Partnering with farmers in cassava-breeding pays dividends

RIU

Validated RNRRS Output.

New cassava-breeding skills, and high-yielding cassava varieties which are resistant to pests and diseases—including cassava mosaic disease—are benefiting both farmers and processors in Ghana. The new varieties developed jointly with farmers yield well with few inputs in rain-fed fields. They also meet local people's preferences for taste and food preparation, and are suitable for other West African countries. Involving processors in selection too has led to high-starch varieties that farmers can find a ready market for. The new, participatory breeding method has produced these new varieties fast, in just five cycles of cropping and selection. It is also being used in Uganda and Tanzania for sweet potato, and could easily be applied to other crops like potato and yam.

Project Ref: **CPP23:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

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

Geographical regions included:

Ghana, Tanzania, Uganda,

Target Audiences for this content:

Crop farmers,

Description

CPP23

A. Description of the research output(s)

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.

Original title: PPT breeding disease resistant cassava

Suggested title: Farmer-participatory, client-oriented breeding for disease-resistant cassava

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

Crop Protection and Plant Sciences Research Programmes

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.

R7565 (2000 – 2003) Participatory breeding of superior, mosaic disease-resistant cassava
R8302 (2003 – 2005) Participatory breeding of superior mosaic disease-resistant cassava: validation, promotion and dissemination
R8405 (2005 – 2006) Participatory breeding of superior, mosaic disease-resistant cassava: enhancing uptake

Lead Institute: **The Natural Resources Institute**, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME4 4TB, UK

Lead person: **Dr Richard Gibson** [email: r.w.gibson@gre.ac.uk; Tel: +44 (0)1634 883254

Main partner: **Crops Research Institute**, P.O. Box 3785, Kumasi, Ghana
Contact: **Dr J Manu-Aduening** [email: jmaduening@yahoo.co.uk]

*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.*

The outputs can be divided into a process [Participatory, client-orientated breeding] and a product [cultivars]:

Participatory, **client-orientated breeding:** A process was developed in **Ghana** whereby **superior cultivars** of **cassava** and potentially other **vegetatively-propagated crops** are selected quickly and effectively from amongst large seedling populations by **farmers** and a **multidisciplinary** team of scientists all working in a close **collaboration** at on-farm communal trial sites using a participatory, client-orientated and **decentralised** breeding approach. Scientists identify, obtain and provide seeds from appropriate crosses, paying particular attention to

incorporating **pest**, particularly **disease resistance** including resistance to **cassava mosaic disease** (**CMD**), the blend of local and exotic parentage, and providing characters of importance to one or more stakeholders in the crop. Seedlings are grown in a communal trial and, at harvest, farmers and scientists select separately to avoid interference and obtain maximum **agro-biodiversity**, all selections being retained by clonal propagation to the next cropping cycle. The process is iterated until most selected clones are apparently superior to local and released variety checks; during this process, farmers take cuttings to their own farms, so providing additional decentralised **selection**. In response to farmer demand for better **market opportunities**, the cassava breeder and other research team members increasingly engaged with post-harvest researchers and other end user stakeholders notably **processors**. These then became involved in selection. Scientists organised multilocational trials and other aspects of achieving **official variety release**. The process provides **experiential learning** for both farmers and scientists, farmers particularly learning the potential of variety development and scientists learning more about farmers' and other stakeholders' needs

Superior cassava cultivars: These are high yielding cultivars resistant to a range of common cassava diseases including **CMD** that were developed by the above participatory breeding programme. These offer opportunities for immediate alleviation of poverty, being appropriate to Ghanaian farmers' requirements and perhaps those of farmers in other **West Africa** countries including **Nigeria**, in particular incorporating: high yield under local **smallholder** farming conditions [**rain-fed**, **low input**]; suitable for **local** palates in particular being poundable all year into ***gari*** and resistant to pests, particularly CMD. A few have also been identified with processors as being suitable for their needs, having a high and stable yield and with very **high dry matter**, four having higher dry matter (26 – 34%) than the current recommended variety for processors, Afisiafi (23% starch).

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*		*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

Cassava. Participatory, client-orientated breeding could also apply to other vegetatively propagated crops, e.g., **sweet potato, potato**, **yam**, and although more challenging, **banana.**

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		*X*			*X*	*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 with. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

Our new cassava clones present a particularly exciting opportunity for West African, particularly Ghanaian, farmers being disease resistant and high yielding. Some have also been identified as suitable for new markets for processed cassava and value can immediately be added by linking work on processing cassava specifically with the use of cultivars identified by processors within this project. These include outputs generated by R6504; R7418, R8268, R6332, R6316 and R7495.

Superior cultivars underpin most agricultural development. Involving a greater range of stakeholders, using farmer participatory approaches and achieving greater client orientation are approaches which therefore benefit a wide range of farmer-oriented outcomes as well as our particular focus on incorporating pest resistance and needs of processors. There are therefore at least 3 ways by which value could be added to this output by clustering it with other outputs by:

1. Incorporating general lessons learnt within this output on farmers and scientists working together with those learnt in other breeding activities, particularly those of other client-orientated breeding or participatory varietal selection projects funded by PSRP, e.g., R8221, R6748, R7324, R7409, R8099, R8269,R7122, R7281R7657, R6826, R8071, R8099, R7434 and PSRP development work.
2. Incorporating specific lessons learnt within this output on breeding disease resistance into superior, farmer-appropriate varieties with those outputs from the CPP and other research activities in which effective pest, particularly disease resistance is identified. These include outputs generated by R8220, R8406, R8422, R8453, R7566, R8414, R8476, R8445, R8030, R8481, R8205, R7452, R8227, R8404, R8456, R8303, R8425, R8247, R6811, R7445 and R6519.
3. Incorporating lessons learnt within this output on how client-oriented breeding can address the needs of processors, especially of root crops. These cut across many outputs generated by the Crop Post Harvest Programme and include those generated by R8261, R7581, R6504, R7418, R8268, R7520, R6769, R6507 and R8273.
4. Combining with outputs generated by other participatory varietal development outputs specifically in Ghana notably R6826 and R7657 on rice participatory varietal selection.

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)**.*

The outputs have been validated in the following main ways by:

1) Smallholder farmers involved in the breeding collaboration consistently identifying key attributes in clones generated by the project and growing the clones they identified with these characteristics on their own farms because of perceived superiorities in earlier communal on-farm trials [Excerpt from email from Ghanaian colleague Dr J Manu-Aduening: With regards to the adoption of our materials, I will say that up to 215 farmers (45%women) in 9 communities took one or more of the accessions to their farms as at 2005 and since then there has been farmer to farmer up-take which we are yet to follow-up.].
2) Cassava processors trialling superior clones on their own farms at their own expense and the trials confirming superior yield and dry matter content.
3) Ghanaian programme scientists confirming high yield, disease resistance and other plant attributes in on-farm replicated field trials.
4) Ghanaian programme scientists committing their own resources to extensive multilocational trials of clones of cassava selected through the participatory breeding process developed, as a part of variety release.
5) Scientific peers' acceptance of the research findings as evidenced during presentations at international conferences, e.g., the International Society for Tropical Root Crops – Africa Branch Triennial meeting in Mombasa in 2004 and, more specifically, by international peer review prior to publication in an internationally renown journal, Euphytica [MANU-ADUENING, J. A., LAMBOLL, R. I., DANKYI, A. A. & GIBSON, R. W. 2005. Cassava diversity and evolution in Ghanaian farming systems. *Euphytica* **144:** 331-340. MANU-ADUENING, J.A., LAMBOLL, R.I., AMPONG MENSAH, G., LAMPTEY, J.N., MOSES, E., DANKYI, A.A. & GIBSON, R.W. 2006. Development of superior cassava cultivars in Ghana by farmers and scientists: the process adopted, outcomes and contributions and changed roles of different stakeholders. *Euphytica* (Accepted)].

An important aspect of the process is that it is more efficient than currently-used breeding processes for cassava; indirectly, part of the validation therefore is that all the above have been achieved within 5 cropping/selection cycles.

*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).

The process of participatory breeding has been validated over the last few years of the projects' existence:

- **Locally,** by moderately poor, male and female smallholders in Nkaakom in the Forest Zone and Aworowa in the Forest Savannah Transition Zone in hot lowland areas. The farming situation was high potential and the communities had good infrastructure, being located on main roads near either a large town or city and one with local processing factories. The farming system was rainfed and the output was validated under local farmer management of the crop [e.g., no fertiliser].
- **Nationally** by Ghanaian scientists belonging to a wide range of disciplines authoring research and other publications.
- **Internationally** by scientific peers chosen by an international refereed journal (Euphytica) authorising publication and by unsolicited support for the publication from Dr A Dixon, the senior cassava breeder at IITA.

The cultivars generated in Ghana by the process of participatory breeding have also been validated at a range of operational levels. The validations are all 2004 onwards:

- **Locally,** at the farm level in Ghana, by moderately poor, male and female smallholder farmers in 9 communities the Forest and Forest Savannah Transition Zone adopting cultivars quickly.
- **Zonally/Nationally** in multilocational trials involving local farmer participation across a range of sites in the Forest Zone and the Forest Savannah Transition Zone in Ghana conducted by national scientists.
- **Commercially** by 2 processors in the Coastal Zone of Ghana conducting trials [with national scientists] [Excerpt from email from Ghanaian colleague Dr J Manu-Aduening: Trials with processors have been harvested and their selections as far as the starch contents are concerned seemed to agree with what have been selected for wider testing for use by PSI. Eight of the accessions had yields ranging from 35-50 T/ha however, 4 had starch contents ranging between 26 and 34%. These are greater than Afisiafi (23% starch) (the recommended variety)].

Current Situation

C. Current situation

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

The cassava clones that have been selected by the participatory breeding process are currently being used by:

- By moderately poor, male and female smallholder farmers in 9 communities in the Forest and the Forest Savannah Transition Zone growing cassava as their main crop or at least one of their main crops. The communities had a range of infrastructural support, some being located on main roads near either a large town or city and one with local processing factories and others being isolated.
- By Ghanaian scientists at the Crops Research Institute in multilocational trials involving local farmer participation across a range of sites in the Forest Zone and the Forest Savannah Transition Zone in Ghana conducted. The communities involved comprised a much wider socio-economic range than in the initial activities, some having extremely poor infrastructures with poor road communications leading to few markets.

- By two cassava starch and flour processors in the Coastal Savannah Zone in trials on their own farms.

The process of participatory plant breeding has been adopted as a key component of breeding activities by programmes at the Crops Research Institute in Ghana. The process has also been incorporated into sweet potato breeding activities in Uganda [Namulonge Agricultural and Animal Production Research Institute] and Tanzania [Agricultural Research Institute Maruku]. An MSc student has been recruited and multilocational trials testing cultivars generated by participatory breeding by NAARI and crossing blocks developed at ARI Maruku.

*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).***

The cassava clones that have been selected by the participatory breeding process are currently being used by:

- **Locally,** at the farm level in Ghana, by in 9 communities in the Forest and the Forest Savannah Transition Zone growing cassava as their main crop or at least one of their main crops. The farming situation of most is high potential though a few were relatively more arid and therefore only medium potential. Some communities have good infrastructure, being located on main roads near either a large town or city and with local processing factories, others were isolated. The farming system is rainfed and the natural climax vegetation would be either forest or forest savannah transition in hot lowland areas.
- **Zonally/Nationally** in Ghana in multilocational trials involving local farmer participation in communities across a range of sites in the Forest Zone and the Forest Savannah Transition Zone. The communities involved comprise a wide range of socio-economic and agro-ecological conditions, some having extremely poor infrastructures with poor road communications and low rainfall, low potential agroecologies.
- Two cassava starch and flour processors in the Coastal Savannah Zone of Ghana on their own farms.

The process of participatory plant breeding has been adopted as a key component of breeding activities by programmes at the Crops Research Institute in Ghana. The process has also been incorporated into sweet potato breeding activities in Uganda [Namulonge Agricultural and Animal Production Research Institute] and Tanzania [Agricultural Research Institute Maruku].

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

The application of a participatory approach to cassava has only recently (2004 onwards) been validated adequately by peer review and local farmer-adoption of resultant cultivars. However, the director of Crops Research Institute, Ghana, has indicated in conversation that farmer participation in plant breeding has been increased across the programmes in his Institute. As part of decentralising cassava breeding, crossing blocks have been planted in 2005 for the first time both at the main Institute located in the Forest zone and at the Wenchi teaching institute located in the Forest Savannah Transition zone. The cowpea breeding programme has also publicly reported that farmer participation has become paramount; rice breeding had already adopted a participatory approach through R6826 and RR7657.

Two medium-sized cassava processors have been involved in trialling project-derived cassava clones in Ghana since 2005.

The process of participatory breeding has been used in Uganda and Tanzania for the vegetatively-propagated crop, sweet potato, as a direct spin-off of project activities in Ghana. In Uganda, the process has advanced considerably, leading to multilocational trials by the national programme. In Tanzania, the process and outcomes are limited to the Kagera Region.

Up to 215 farmers (45%women) in 9 communities have taken up one or more of the accessions developed through participatory breeding to their farms as at 2005; since then it is assumed that there has been further farmer to farmer up-take.

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).***

Two very different outputs - new cassava cultivars and a different approach to breeding - required very different promotion strategies.

New cassava cultivars: Clones apparently superior to local and released variety checks were only identified during the last crop generation of the project and have not been released officially. The only adoption that could occur was therefore informal adoption of a select few clones by farmers involved in the trials and their contacts. This appeared to be a geographically restricted and otherwise inefficient means of promotion. The project and subsequent activities of collaborators therefore placed priority on achieving official release of the best clones. The Ghanaian Variety Release Committee is the key institutional structure so the project fostered close relationships with this organisation

Farming community situation analyses, project workshops with farmers and other stakeholders in cassava and project surveys of current and potential markets for cassava in Ghana [Data presented in project working papers] identified that farmers currently lack adequate markets for their crop and that processors using cassava as a source of flour for readymade foods and for high quality starch were already providing a worthwhile market. Addressing their concerns were therefore identified as key and the project developed close links with two such processors which had their own farms, allowing project-developed cassava clones to be field-tested by the processors for their specific requirements.

A novel aspect of our approach has therefore been our involvement of private companies [processors] in the evaluation of cultivars. We believe that this linking of pre- and postharvest activities is vital for widespread adoption of the new varieties as well as the long-term sustainability of the participatory breeding approach [It is not enough to link solely with farmers as this offers them little that is really new].

For our participatory breeding activities, a key aspect was that they were initiated within national agricultural research institutes [NARIs] and fully involved scientists in the relevant national programmes. This has provided a means by which the process can easily be disseminated to other national crop breeding programmes. It has also ensured easy access to national and international germplasm collections so sourcing diverse and nationally-appropriate seed families, essential to the breeding process. At the other end of the process, this involvement with NARIs has enabled close access to official varietal release committees.

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.

Formal plant breeding has been successful for high potential farming systems, particularly for irrigated lands but has often failed to generate varieties which are adopted by farmers in rainfed marginal agricultural ecologies. Such systems are particularly susceptible to degradation resulting from farmers and their families having to misuse their natural environment because crop failure, to which farmers are more vulnerable if they have access only to poorly-adapted high-yielding varieties, has provided no alternative. Participatory and decentralised on-farm plant breeding is, by contrast, particularly appropriate for the development of varieties for rainfed marginal agricultural ecologies, leading to less frequent crop failures. In addition, farmer involvement in crop improvement is likely to generate superior cultivars appropriate to a diversity of needs including alternative uses for crop 'residues' as livestock feed, fuel, thatching etc. By satisfying these needs through cultivated crops, cultivars developed through participatory breeding provide alternatives to the destructive harvesting of natural vegetation.

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

No. There are no adverse environment impacts expected from a shift from formal to participatory plant breeding processes.

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)***

Yes. Cassava provides poor people with a very resilient crop capable of coping with variation in weather including unexpected droughts. It also is has the capacity to yield large amounts of food from a small amount of land and from relatively infertile soils.

Increased populations of whiteflies and consequently increased spread of CMD are an expected outcome from increased temperatures. Superior varieties, especially when resistance is also included, are clearly a very cost-effective solution to farmers for poor performance on marginal soils and susceptibility to pests including CMD; the investment has been made by either the state or donors that funded their breeding and farmers at most have to make a one-off investment to obtain the new varieties.

Annex

Annex

Date:	Mon, 16 Oct 2006 19:41:23 +0100 (BST)
From:	"joe manu" <jmaduening@yahoo.co.uk> Add to Address Book Yahoo! DomainKeys has confirmed that this message was sent by yahoo.co.uk. Learn more
Subject:	Re: Research into use
To:	"GIBSON RICHARD W" <R.W.Gibson@greenwich.ac.uk>

Dear Richard,

I have looked at the proforma for the RIU programme and I believe a lot of work has already gone in and I think most of the responses are very accurate.

With regards to the adoption of our materials, I will say that up to 215 farmers (45%women) in 9 communities took one or more of the accessions to their farms as at 2005 and since then there has been farmer to farmer up-take which we are yet to follow-up.

We had to include one very promising material(AW34) which came up as the highest starch material(34% starch)amonsgt the materials tested throughout the country. This material plus the 3 accessions planted for inspection last year have been replanted and we hope to get them ready for release next year. It is also worth noting that 6 of our materials (all having starch contents > 26%) have been selected amongst top 26 materials being evaluated for PSI on starch and alcohol production.

Trials with processors have been harvested and their selections as far as the starch contents are concerned

seemed to agree with what have been selected for wider tesing for use by PSI. Eight of the accessions had yields ranging from 35-50 T/ha however, 4 had starch contents ranging between 26 and 34%. These are greater than Afisiafi (23% starch).

The next phase of RTIP will start in January next year and I believe our process and product will be taken up during this phase. I have already sent a brief write-up on the role of participatory breeding and selection to them.

I hope you had a nice trip to Uganda. Best regards.

Joe Manu-Aduening