New sorghums combat witchweed

RIU

Validated RNRRS Output.

Small farmers in dry areas of Tanzania can now grow sorghum again. Previously, rampant witchweed stifled their crops of sorghum and maize, so they had to grow pearl millet and cassava instead. Now they plant two new varieties of sorghum that are resistant to witchweed. And they apply manure as another weed deterrent. Farmers themselves tested the new varieties of sorghum. The ones they chose, as well as doing well where there's witchweed, are drought-tolerant and mature early, yield well and are good to eat. When farmers apply manure, yields are a quarter to half as much again. These two varieties are now registered and formally released, and farmers in Tanzania are already using them.

Project Ref: **CPP78:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP78

A. Description of the research output(s)

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

Geographical regions included:

Tanzania,

Target Audiences for this content:

Crop farmers,

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

***Striga* management in sorghum**

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

The outputs described here were validated by projects funded by the Crop Protection Programme. Sorghum cultivars *Hakika* and *Wahi* were derived from a sorghum breeding programme at Purdue University, USA, funded by USAID though the INTSORMIL programme. This has subsequently also funded on-farm trials and demonstration of the cultivars in Tanzania during 2005 and 2006.

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

R6291 [1996-1999]; R6654 [1996-2000]; R7564 [2000-2003]

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University of Sheffield (MC Press m.c.press@shefield.ac.uk)

Ilonga Agricultural Research and Training Institute, Tanzania (AM Mbwaga ambwaga@yahoo.co.uk)

LZARDI Ukiriguru, Mwanza, Tanzania (Robert Kileo kileorobert@yahoo.com)

Dodoma Rural District Council (Mr J Semwaiko, District Extension Officer)

Missungwi District Council, Mwanza Region.

*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Outputs were generated between 1996-2003 through laboratory trials, replicated research trials and participatory on-farm trials with supporting socio-economic evaluation in two semi-arid areas of **Tanzania** on soils infested by the parasitic **witchweeds *Striga asiatica*** (in Central Zone) and ***S. hermonthica*** (in the Lake Victoria Basin):

- Two ***Striga* tolerant sorghum** lines, registered and released in November 2003 as cultivars *Hakika* and *Wahi*. Their superior performance on *Striga* infested land compared to previously

available landraces and cultivars was validated in p**articipatory on-farm trials.** Both were ranked highly by both men and women sorghum producers on the basis of early maturity, drought tolerance, high yield on *Striga* infested fields and a range of post-harvest (eg palatability) criteria;

Ø Farmer evaluation demonstrated the value of using animal manure to improve **soil fertility** and sorghum yield when planting *Hakika* and *Wahii* on *Striga* infested land;

Ø A simple **decision tree** to match sorghum cultivars to soil type;

Ø **Learning tools were assessed and Extension training materials** to support promotion of *Hakika* and *Wahii* include two leaflets describing the cultivars and two leaflets describing **integrated *Striga* management** for sorghum producers.

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
X	*X*				

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

The outputs focus on sorghum. Use of animal manure to reduce the impact of *Striga* infestation is also a useful practice to use for other susceptible cereals, particularly maize.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

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

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

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

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

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

Effective seed systems will be essential if farmers are to benefit from the new sorghum cultivars. The ICRISAT Sorghum and Millet Improvement Programme piloted community based seed multiplication options in Dodoma Region including village primary school plots (see Rohrbach, *et* al., 2002. *Comparative study of three community seed supply strategies in Tanzania.* Bulawayo, Zimbabwe: International Crops Research Institute for the Semi-arid Tropics). Another option is the Quality Declared Seed system implemented in various parts of the country, including for sorghum in Dodoma Rural district, by the GoT Ministry of Agriculture seed unit (funded by ASPS DANIDA). Links are already established with the Good Seed Initiative (R8480) and there would be added value to mutually improving farmer seed management. FIPS Africa experience of projects R8219, R7405 (honest broker negotiating with private sector e.g. mini-packs of seeds) is valuable.

Kernel covered smut is a widespread cause of yield loss in sorghum in East Africa. NRI in partnership with Ilonga Agricultural Research Institute [R7518, 1999-2002] validated in-field panicle selection in four villages of Dodoma Rural District to allow farmers to plant smut-free seed and a set of supporting extension materials (leaflets, and a video) were prepared. Teaching about smut control was also incorporated into the curriculum, tested in 12 schools. Seed selection practices should be promoted with the *Striga* tolerant sorghum cultivars.

Continuous cropping of cereals has resulted in declining yields associated with low soil fertility. The Tanzania NARS and ICRISAT released two pigeon pea cultivars, *Mali* and *Komboa*, suitable for intercropping in sorghum. Pigeon pea can contribute nitrogen to the soil to enhance soil fertility and pigeon pea sorghum inter-crops should be demonstrated to farmers in semi-arid Tanzania. *Hakika* and *Wahi* have been demonstrated in Singida rural district in combination with water harvesting by tied ridging a practice that needs to be disseminated further.

District council agricultural team partners included pilot demonstration of *Hakika* and *Wahi* within crop protection communication strategies developed with projects R8248/R8349. Extension training material (a leaflet) and radio programmes on *Striga control* are available to use in future up-scaling.

Other projects providing novel learning and communication approaches and tools to improve farmers' understanding of pest problems include R8422 in Tanzania and R8448 (e.g. participatory video and computer animation). Lessons are also available on increasing utilization of sorghum (R6640) and linking farmers with markets (R8250, R7494).

Validation

B. Validation of the research output(s)

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

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

category the validation was applied and any increases in productivity observed during validation ***(max. 500 words)****.*

Following an initial characterisation exercise to identify farmers knowledge of *Striga* species as constraints to sorghum production and the role of sorghum in their cropping systems a series of on-farm trials were undertaken in two agricultural zones of Tanzania to evaluate a small number of candidate *Striga* tolerant or resistant sorghum lines under farmer management. Farmer research groups were formed with the assistance of district council crop production or crop protection specialists and village extension officers in Central zone while existing farmer research groups previously formed by the zonal research team were used in Lake Zone. Farmers were provided with seed to plant using their own management practices. Mid- and end of season evaluations were facilitated by the research team. Groups of men and women prioritized a set of pre- and post-harvest criteria for sorghum cultivars and used these in matrix ranking of lines under evaluation. The research team collected data on *Striga* emergence and sorghum yield. Sites provided replicates for statistical analysis. Parallel, replicated trials were implemented on four research station sites, including one that was free from *Striga* over a three year period to provide “uniformity trial” data needed by the Tanzania Official Seed Certification Institute for registration purposes. This included assessments of a range of diseases. Detailed laboratory trials were undertaken at Sheffield University UK to confirm resistance under controlled conditions, to elucidate the mechanism of resistance (due to maintenance of photosynthesis despite infection) and to show how in the case of Hakika resistance was maintained even under low soil nitrogen conditions. A range of soil types on which *Striga* is a problem were identified according to farmer criteria and used for on-farm trials with a selection of sorghum lines. Backed up by a replicated trial on a research station site the data was used to derive a decision tree to guide deployment of sorgum genotypes to soil types and farmer different levels of farmer access to animal manure. On-farm trials were also implemented with resistant sorghum lines planted with or without manure application.

Lines P9405 and P9406 (subsequently released as Hakika and Wahi respectively) supported lower numbers of emerged *S. asiatica, S. forbesii* and *S. hermonthica* than other lines, particularly the released cultivar Pato. P9405 and P9406 tended to be more productive, producing higher yield than Pato and Macia at *Striga* heavily infested sites. P9405 produced significantly higher yields than Pato in seven of nine year x location replicated tests. P9406 performed better than Pato in six trials. The yield advantage of Hakika and Wahi was confirmed on-fsrm on *Striga* infested land. Farmers ranked Hakika and Wahi highly for a number of important traits including drought tolerance, low infestation of *Striga* early maturity, yield and palatability criteria so these were taken forward for registration. Application of manure increased yields of Hakika and Wahi by 25 to 40%. Learning tools and extension training materials were assessed by farmers in Central Zone.

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

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

Validation was undertaken with three village communities in Dodoma rural and Urban Districts (*S. asiatica* infested areas of Dodoma Region, Central Agricultural Zone) and two village communities in Misungwi District (*S. hernonthica* infested areas of Mwanza Region, Lake Agricultural Zone). Uniformity on-station trials were undertaken at Hombolo (*S. asiatica* infested in Central Zone), Ukiriguru (*S. hernonthica* in Lake Zone), Melela (*S. asiatica* and *S. forbesii* infested in Morogoro Rural District, Eastern Zone) and at Ilonga (*Striga* free, Eastern

zone). The uniformity trials and validation PVS trials were implemented over three seasons from 2000 to 2002. At least five farmers planted PVS trials in each village with each sorghum line grown on a plot of at least 50 m^2. Group cultivar evaluation sessions were attended by 15 to 30 farmers. Group members were volunteers and were not purposively selected except that each grew sorghum and experienced the problem of *Striga* on their land and experienced low and declining yields. Although encouraged, there was under-representation of women in some groups. All trial sites were located in semi-arid areas of Tanzania. Sorghum is grown on sandy free draining soils in Dodoma Region by farmers who also grow pearl millet and also maize when rainfall is favourable. In Misungwi many households had ceased producing sorghum or maize due to *Striga* and concentrated on pearl millet and cassava as their staple food crops.

Current Situation

C. Current situation

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

Sorghum cultivars *Hakika* and *Wahi* are now being used by limited numbers (1000+) of smallholder farmers with seed distributed by a number of district council managed extension programmes. The Extension teams have generally obtained seed from the research programme at Ilonga for distribution in small quantities, typically 1 kg per household. Farmers in Dodoma are producing Quality Declared Seed and primary schools are hosting demonstrations of the varieties.

The cultivars have been included in seed multiplication undertaken by Simba Seed Farm (GoT) and Singida District council.

Seed of both cultivars was provided to the national sorghum research programmes in Uganda and Sudan in 2006 within the regional project (*Integrated Striga management in East and Southern Africa*) funded by EU through the ASARECA East and Central Africa Sorghum and Millet network. Following seed multiplication the cultivars will be tested on-farm each country.

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

In Tanzania *Hakika* and *Wahii* are being used in the following locations:

ZONE/ District	**Programmes**
LAKE	
Misungwi	- On-farm trials implemented by GoT research institutes with INTSORMIL funding - Seed multiplication from Ukiriguru research programme
Kwimba	– Seed multiplication from Ukiriguru research programme

Mara	- Seed purchased for distribution to farmers by District Agricultural and livestock Development Office.
Meatu	- Seed purchased for distribution to farmers by District Agricultural and livestock Development Office
CENTRAL	
Singida Rural	- Mpambaa seed farm (Singida Rural DC) – 15 acres Wahi planted in 2005/06 - On-farm trials implemented by GoT research institutes with INTSORMIL funding - PADEP – World Bank funding
Kongwa,	- On-farm trials implemented by GoT research institutes with INTSORMIL funding
Dodoma Rural	– Seed multiplication for distribution through GoT Quality Declared Seed programme
S. HIGHLANDS	
Chunya (Mbeya region)	- On-farm trials (ECARSAM network of ASARECA – funded by EU)

14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading ***(max 250 words).***

The following use of *Hakika and Wahi* has been reported for the 2005/06 season:

Singida Region:

Singida Rural District (INTORMIL project) – cultivars grown on 790 acres in six villages. This has expanded from an initial 12 farms in four villages in 2004. In addition seed has been distributed to 176 farmers across 15 farmer groups in 6 villages supported by the district PADEP project. The district council is multiplying *Wahi* on 15 acres at their Mpambaa seed farm.

Iramba District – (INTORMIL project) 30 farmers in 5 villages growing *Hakika* and *Wahi* plus plots at 10 primary schools.

Dodoma Region:

Kongwa District (INTORMIL project) – cultivars grown by 120 farmers in 12 villages with two growers also producing 200 kg seed.

Mpwapwa District (INTORMIL project) – cultivars grown by 120 farmers in 12 villages.

Dodoma rural – six farmers in three villages who were involved in the Quality Declared Seed programme produced 2.8 t of seed for sale.

Mbeya region

Chunya– (INTORMIL project) 40 farmers in four villages provided with seed

Mwanza Region:

Misungwi district – In 2003, 20 farmers produced 0.5 acre of Hakika and sold 1.5 t seed to the Regional Commissioner of Mara for distribution to farmers in all districts of Mara region. CARE Tanzania purchased seed from the same farmers for distribution in Magu district.

In 2005/06 20 farmers in Misungwi and 23 in Kwimba district were each provided 3kg of either Wahi or Hakika for planting on 0.5 acre. The zonal research programme produced 120 Kg seed at Ukiriguru Research Institute which was sold to Meatu District.

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

Funding from the CPP projects that developed the outputs described in this dossier ensured that some initial multiplication of seed occurred to allow limited promotion in a number of districts and further seed has been produced with the support of INTSORMIL. Secure funding (from the CPP projects and GOT) for breeders seed production at Ilonga has been vital to the promotion that has taken place to date as has been the capacity of both Ilonga and Ukiriguru research institutes to produce uniform true to type seed.

Transfer of knowledge of the cultivars and their use in integrated *Striga* management systems via farmer groups has worked well under the INTSORMIL project in Singida, empowering farmers to evaluate technology options to make own decisions.

A major factor leading to the levels of adoption achieved to date has been a commitment by district councils to include promotion of the new sorghum lines in their district agricultural development programmes.

Awareness within the farming community has been increased through local and national radio programmes in Singida, Dodoma and particularly by involvement of district staff in workshops organised by the CPP projects that developed these outputs and subsequently with USAID initiative.

The policy environment has created opportunities and challenges. Liberalisation of input and output markets (since late 1980s/ early 1990s) has resulted in a wide range of players entering the market in higher potential areas, but not in areas where sorghum is grown. Production of Quality Declared Seed (QDS) of open pollinated varieties by trained village based farmers is formally recognised, and financially supported by DANIDA ASPS, enhancing local ownership & management of seed and improving access to seed for farmers in remote areas.

Regional harmonization of seed regulation amongst East African countries would facilitate the release of varieties elsewhere in the region.

Environmental Impact

H. Environmental impact

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

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

The promotion of new sorghum cultivars by extension service providers and the resulting farmer adoption by farmers will have few environmental impacts. Recent estimates from the International Fertiliser Development Center have drawn attention to the scale of plant nutrient loss through erosion and nutrient mining in sub-Saharan Africa. While average fertilizer use in Tanzania was less than 2 kg ha^{-1} in 2002, loss of nitrogen, potassium and phosphorus was estimated at 61 kg ha^{-1}, one of the highest annual rates in Africa. As few poor farmers are in a position to purchase fertiliser, the use of a low-cost organic approach is an essential alternative. Use of animal manure to improve sorghum production will lead to an increase on soil futility, soil structure and moisture holding capacity. An indirect benefit of adoption of the new sorghum cultivars is the higher biomass accumulation in the crop canopy compared to that achieved with susceptible cultivars that are often severely stunted by the parasite. If planting is widespread the greater biomass will result in longer periods of annual carbon sequestration from atmospheric CO_2 .

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

There are no foreseeable adverse environmental impacts associated with growing early maturing *Striga* tolerant sorghum cultivars or using animal manure to improve sorghum growth and yield.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Climate models predict that by 2100 rainfall will decrease by up to 20% in the semi-arid central areas of Tanzania with national grain production falling by 10% by 2080, with particularly severe yield reductions in maize (see Downing, 2002; In Brining, J.C. and Downing, T.E. [Eds.] *Managing the Earth: The Linacre Lecture.* Oxford University Press, pp 5-34). Farmers are already responding to climatic variability by planting more sorghum with the area planted to the crop in Morogoro region increasing in three of the seasons from 1994/5 to 2000/01, when maize production remained static or declined (see Paavola, 2004. Working Paper EDM 04-12, Centre for Social and Economic Research on the Global Environment, University of East Anglia: Norwich, UK). Increasing sorghum productivity in the semi-arid zone of Tanzania will therefore be a continuing priority for both food security and household income. Shorter duration cultivars such as Hakika and Wahi provide farmers with greater flexibility as climatic variability increases. These cultivars can be planted much later in the season when the onset of rain is delayed than is possible with the longer duration local landraces that are still commonly grown.

Annex

Appendix 1. Acronyms and Abbreviations

ARI	Agricultural Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASDP	Agricultural Sector Development Programme
ASPS	Agricultural Sector Programme Support
ASSP	Agricultural Sector Support Programme
CPHP	Crop Post Harvest Programme
CPP	Crop Protection Programme
DADPs	District Agricultural Development Plans
DADS	District Agricultural Development Strategy
DANIDA	Danish International Development Assistance
DFID	Department for International Development
ECARSAM	
EU	European Union
FFS	Farmer Field School
FIPS Africa	Farm Inputs Promotions Africa
FRG	Farmer Research Groups
goT	Government of Tanzania
GSI	Good Seed Initiative
IFAD	International Fund for Agricultural Development
INTSORMIL	
MDGs	Millennium Development Goals
M&E	Monitoring and Evaluation
NGO	Non Governmental Organisation
NRI	Natural Resources Institute, UK
OPV	Open Pollinated Varieties
PADEP	Participatory Agricultural Development and Empowerment Programme
QDS	Quality Declared Seed
RIUP	Research Into Use Programme
RNRRS	Renewable Natural Resources Research Strategy
SADC	Southern African Development Community
SSA	Sub Saharan Africa
TOSCI	Tanzania Official Seed Certification Institute