Winning the battle against cassava mosaic disease

RIU

Validated RNRRS Output.

Millions of farmers in Uganda and Tanzania are fighting the cassava mosaic disease (CMD) pandemic using new, resistant cassava varieties and other control methods. Government organisations and NGOs are multiplying and distributing these CMD-resistant varieties on a huge scale. And, new options, such as selecting clean planting material and identifying varieties resistant to the whiteflies that spread the disease, are also proving useful. Leaflets and a guide that describe CMD control strategies, developed by Ugandan and Tanzanian partners and validated by farmers, are available in different languages including English, Swahili and Luganda. The solid, scientific knowledge gained about control strategies and how they work will be invaluable to other countries threatened by CMD, such as Rwanda, Burundi, DR Congo, Republic of Congo, Gabon and Nigeria.

Project Ref: **CPP24:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP24

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

Geographical regions included:

Burundi, Congo DR, Gabon, Nigeria, Rwanda, Tanzania, Uganda,

Target Audiences for this content:

Crop farmers,

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: Extending the control of cassava mosaic disease

Suggested title: Control of cassava mosaic disease

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

Crop Protection Programme

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.

Main projects
R8456 [2005 – 2006] Extending the control of cassava mosaic disease and cassava whiteflies in East Africa
R8303 [2003 – 2005] Maximizing, disseminating and promoting the benefits to farmers of cassava varieties resistant to cassava mosaic disease

Closely associated projects
R8404 [2005 – 2006] Promotion of control measures for cassava brown streak disease in E and S Africa
R8227 [2003 – 2005] Promotion of control measures for cassava brown streak disease
R8041 (2001 – 2004) Tropical Whitefly IPM Project
R7505 [1999 – 2002] Strategies for the sustainable deployment of cassava mosaic disease resistant cassava in East Africa
R7563 [2000 – 2002] Management of cassava brown streak disease and mosaic disease in eastern southern Africa
R6617 (1994 - 7 extended to 1998) Whitefly borne viruses of sweet potato and cassava

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*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.*

Cassava mosaic disease (**CMD**), caused by **whitefly-borne** cassava mosaic **begomoviruses** [**geminiviruses**], is the most important disease affecting cassava in **Africa**. In particular, a natural recombinant of ***East African cassava mosaic virus*** (**EACMV**) with *African cassava mosaic virus* (**ACMV**), **EACMV-Ug** [also known as **UgV** for Uganda variant], identified in **Uganda**, has been linked with a **pandemic** first recognised in Uganda in the late 1980s, spreading to most of the country and to neighbouring **Kenya** in the 1990s, and since spreading to the **Lake Zone** of **Tanzania**, **Rwanda, Burundi**, **DR Congo, Republic of Congo and Gabon**. It even threatens **Nigeria**, the major producer of cassava in Africa. The pandemic is associated with EACMV-Ug causing a particularly severe disease, especially in the presence of ACMV, and increased numbers of the whitefly, ***Bemisia tabaci***, **vector** of cassava mosaic geminiviruses in Africa. The enhanced vector population and high virus titres of EACMV-Ug and ACMV allowing easy virus acquisition and therefore infection appear to be the main forces driving the spread of the pandemic. The increased whitefly numbers have been associated with populations with a particular DNA fingerprint, with cassava infected by EACMV-Ug being more suitable for whitefly multiplication and with increased use of some **CMD-resistant** cassava varieties which inadvertently are very good whitefly hosts.

The main strategy to control the pandemic has been the development of CMD-resistant cassava varieties by national and international programmes, particularly the **Ugandan National Cassava Programme** (**UNCP**) based at **Namulonge Agricultural and Animal Production Research Institute** (**NAARI**), the **Tanzanian Root and Tuber Research Program** (**TRTRP**) at **Ukiriguru Agricultural Research Institute** (**ARI**) and at **Maruku** ARI and the **International Institute of Tropical Agriculture** (**IITA**). Project outputs include validating these varieties as a control strategy, understanding and exploiting how these varieties resist CMD through **resistance** to getting infected, **recovery** from infection and a high likelihood that cuttings taken from infected plants, particularly from upper parts where recovery has occurred, will **revert** (**reversion**) to give disease-free plants, all factors combining to achieve disease-free crops. The project, working with farmer groups in Uganda and Tanzania over the last several years, has identified preferred CMD-resistant varieties, monitored and evaluated different ways of distributing planting material to farmers and proposed improvement. It has also researched **selection** of **clean planting material** of CMD-susceptible varieties, especially when protected by interplanting amongst CMD-resistant varieties. Recently, **whitefly-resistant** cassava clones have been identified within advanced CMD-resistant germplasm; combining these characters may achieve more durable resistance. **Leaflets** and a **guide** validated by farmers and describing **control strategies for CMD** have been developed by UNCP and TRTRP in

different languages including English, Swahili and Luganda and distributed at **farmer** meetings.

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

Main commodity: **Cassava**.

Whitefly-borne viruses, particularly geminiviruses belonging to the genus *Begomovirus*, are the causal pathogens of diseases of many warm temperate, semi-tropical and tropical climate crops. Whilst a few affect staple food crops such as cassava, beans and sweet potato, many also affect higher value horticultural food crops like tomato, peppers and cucurbits. The latter are also important to poor people because they provide cash and are an important source of vitamins and other essential dietary requirements. The control strategies for cassava mosaic diseases provided by project outputs may also be tailored to support control strategies for whitefly-borne viruses affecting these crops.

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

The primary aim of the project outputs are to restore and then sustainably increase productivity of cassava following the CMD pandemic. This achievement needs to be linked to postharvest outputs generated by CPHP projects on cassava [R6504; R7418, R8268, R6332, R6316 and R7495]. In this manner, increased productivity will be sustained by increased markets for fresh and processed cassava. In this manner, the pre- and postharvest outputs will gain positive feedbacks from each other.

Value could be added to project outputs by clustering them with those on the control of other whitefly-borne viruses. These include outputs on another whitefly-borne virus of cassava, Cassava brown streak virus [projects R8227, R7563], also *Sweet potato chlorotic stunt virus* affecting sweet potato [projects R8457, R8243] and *Tomato leaf curl virus* on tomato [projects R8425, R8247].

More limited value could also be obtained by clustering with outputs of other IPM projects and with one on the evolution of begomoviruses [R8222].

There are also numerous national and regional programmes involved in the dissemination of improved cassava production methods. These include the Cassava Mosaic Pandemic Mitigation in East and Central Africa Project, co-ordinated by IITA and financed by USAID-OFDA, the Crop Crisis Control Project (C3P) led by a Catholic Relief Services-IITA consortium (http://c3project.iita.org/), and the Pre-emptive Management of Cassava Mosaic Disease in Nigeria Project, and programmes for the multiplication and distribution of superior planting materials and evaluation of germplasm for cassava in Mozambique. Many of these programmes are building on achievements made through DFID-funded work falling under the CPP projects indicated above.

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)**.*

Outputs were validated by different groups of people in several ways:

- By farmer groups conducting on-farm trials assessing different management strategies, group meetings assessing the usefulness of leaflets, guides etc. The trials were generally suggested by scientists to the farmers who then agreed they were keen to be involved and provided the practical elements of each trial. Individual trials generally included an element of demonstration and often had limited replication; adequate replication was achieved by combining the results of several trials. Farmer

groups comprised smallholder farmers, e.g., few had machine-powered implements, growing most of their own food and having a small surplus for sale. Whilst farmer groups were generally gender balanced including women leaders, it should be appreciated that farmers involved in group activities were generally the richer, better educated and more active members of the community. Groups represented both Christian and Moslem religions.

- By national scientists conducting on-farm multilocational, on-station trials and screenhouse trials of different control practices for CMD including comparing different varieties and management practices. Trials were replicated, fully-randomised complete block designs generally repeated for at least two cropping cycles.

- By peer international scientists providing external reviews of project outputs when published as Final Technical Reports and peer reviews of project methods and analyses prior to publication of project results in international scientific journals. These have included *Advances in Virus Research*, *Virology*, *Plant Pathology*, and *Biocontrol Science and Technology*. Project outputs have also been subjected to peer scrutiny when disseminated through presentations at regional [e.g., *9th Triennial Symposium International Society of Tropical Root Crops – Africa Branch* and *7th African Crop Science Society Conference*] and international [e.g., *2nd European Whitefly Symposium, Cavtat, Croatia - 5-9 October 2004*, *6th Intrtl. Sci. Meeting Cassava Biotechnology Network,* and *IX International Plant Virus Epidemiology Symposium, April 4 – 7, 2005. Lima, Peru*].

*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)**.*

Outputs were validated for the following circumstances:

- By smallholder farmers in Central [Mpigi, Luwero and Iganga districts] and north-eastern [Apac and Lira districts] Uganda and in north-eastern Tanzania [Kagera Region] using manual tools for cultivation, clearing the land by slashing and burning. These are rain-fed farming systems in agro-ecological environments in which complete forest cover or incomplete forest cover plus tall grass would be the natural climax vegetation and the environment would be wet to semi-arid. Trials were done mainly during 2000 – 2004; validation of leaflets and guides were done mainly during 2003 – 2005.

- By on-station trials done during 2000 – 2004, building on earlier DFID and other donor funded trials since 1991 at Namulonge Agricultural and Animal Production Research Institute located some 30 kms north of Kampala in Uganda in rainfed systems where humid forest would be the climax vegetation. Trials were planted on research fields previously fallowed, generally treated with herbicide [Round-up] and ploughed by tractor; subsequent management involved manual hoeing to control weeds and manual harvest.

- By peer review of scientific papers mainly by journals published in Europe/ N. America and therefore

probably mainly by scientists from those areas.

Current Situation

C. Current situation

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

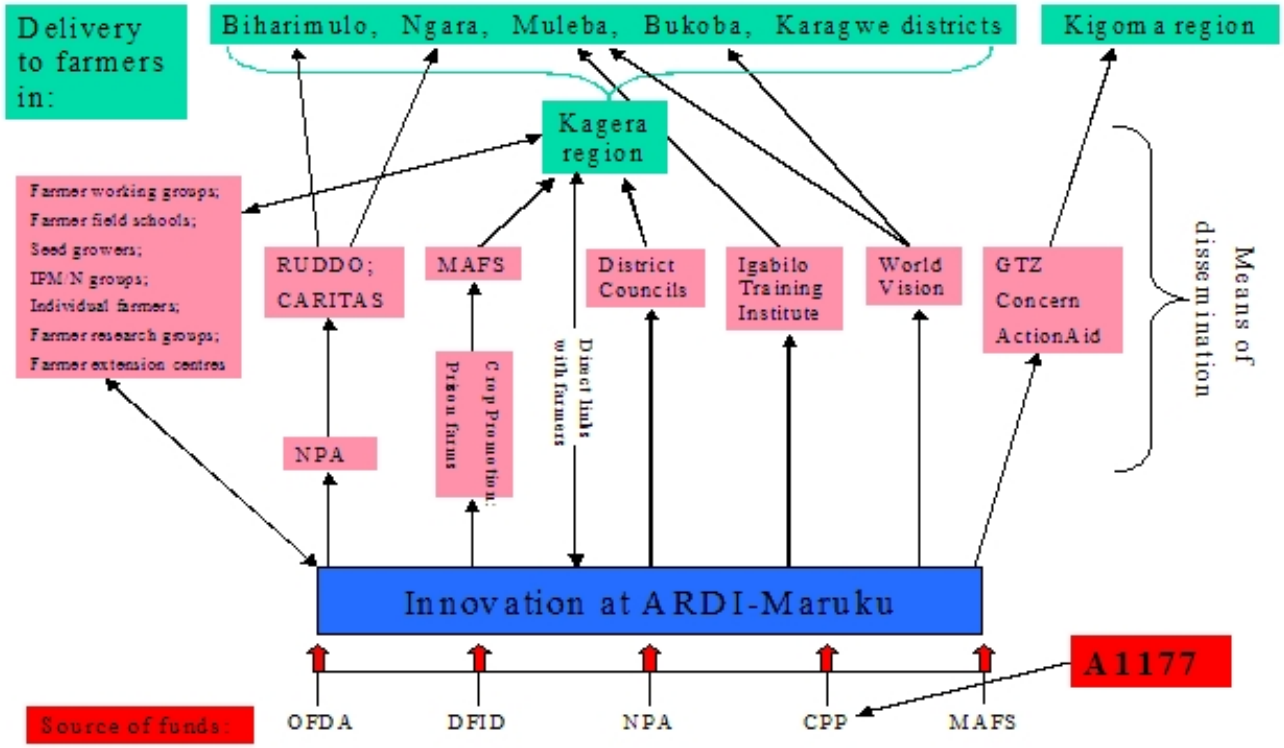
The outputs are currently being used by:

- Millions of smallholder farmers in Uganda and tens, perhaps hundreds of thousands of smallholder farmers in the Lake Zone of Tanzania. In particular, farmers are growing CMD-resistant varieties developed and distributed as part of project outputs widely promoted throughout these regions. To a more limited extent, farmers are also selecting clean planting material.

- By government organisations [training institutes, prison farms, district extension officers, research scientists] and NGOs [e.g., Actionaid, Concern, RUDDO, World Vision] involved in assisting smallholder farmers especially in the Lake Zone of Tanzania [see diagram below]. These organisations are multiplying and distributing CMD-resistant varieties developed as part of project outputs and also using training protocols and training materials (leaflets, guides) as part of their extension activities.

- By scientists elsewhere in the region and in Africa as a basis for control strategies for CMD

Figure: Some of the organisations in the Lake Zone of Tanzania using project outputs.



*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).***

Project outputs are primarily being used by farmers throughout Uganda and in north-western Tanzania. The CMD pandemic affected almost all Uganda by 2000. Project-developed strategies are now widely used throughout the country although dissemination activities are reducing.

The pandemic has affected Tanzania only since about 1998. Entering through the Lake Zone, it is still spreading and many farmers still need training and to receive CMD-resistant varieties. Training is being provided in NW Tanzania only and to four different groups: i) district and Norwegian People's Aid (NPA) extension personnel, ii) farmer groups in farmer field schools (FFS), iii) FFS group facilitators and field officers, and iv) districts and prison agricultural officers from selected districts and stations in Tanzania. The diagram above illustrates the partners in this exercise and their locations in the Lake Zone. In particular, RUDDO Caritas is funded by the NPA to train and provide planting material to farmers in refugee-affected areas of Biharamulo and Ngara districts of Kagera region; GTZ, Concern and ActionAid have begun to extend into neighbouring Kigoma Region.

Knowledge outputs disseminated regionally through publications in international and regional journals and at international and regional scientific meetings are also being tailored by national scientists in other countries e.g., Rwanda, DR Congo, and disseminated to their farmers.

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

Probably millions of farmers in Uganda are now using CMD-resistant varieties. Surveys of farmers' fields in six districts [Iganga, Kamuli, Luwero, Masindi, Mpigi and Mukono] by the National Cassava Programme indicate plantings of CMD-resistant varieties increased from 0% in 1990 – 1994 to reach 35% in 2003 by which time most Ugandan farmers were growing some resistant varieties, though most also maintained crops of their traditional landraces.

In Tanzania, few CMD-resistant varieties had been distributed anywhere by 1998. Material is now being multiplied and distributed to farmers in the Lake Zone, especially to farmer groups within Ngara and Biharamulo districts using funds provided by Norwegian Peoples' Aid to assist farmers in refugee-affected areas. The two tables below indicate the scale and achievements of the operation.

Table: CMD-resistant planting materials multiplied under NPA-funding and available for distribution as identified in a survey in November 2004

Site	Source of materials	Amount and beneficiaries
Biharamulo Daldo's office	Nyakahura Primary Nursery	More than 150,000 cuttings to be taken to various farmer groups
Ngara Daldo's office	Nyakahura Primary Nursery	About 180,000 cuttings to be distributed to farmer groups
Rusahunga division Kalenge	RUDDO	71,000 cuttings to be loaned to 5-farmer groups
Nyantakara, Iyengamirilo & Mavota	RUDDO	180,000 cuttings to be loaned to farmer groups
Nyarubungo Division	RUDDO	243,000 cuttings to be loaned to 15-farmer groups in 8 villages
Murusagamba division Muganza ward	RUDDO	68,000 cuttings to be provided to 5-farmers groups in 3 villages
Mulonze & Nyakanazi Rulenge division	RUDDO	114,000 cuttings provided to 2 groups
Keza, Bukirilo and Rulenge wards	RUDDO	315,000 cuttings provided to 24 groups
> 9 farmers' groups	Songambele farmer's group	9.5 to be ratooned and distributed to farmers
CARITAS	Main nursery	Expansion of multiplication plot to 21,800 plants
Igabiro Agricultural Training Institute	On-station nursery	5 farmer groups at Biilabo, Omurunazi, Kabirizi, Kashanda and Ngenge to receive planting materials for >2 acres each

Table: Cassava multiplication at Nyakahura ward in Biharamulo 2003/2004 seasons

VILLAGE	Number Of Groups	Group Members		Total Acreage	Number of Cuttings Given
		2003	2004		
Nyakahura	2	19	45	16	65,410
Mabare	3	10	80	34	134,719
Mihongora	2	10	124	28	111,313
Nyabugombe	1	0	13	3	13,000
TOTAL	8	39	262	81	324,442

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).***

In both Uganda and Tanzania, cassava is one of the most important food crops, CMD was identified as having a major impact on livelihoods and had been identified by farmers, extensionists, researchers and policymakers in agricultural government ministries as high priority. Consequently, there was a strong national commitment to deal with the CMD pandemic.

There was also a strong, integrated and innovation systems approach to the pandemic involving partnerships linking national programme activities with regional and international efforts. Additionally, the project funded an NRI staff member based in Uganda co-employed by the International Institute of Tropical Agriculture. As well as conducting its own research and breeding programme to combat the CMD pandemic, IITA also manages more extensive regional and country-wide programmes on cassava rehabilitation, notably through the regional CMD Pandemic Mitigation Project, currently targeting Kenya, Tanzania, Rwanda and Burundi, and through its participation in the C3P project, which in addition to the above countries also works in Uganda and DR Congo. The close linkages achieved by sharing staff also assisted in ensuring that project outputs were jointly exploited in these large rehabilitation programmes.

Long-term funding provided by DFID, for Uganda since the early 1990s, was maintained in an almost continuous stream until 2005. Gatsby and other donors also contributed in a well-co-ordinated manner. This gave researchers opportunity to conduct the necessary research, yet maintain limited links with farmers so as to ensure relevance of research and quality of training and materials, particularly planting material.

A major success of the project in Tanzania was to establish a close linkage with Norwegian People's Aid and its infrastructure already in place, its links with NGOs and its funds enabled an extensive and high quality rehabilitation of cassava production in Ngara and Biharamulo districts through extensionists of NPA and NGOs to

be achieved speedily, researchers maintaining quality control of training whilst being sheltered from the day-to-day business of farmer training.

In a somewhat similar but also somewhat different manner, a new institutional arrangement, the National Network of Cassava Workers (NANEC) was developed in Uganda and funded by Gatsby Charitable Trust. This also achieved a similar flow of up-to-date information from researchers to extensionists whilst also shielding them from direct farmer training. As well as being created *de novo*, NANEC provided a national service; however, Tanzania has a more decentralised extension system with a strong zonal administrative structure.

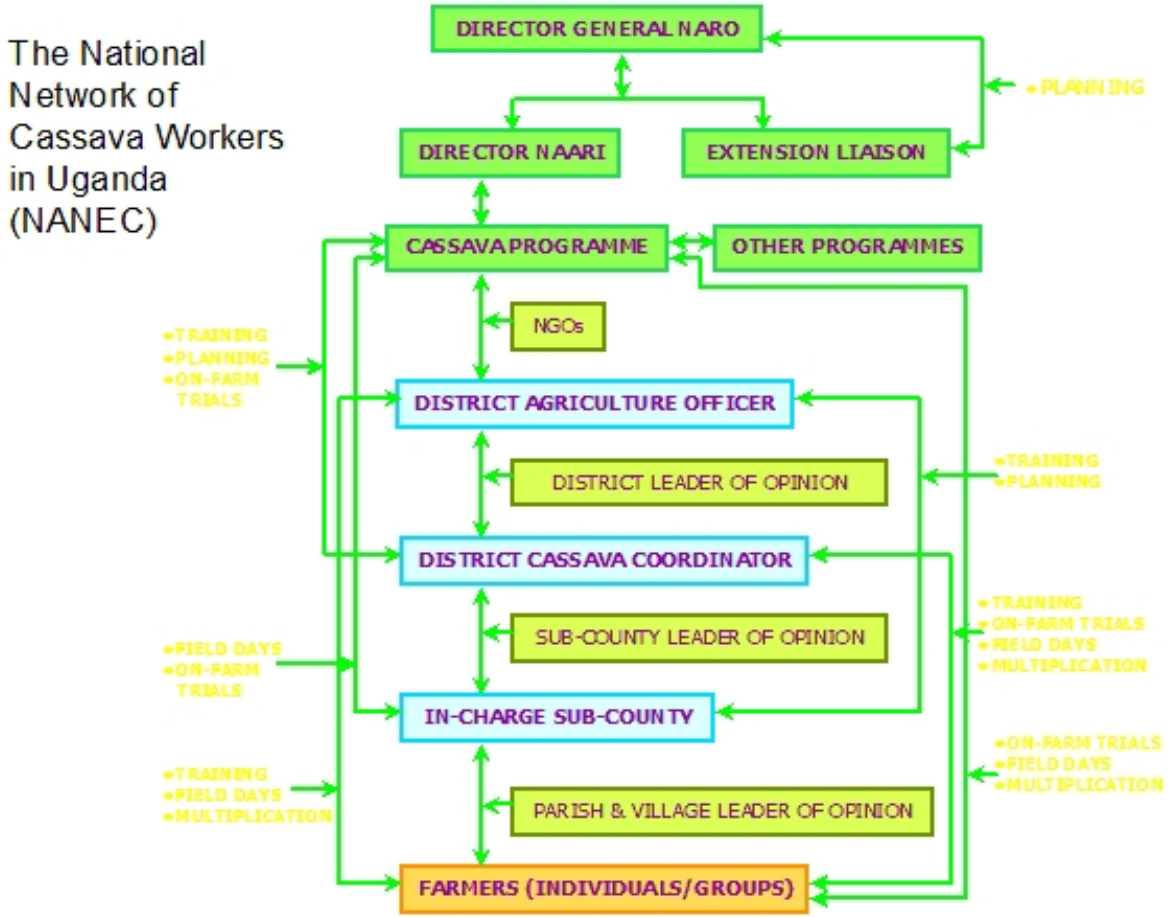


Figure provided by Dr Anton Bua, Head of Ugandan National Cassava Programme

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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 technologies developed are largely neutral in their effects on the environment. No pesticides or genetically manipulated crops are involved in the outputs. No major changes in cropping practice are involved. Land cover may be increased by the more rapid growth of healthier crops and more vigorous varieties, reducing erosion. Adoption of the outputs may lead to increased land area cropped by cassava but this may indirectly be beneficial because cassava has a greater food output/unit land than most crops so this will lead to less land having to be cropped, allowing longer fallows.

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

No. None have been identified to date and no adverse environment impacts are to be expected from a shift from CMD-susceptible varieties to CMD-resistant varieties. Selecting clean planting material is also unlikely to have adverse effects as is the limited amount of roguing needed in a CMD-resistant variety.

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. Poor people turn to cassava when climate change or natural disasters occur because it is has the capacity to yield large amounts of food from a small amount of land and within a short time (3 mths; faster than most other staple food crops). Cassava is also very resilient in the face of erratic rainfall because of its indeterminate growth, unlike, e.g., maize. NGOs have begun to provide cassava planting material for refugees. Under such circumstances, it is vital that high-yielding, disease-resistant varieties are provided, the plant material is selected from disease-free parents and farmers are trained to rogue diseased cuttings.
