J.P., MGONJA, M.A., MANYASA, E.O., KALOKI, P., WANYERA, N.M., OKWADI, J., MUTHUMEENAKSHI, S., BROWN, A.E. AND LENNE, J.M. 2005. Enhancing finger millet production and utilisation in East Africa through improved blast

management and stakeholder connectivity. Aspects of Applied Biology 75, Pathways Out Of Poverty, pp. 11-22, Eds. Harris, D., Richards, J.I., Siverside, P., Ward, A.F. and Witcombe, J.R. Association of Applied Biologists, UK.

SREENIVASAPRASAD, S. 2005. Finger (millet) foods. Crop protection Programme Highlights, DFID-CPP, UK, p. 1.23.

Regional Stakeholder Workshop, Facilitating the promotion of improved and blast resistant finger millet varieties to enhance production, Sep 13-14 2005, Nairobi, Kenya [included 15 talks covering outputs of R8030 & R8445, national, regional and global perspectives on finger millet production and utilization on Sep13, 2 rounds of brain storming sessions and 2 plenary discussion sessions]

OJANJI, W. 2005. Blast Management, Science Report, pp. 6-7, The Standard, East Africa, 28 Sep 2005 (News coverage following the stakeholder workshop in Nairobi).

Coverage in Kenyan Television Network, KTN on the exhibits and participant interview, Sep 9, 2005 (coverage following the stakeholder workshop in Nairobi).

SREENIVASAPRASAD, S., TAKAN, J.P., MUTHUMEENAKSHI, S., OBILANA, A.B., MANYASA, E., AUDI, P., ODUORI, C.A., COLL, R., BROWN, A.E., TALBOT, N.J. AND BANDYOPADHYAY, R. 2005 Finger millet blast in East Africa: Pathogen diversity and disease management. Regional Stakeholder Workshop, Facilitating the promotion of improved and blast resistant finger millet varieties to enhance production, Sep 13-14 2005, Nairobi, Kenya.

SREENIVASAPRASAD, S., TAKAN, J.P., MUTHUMEENAKSHI, S., CHIPILI, J., TALBOT, N.J., MANYASA, E.O. AND SERE, Y. 2005. Blast pathogen *Magnaporthe grisea* populations on finger millet and rice in Africa reveal contrasting patterns. Plant Pathology with a Purpose, BSPP Presidential meeting, 19-21st Dec 2005, University of Nottingham, Nottingham.

Finger millet awareness day. Kampala, Ugnada, 9 Feb 2006 and Stakeholder engagement at the DFID-Programmes Research showcase, 10 Feb 2006, Kampala, Uganda [including 11 presentations on stakeholder perspectives on constraints, opportunities and challenges in finger millet productions and utilisation]

LENNE, J.M. 2006. File note on progress and plans on improving finger millet production and utilisation in East Africa, sent to Rockefeller and Kilimo Foundations, 24.02.2006.

SREENIVASAPRASAD, S, MUTHUMEENAKSHI, S, TAKAN, J.P, OBILANA, A.B., MANYASA, E.O., BROWN, A.E. 2006. Finger millet blast in East Africa: pathogen diversity and management strategies. Article in Perspectives on Pest II, DFID-CPP, pp 52-53, 2006 (in press).

Proposed for July 2006 - Finger millet promotion day, led by Maganjo Grain Miller, Kampala, Uganda. Working with consumers, local farmers, and distributors involving the above three groups and all the stakeholders that were involved in the awareness day BUT, the main objective is to involve the local consumer, and the local farmers (the local community in general).

Appendices

1. Varietal performance in mother and baby trials in Kenya

Results from mother trials in Alupe

Name	Yield (t ha^{-1})	Blast score 1-9	Days to flowering	Plant ht (cm)
KNE 688	1.85	1.9	77	110
ACC 32	1.81	3	68	104
KNE 814	1.76	1.9	71	108
KNE 1149	1.71	1.9	80	114
P 224	1.67	2.3	71	109
ACC 14	1.44	1.9	74	109
LOCAL	1.34	2.8	75	108
ACC 29	1.07	2.1	79	119
Trial mean	1.58	2.2	74.31	110
SE	0.26	0.28	1.84	7.17
CV%	16.7	12.5	2.5	6.5

Grain yield in baby trials, Alupe

Variety	Grain yield (t ha^{-1})
P 224	1.73
ACC 32	1.66
KNE 814	1.57
KNE 1149	1.45
ACC 14	1.44
ACC 29	1.38
KNE 688	1.37
Grand mean	1.52
SE+	0.37
CV %	24.6

Farmer varietal preference, Alupe and Nambale, Teso district

Variety	Reasons for preference
Acc 14	Big panicles/high yield, brown grain, low finger blast.
ACC 29	Grain color (dark brown), low finger blast
KNE 814	High yield, low finger blast
P 224	Big panicles, high yield
KNE1149	High yield
Local	Grain color

2. Varietal performance in mother and baby trials in Uganda

Composition of farmer groups involved in different ditricts

Site No.	District	No. female farmers	No. male farmers	Total
1	Kaberamaido	18	24	42
2.	Amuria	13	15	28
3.	Soroti	9	16	25

Standard evaluating system for finger millet blast

Tillers with blast (%)	Reaction
0-20% infected	Resistant
21-40% infected	Moderately resistant
41-60% infected	Moderately susceptible
61-80% infected	Susceptible
81-100% infected	Highly susceptible

Mean disease score (finger blast and head blast), number of primary tillers, plant height, and yield at four locations in Uganda

Parameter	Angalibu	Angaro	Kikota	Oselel
Finger blast (%)	14.5_b	16.9_b	22.2_a	24.9_a
Head blast (%)	15.1_b	15.6_b	25.2_a	20.9_{ab}
Number of primary tillers	0.14_c	0.64_b	1.39_a	0.25_c
Plant height (cm)	69.3_b	71.1_b	77.8_a	59.1_c
Yield (kg/ha)	1.93_b	2.98_a	3.08_a	1.58_c

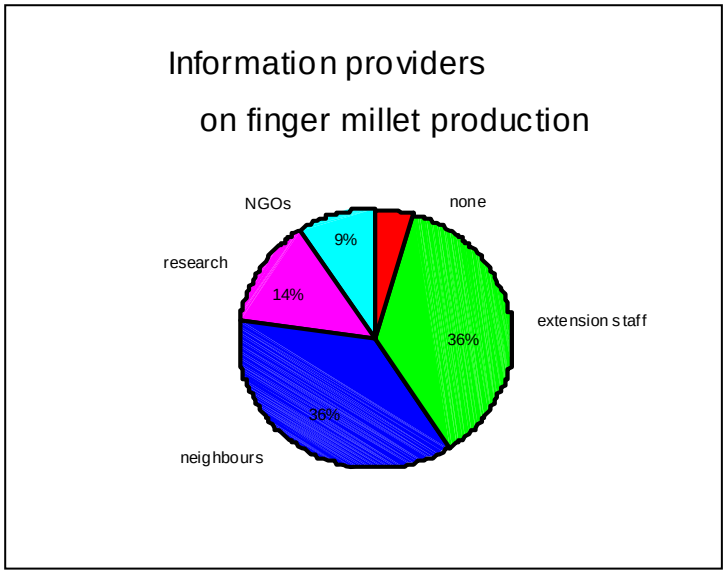
Means in the same row bearing the same subscript are not statically different.
Means based on 7 lines of finger millet viz: Gulu E, Pese 1, Sec 915, Seremi 1, Seremi 2, SX 8 and local checks.

Mean performance of individual varieties of the on-farm trials over 4 sites in Uganda

VARIETY	Primary tillers	Plant height	Finger blast	Head blast	Yield
GULU E	0.68_a	68.8_c	24.9_{ab}	24.3_{bc}	3.02_a
LOCAL	0.56_a	62.6_d	17.6_{bc}	23.6_{bc}	1.45_c
PESE 1	0.56_a	79.1_a	25.6_{ab}	25.7_{ab}	2.44_a
SEC 915	0.75_a	58.7_e	20.1_{bc}	15.1_{cd}	2.39_b
SEREMI 1	0.56_a	$76.6a_b$	8.0_d	7.6_{de}	2.23_b
SEREMI 2	0.5_a	64.3_d	29.8_a	33.9_a	2.32_b
SX 8	0.62_a	75.3_b	11.1_d	4.1_e	2.93_a
Site Mean	0.61	69.3	19.6	19.2	2.39
CV % (0.5)	23.1	8.2	22.4	45.0	16.2

3. Varietal performance and row planting promotion trials

4. Farmer field days to increase the awareness of blast disease and its management



5. Regional stakeholder workshop participants, millet product exhibits and pelleted finger millet seed

6. Stakeholder Perspectives on Finger Millet Production and Utilisation (from the Nairobi Workshop)

Participants formed three groups representing researchers, farmers and industry. Each group discussed constraints and opportunities to/for finger millet development from their particular perspective. These findings were later presented and discussed in plenary. This process allowed the meeting to consider a wide variety of views in detail, and provided a strong base for discussions on a regional action plan.

RESEARCHERS GROUP

Constraints

1. Genetic resources

- Germplasm (assembly, resources and enhancement, breeding). There are important gaps in the region's germplasm collections, in cultivated varieties as well as wild species. The available germplasm also needs to be more fully characterized and utilized in breeding programs.
- Improved varieties (availability, promotion and dissemination). We must continue to develop new, improved varieties adapted to specific production zones
- Seed production and distribution. Lack of seed of available varieties is a major constraint to adoption

2. Production

- Weeds – Striga and others, especially wild *Eleusine*
- Pests, diseases – blast, shootfly, stem borer
- Birds
- Drought
- Poor soil fertility: fertilizer and other amendments rarely applied on finger millet
- High labor demand for land preparation, planting and weeding
- Post harvest quality and management

These constraints have reduced productivity; as a result, farmers are not interested in expanding or commercializing finger millet cultivation, preferring to grow the crop on small plots for household consumption.

3. Policy

- Inadequate awareness among policy makers
- Lack of enabling policy environment
- Low funding for R&D
- Price fluctuation linked to production variability
- Competition from other crops

4. Other issues

Limited product range: few finger millet based foods are available in urban markets, reducing sales and promotional prospects.

key constraints: lack of new varieties: improved varieties need to be developed and promoted, associated with adequate seed supply

Opportunities

1. Genetic resources

- Improved varieties with high yield, local adaptation and blast resistance, are available – already developed and tested, or in the final stages of testing
- Seeds systems models are available, and have been successfully used for seed production and distribution in other small-grained cereal crops
- A regional program for testing and promotion of new varieties can be established, using networks and linkages already in place for sorghum and pearl millet
- Germplasm assembly, evaluation, utilization can be enhanced through partnerships between countries, facilitated by ICRISAT and regional bodies

2. Production
- Integrated pest and disease management in finger millet has been well studied. Crop management 'packages' are available for diseases (including blast), weeds (e.g. row planting, and control using animal draft power), and water and soil fertility management
- Tools and methodologies are available for pathogen studies and resistance screening
- Synergies can be exploited for further progress – with other crops, and among various research institutions in the region.

3. Post-harvest grain quality
- Information is available on post-harvest grain quality management. Potential low-cost technologies and interventions have been identified
- Strong links already established between farmers and processors in some areas and for some crops. These can be extended to finger millet

4. Policy environment
- NARO-Uganda's approach to finger millet involves close interaction between R&D agencies and policy makers. This could serve as a model for other countries
- Donor interest in finger millet is increasing (because of its nutritive value); opportunities for increased R&D funding
- Links between research, NGOs and extension already exist, but can be strengthened to promote finger millet
- ECARSAM, as an established regional network, can lead or facilitate policy advocacy

INDUSTRY GROUP

Constraints

1. Poor grain quality: grain delivered to processors is usually of poor quality
- contaminated by foreign matter (stones, dust, sand, husk)
- high moisture content caused by poor drying, poor storage
- immature grain, harvested too early
- mixed with other grain (e.g. sorghum) either accidentally or deliberately

2. Low, irregular supply
- Grain supplies are low and irregular because of low and variable production and lack of an efficient marketing chain. This increases processors' cost of production, thus reducing profits.
- Processors are unable to maintain regular supplies to urban markets, and lose customers

3. Packaging
- Packaging of processed foods (flour, meal) is expensive; lower-cost packaging does not give adequate shelf life
- Packaging is not targeted/segmented at consumers

4. Limited product diversification
- No research on processing and development of new food products
- Poor linkages between research-processor-consumer, hence lack of feedback on consumer demands and market opportunities

5. Weak processor associations
- Finger millet processors are not well organized (unlike other crops); hence limited capacity for policy advocacy or for strengthening markets, supply chain etc

6. Policy issues
- Lack of official product standards or quality grades; reduces incentive to improve quality
- No enabling policy, finger millet remains low priority for policy makers

key constraints: poor grain quality, weak marketing chain

Opportunities

1. Poor grain quality

Grain quality can be improved by:

- increase awareness of farmers, traders
- aggressive promotion of production practices e.g. improved threshing methods
- establish price incentives based on quality

2. Low, irregular supply

Grain supplies can be improved through:

- better market information systems for grain buyers and sellers
- better grain collection systems, e.g. bulking at collection centers
- improved processor-farmer chain

3. Product diversification

Availability of a wider range of products will increase utilization. Accordingly, we need to:

- stimulate research interest in development of new products
- improve processor-consumer linkages to better identify and service consumer needs
- improve access to information: new products/technologies for processors, product availability, price, advantages etc. for consumers

FARMERS GROUP

Constraints

Finger millet is grown primarily on a small scale, for household consumption. Production suffers from various constraints:

- Low prices
- Low yields due to various factors – soil fertility, lack of improved varieties, pests, weeds, diseases, labor shortages, poor technology adoption, lack of timeliness in farm operations
- Unavailability of seed of improved varieties
- Lack of information on household utilization, crop husbandry, post-harvest technology, markets
- Lack of credit facilities

In particular, research/development interventions are needed to improve soil fertility and seed availability.

Other major constraints:

- Farmers are not involved in decision making – traders, processors and policy makers make all decisions
- Negative community attitude – finger millet is considered an inferior food
- Unofficial cross-border trade creates opportunities for Ugandan producers, but Kenyan farmers are out-competed by imports

key constraints: farmers not involved in decision making; low yields; negative community attitude towards finger millet

Opportunities

Labor saving operations, e.g. row planting, use of draft power, can reduce production costs and also improve yields by improving timeliness of operations

Seed availability can be improved in various ways:

- Establish farm demonstrations, and distribute a portion of the harvested grain/seed to other farmers
- Promote pre-released varieties, where seed production for local sale/exchange is permitted by law
- Establish community seed banks

- The community must appreciate and enforce collective ownership of initial seed, i.e. recipients of seed from NGOs or extension programs must share with other farmers

Soil fertility improvement:
- Education, training on use of manure and inorganic fertilizer
- Planting agroforestry trees; training and seedlings may be needed
- Use of legume crops
- Interventions to improve availability and reduce cost of fertilizer

Other opportunities for promoting the crop:
- Inclusion of finger millet in food relief programs will create market opportunities for local producers
- Publicity and awareness campaigns will help remove the common perception that finger millet is inferior to wheat or maize
- Networking and formation of farmer groups will help improve production, and access to inputs and markets

Blast management

THE STANDARD
No. 27367 www.eastandard.net OUTSTANDING EVERY DAY Wednesday, September 28, 2005 KSh35/00 (TSh600/00 : USh800/00)

The bumper harvests are back and there's no more talk of famine. Wandera Ojanji explains how a new variety of finger millet has helped farmers beat blast infection.

Oduori Odera smiles with contentment every time he looks at his two-acre farm under finger millet. The crop is lush, a sign of another bumper harvest. His neighbours in Angorom Location, Teso District, are also happy that the new variety of finger millet they are growing is yielding higher and faster than the previous one.

For many years ago, the villagers faced starvation after blast, a fungal disease, attacked their crop and destroyed it before it matured. Initially, they did not know the name or cause of the disease and described it by the symptoms. The disease damaged the foliage, neck and fingers in different growth stages.

Infection prior to milking stage induced finger sterility and reduced the grain weight and number, while infection after milking stage resulted in reduction in seed size, number and seed weight. Farmers in neighbouring Uganda described it as *ebwetele, obapu* or *kalajajwa* — meaning 'dry heads'. In Kisii, it was known as *egetebo*.

"We did not know the name of the disease. It made the 'necks' of young plants to shrivel. The infected plants did not bear cereals and we did not know how to control it," says Oduori.

The yields decreased to levels where the peasants could not meet food and financial needs of their families. For instance, Oduori harvested 450 kilos only in 2003 season. This alarmed the farmers because the cereal was a major staple food and played an important role in the dietary habits and economy of most subsistence farmers. Most sell the surplus to meet their basic needs and prepare *akobuile* — a traditional brew used in cultural rites and for commercial purposes — from finger millet.

However, this changed last year when the International Crops Research Institute for Semi-Arid Tropics (Icrisat) introduced a new blast resistant variety for planting.

> Although it has been suggested that the blast pathogen hides in seed and crop debris, very little is known of its genetic and pathogenic diversity in East Africa.

Mary Mgonja, a plant breeder at Icrisat in Nairobi says that although farmers in Uganda and Kenya were aware of the disease, they did not know what it was, the cause, mode of transmission and control measures for the disease.

She says blast is caused by a fungus, *Pyricularia grisea*, and is spread by wind. Mgonja says apart from other constraints like lack of improved and high-yielding varieties and poor soil and crop management, blast is one of the critical constraints to finger millet production in East Africa.

"Blast affects finger millet at all stages of growth and most of the traditional varieties are highly susceptible. Certain forms of blast can cause failure of the grain to set and seeds to shrivel, resulting in major yield losses," she says.

The researcher says although it has been suggested that the pathogen over-seasons on seed and crop debris as well as weeds and wild grasses, very little is known of the genetic and pathogenic diversity of the finger millet blast pathogen in East Africa.

A survey by Icrisat, Kenya Agricultural Research Institute (Kari) and Uganda's National Agricultural Research Organisation (Naro) identified blast as the most prevalent finger millet diseases in Busia, Teso and Kisii districts in Kenya, contributing to between 10 to 50 per cent grain losses. The figures were even higher in Uganda, with the disease causing between 24 to 68 per cent grain losses.

Oduori is one of the many farmers in Kenya and Uganda benefiting from research by Icrisat in collaboration with other institutions in Kenya and Uganda to develop blast resistant and better performing finger millet varieties. The collaborating institutions are Naro, Serere Agricultural and Animal Production Research Institute (Saari) in Uganda and Kari.

Today, Oduori is a happy man. Last season he harvested about 2,000 kilos of millet. And he expects more this season.

"Finger millet is not just a food and cash crop for us. It has significant cultural and traditional values among us. It was becoming extremely difficult to undertake some of our cultural rites without finger millet. Life is once again becoming normal with these new varieties," says Prescilla Nakayoro from Punyula Division, Busia District.

Mgonja says research on finger millet (*Eleusine coracana L.*) is driven by the fact that it is a staple food for millions of people in the region.

"The cereal plays an important part in the subsistence of farmers in the region. It is especially important for pregnant women, nursing mothers and children. The high nutrition value of finger millet can also sustain the health of HIV-positive and malnourished people. It is the grain of choice for processed flour for porridge by urban consumers," she says.

Faith Mutwiri of Ungo Group, a company that processes finger millet into porridge flour, says it has high levels of iron (5 per cent) and calcium (35mg per 100g). The iron content in maize is 2.7 per cent and 25 mg per 100g. Finger millet is also very rich in phosphorous and amino acids, especially lysine and methionie and Vitamin B.

Mgonja notes that the crop is hardy and grows well in a wide range of soil and climatic conditions. Unlike sorghum or maize, the seeds can be stored for longer periods without any insect or pest damage. These attributes make finger millet very ideal in providing food security to people in famine prone areas.

Other than the common uses of finger millet — making *ugali*, porridge and local brewing — it is now used as malt for industrial production of alcohol.

According to Food and Agricultural Organisation (FAO) statistics, production of finger millet has been on the rise in Uganda. Last year, the country produced 700,000 metric tonnes of finger millet, up from 534,000 in 2000. During the same period, 420,000 metric tonnes of sorghum were harvested.

Although there are no official estimates for last year, production in Kenya also appears to be on the increase. In 2002, Kenya produced 72,194 tonnes, up from 38,683 in 1997, according to BM Kenyenji, a researcher with Kari, Embu.

Dr Nelson Wanyera, breeder and team leader Naro/ Saari Blast Management and Finger Millet says finger millet is the second most important cereal in Uganda after maize.

Mgonja laments that finger millet has been given low research and development priority at both the national and international levels compared to cereals like maize, wheat, rice and even sorghum. This is supported by Dr S Sreenivasaprasad of Horticultural Research Institute, University of Warwick, UK.

"Finger millet has not received the attention it deserves from international and national scientific research and development communities, although it is nutritious and is a major staple crop for millions of people in East and Central Africa and India," says Sreenivasaprasad, who is leading the team of plant breeders and other scientists in developing and promoting blast resistant finger millet varieties.

Above: Oduori Odera with his wife Beatrice in their farm in Angorom, Teso District.

Top: One of the blast resistant varieties of finger millet. Below: Withered fingers of an infected crop.

He spoke recently at a stakeholders' workshop on promoting blast-resistant finger millet varieties to enhance production in Nairobi.

The main aim of the workshop was to improve understanding and communication between key stakeholders in the finger millet production and supply chain in Kenya and Uganda. It provided the opportunity for representatives from all stakeholder groups to articulate and discuss their constraints and needs for the benefit of other stakeholders.

With support from the Crop Protection Division of Department of International Development, Icrisat in 2001 started screening varieties to identify those that were resistance to blast and suitable for East Africa. The screening was done at Kari's Alupe field station in western Kenya and Serere Research Station in Uganda up to 2004.

The team found that the three most popular finger millet varieties *enaikuru* in Kisii, *enamware* in Teso and *ikhulule* in Busia and other local varieties were susceptible to blast. In all cases, the disease incidences were much higher in the first growing season, February to July, than in the second growing season, August to December. This was attributed to high rainfall hence high humidity, which favours blast pathogen development.

"The challenge then was to come up with improved varieties that are blast resistant and at the same time acceptable to farmers. From the participatory rural appraisal we carried out in Kenya and Uganda, farmers preferred varieties that mature early, are blast resistant, high yielding, have good palatability and good brewing qualities," says Sreenivasaprasad.

After screening, the researchers identified varieties Acc14, 29, 32 and 44 and Icrisat germplasm lines KNE620, 629, 688, 814 and 1149 as suitable for the farmers. Other than high resistance to blast, they also showed good agronomic performance, according to Eric Manyasa, a researcher with Icrisat, Nairobi.

Chrispus Oduori, a researcher with Kari in Kakamega, says with good crop husbandry, these varieties produced in excess of 1,500 kilos of grain per hectare. Previous varieties yielded about 600 kilos per hectare. Wanyera says they have identified 43 varieties with high resistance to both neck and finger blast.

He particularly singled out varieties such as Gulu E, Seremi 1, Seremi 2, Pese 1, SX 8, SEC 915 and P224 as blast resistant, high-yielding, have good grain quality and mature early.

This was confirmed by pilot studies in Busia, Teso and Kisii districts in Kenya and Soroti, Pallisa and Lira districts in Uganda. The researchers also concluded that varieties producing dark-coloured seeds and compact heads were more blast resistant compared to white-seeded and open-headed varieties. Neck and-panicle blast are very destructive. However, improved varieties Gulu E and P224, which are liked for their early maturity by farmers, were relatively less resistant to blast than farmer varieties.

Manyasa says that while most of the new varieties can perform well in a variety of soil and climatic conditions, farmers choose a variety based on other preferred characteristics like early maturing, drought tolerance, uniformity in height, tillering, large heads, non-shattering, high yielding and good brewing qualities.

For instance, farmers in Pallisa District, Uganda, which has high blast incidences, prefer the highly blast resistant Seremi 1 and Seremi 2 to Gulu E and P224 that are less resistant but high yielding. But fighting blast will require more than introducing blast resistant varieties. The scientists state that good agronomic practices, especially weeding and choice of seed, play an important role in minimising the incidences and severity of blast. Sreenivasaprasad says that blast isolates from weeds were capable of infecting finger millet, particularly blast isolates from wild finger millet.

"These were as aggressive as some of those from cultivated finger millet isolates. Blast was commonly observed on weeds especially wild millet such as *Eleusine indica*, (most common), *Dactyloctenium, Digitaria* and *Cyperus* species occurring in finger millet fields. Weed management is thus a key component of tackling blast."

Sreenivasaprasad challenges farmers to use clean certified seeds because seed-borne pathogens like *bipolaris* contribute to disease development, with higher blast levels in seed lots of susceptible finger millet varieties. Wanyera agrees, adding that farmers will record more yield if they planted the cereal early to beat the blast growth cycle.

While domestic and cross border trade in finger millet is brisk, international trade is yet to develop. And even where the business is brisk, the market is seasonal, peaking just after harvest or during the festival Easter and Christmas seasons. In some areas in East Africa, cultural, religious and traditional factors strongly influence the demand for finger millet. Locally, the price also varies between Sh25 and Sh35 per kilo, depending on season and distance from producing area.