25 YEARS OF

UNRIVALED AGRICULTURAL RESEARCH EXCELLENCE



NARO

A COMPENDIUM OF NARO'S SUCCESS STORIES



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NARO

A COMPENDIUM OF
NARO'S SUCCESS STORIES



FOREWORD

25 years of unrivalled agricultural research excellence, still going strong!

From the late 80's to the early 1990's, Uganda's agriculture sector grappled with emerging and destructive pests and diseases that threatened to decimate most of the country's strategic crops. Case in point is cassava; due to the African Cassava Mosaic Virus Disease, almost all the cassava land races were wiped out. Similarly, coffee that formed the major backbone of Uganda's agricultural export succumbed to Coffee Wilt Disease resulting into losses of more than 50% of the coffee tree population in the country. In totality, the resultant effects of those militating factors included food and nutrition insecurity, joblessness and reduced incomes at both household and national levels. This was unsettling to say the least but no hope was lost following the establishment of the National Agricultural Research Organisation also known as NARO as a premier institute for Research and Development.

> **NARO has generated and promoted over 1,000 agricultural technologies, innovations and management practices**

NARO, whose genesis stems from the 1992 Statute that established the National Agricultural Research Organisation, that later transformed into an all embracing institution that brings on board all the national agricultural research systems (NARS) with the enactment of NAR Act 2005,

was established under the hedges of the Ministry of Agriculture Animal Industry and Fisheries (MAAIF). NARO responds to challenges that are considered opportunities at both national and agro ecological zone levels. The NAR Act 2005 provides for the establishment of Public Agricultural Research Institutes (PARIs) and other agricultural research service providers. The list of agricultural research service providers include academia, private sector, NGOs, Community Based organizations and farmers groups with their only prerequisite being registered under NARO.

The PARI nomenclature caters for National Agricultural Research Institutes (NARIs) and Zonal Agricultural Research Development Institutes (ZARDIs). The NARIs respond to issues of national and strategic importance and there are seven (7) of them: National Crops Resources Research Institute, National Agricultural Research Laboratories, National Coffee Resources Research Institute, National Forestry Resources Research Institute, National Livestock Resources Research Institute and the National Semi Arid Resources Research Institute. The ZARDIs respond to issues specific to agro ecological zones and there are nine (9) of them: Mukono ZARDI, Mbarara ZARDI, Ngetta ZARDI, Kacwekano ZARDI, Rwebitaba ZARDI, Nabuin ZARDI, Bulindi ZARDI, Buginyanya ZARDI and Abi ZARDI. From inception, NARO was and still is mandated to coordinate and participate in the research agenda of crops, livestock, fisheries, forestry while taking due cognizance of environmental health.

Over the years NARO has been rated as one of the best Agricultural Research Institutes on the African continent and attained global recognition for its outstanding contribution in the Agricultural Research stage in plant and animal health through breeding of novel varieties, pest and disease management, value addition etc. In the last decade, our research has been geared to increasing the nutrient density of these crops which will in turn address the hidden hunger challenge that has been prevalent in sub Saharan Africa. NARO is also host to regional Centres of Excellence in Agricultural Research for Cassava and Banana and is most recently taking the lead in Groundnut breeding in East and Southern Africa. As testament to the Centre of Excellence accolade, certain crops bred by NARO scientists have been adopted in local industries for local consumption and export markets. One of these is Epuripur sorghum variety that has been adopted by the breweries industry, the other is cassava that has demonstrated high potential for commercialization through ethanol production for export, local breweries production and most recently potential for biodegradable plastics production.

As Government of Uganda sets its eyes on attaining middle income status for the country by 2025, all hope is banked on achieving this by migrating the 68% subsistence farmers to commercial farming.

> NARO has only been able to attain the success it has as a result of strong collaborations and partnerships with a number of institutions at national, regional and global levels.

The paradigm shift from subsistence farming to commercial farming will be untenable if the focal point is on increased agricultural production based on increased land expansion rather than increased agricultural productivity based on smart agronomic practices, intensification and diversification.

NARO has generated and promoted over 1,000 agricultural technologies, innovations and management practices that are being utilized by our small scale subsistence farmers albeit not extensively. With the revitalization of the agricultural extension system under MAAIF, attaining middle income status will be dependent on increasing agricultural productivity through adoption of NARO technologies that include use of improved seeds, adoption of agronomic practices, adoption of post-harvest handling and storage, well targeted value addition for increased market access, competitiveness and profitability. This will have a ripple effect by positively impacting farmers' incomes leading to the eventual migration from subsistence to commercial agriculture.

Our ground-breaking research interventions are of no use without a robust system that enables timely delivery to the farmer who is our end-user. It is for this reason that we thank the ministry for revamping the extension system. I strongly believe with strong alliance and support from GOU, the research-extension-farmer triangle that worked well in the past will thrive again.

NARO has only been able to attain the success it has as a result of strong collaborations and partnerships with a number of institutions at national, regional and global levels. Today as we court the Private sector, these questions remain: can the private sector invest in agricultural research to allow for a sustainable and buoyant research system in the country? Can the private sector respond to the factors that curtail productivity, value addition and market competitiveness? It is only when these questions are addressed affirmatively that the sustainability of the agricultural research system in this country can be guaranteed.

Last but not least, the end products that we are proud of today are the result of the resilience and hard work of NARO staff over the years and I would like to extend hearty gratitude to them. To the team that has worked tirelessly to compile this compendium and bring it to life, thank you! As you flip the pages of this compendium, may the toil and tenacity of all our staff over the years speak to you.

Happy Reading!

FOR GOD AND MY COUNTRY



Dr Ambrose Agona
DIRECTOR GENERAL



NARO TOP MANAGEMENT



Dr. Ambrose Agona
Director General, National
Agricultural Research Organization



Dr. Yona Baguma
Deputy Director General,
Research Coordination



Dr. Imelda N. Kashaija
Deputy Director General,
Agricultural Technology Promotion



Prof. Justus Rutaisire
Director Corporate Services



CPA Mary Kiggundu
Director Finance



Mr. Robert Bagonza
Director Human Resource



CPA Denis Owor
Head Internal Audit

NARO at a glance

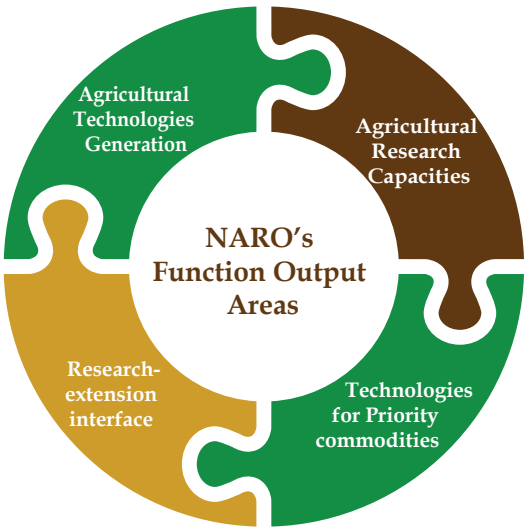
Vision

A market responsive, client oriented and demand driven national agricultural research system

Mission

To generate and disseminate appropriate, safe and cost effective technologies

How We Conduct Our Work



NARO executes her mandate with the guidance of focussed strategic output areas

NARO transforms research into grounded impact through established long-standing partnerships



NARO In Uganda



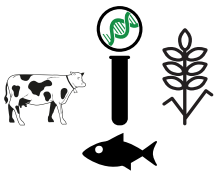
NARO Locations around Uganda

- NARO Secretariat
- 1 NaCRRI
- 2 NARL
- 3 NaFORRI
- 4 NaCORI
- 5 NaFIRRI
- 6 NaSARRI
- 7 NaLIRRI
- 8 Mukono ZARDI
- 9 Kachwekano ZARDI
- 10 Mbarara ZARDI
- 11 Rwebitaba ZARDI
- 12 Bulindi ZARDI
- 13 Abi ZARDI
- 14 Ngetta ZARDI
- 15 Nabuin ZARDI
- 16 Buginyanya ZARDI

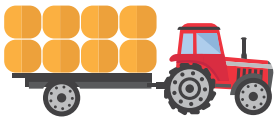
Societal Impact



Close to 2,000 scientists & support staff (core & project based), work at NARO







Over 1,000 agricultural technologies, innovations and management practices generated & promoted



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    - Orange fleshed sweet potato
    - Potato
    - Rice
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Annex

List of contributors

Services available at the agricultural research institute nearest to you

ACKNOWLEDGEMENTS

This inventory has been a collaborative effort and we would like to thank all the people and organizations that contributed to it. First, we wish to appreciate the support by the World Bank and the National Agricultural Research Organization (NARO) through the Competitive Grants Scheme (CGS) which made this work possible. We acknowledge the efforts of NARO Top Policy Management (TPM) for approving the financial support to this project. The visionary leadership and inspiration from NARO Deputy Director Generals (DDGs)-Dr. Imelda N. Kashaija and Dr. Yona Baguma throughout the implementation of this project merits special applause.

We are especially grateful to all NARO Institute Directors, Program Leaders, Scientists and Technicians for their dedication and commitment towards providing the content for the inventory. Journalists and NARO Communication Officers are particularly appreciated for their active role in data collection and content development. Appreciation also goes to all the authors who took time to research, interview and document NARO's successes/efforts in their respective institutes and spheres of expertize. We also acknowledge the people who willingly participated in interviews, contributed to and assisted this work in myriad ways, enriching the content with their experiences and critical ideas.

Special thanks go to the editor, Paul Tibiti Watuwa for their insightful advice. The Project team: Anita Tibasaaga, Joshua Raymond Muhumuza, Owen Singura, Kefa Atibuni, and Victoria A. Mbigidde who shared the stress and excitement in the production of this book is gratefully acknowledged. We are deeply indebted to Dr. Barbara Mugwanya Zawedde– Coordinator, Uganda Biosciences Information Center (UBIC) and Project Principal Investigator for her pioneering and passionate leadership that provided the spark for this work from start to finish.

We believe that this compilation, presenting testimonies of those who have managed, offers a highly valuable resource for everyone with an avid interest in agriculture, and NARO's efforts towards improved agriculture and national development.



LIST OF ACRONYMS

AbiZARDI	Abi Zonal Agricultural Research and Development Institute
ADB	African Development Bank
AGRITT	Agricultural Technology Tranfer
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ARDCs	Agricultural Research and Development Centres
BugiZARDI	Buginyanya Zonal Agricultural Research Development Institute
Bulindi ZARDI	Bulindi Zonal Agricultural Research Development Institute
CABI	Centre for Agriculture and Biosciences International
CBOs	Community Based Organisations
CIRAD	Centre de coopération Internationale en Recherche Agronomique pour le Dévelopement(The French agricultural research and international cooperation organization)
CSOs	Civil Society Organisations
DANIDA	Danish International Development Agency
DFI	District Farm Institute
DFID	Department for International Development
EAAPP	Eastern Africa Agricultural Productivity Project
GDP	Gross Domestic Product
IAEA	International Atomic Enercy Agency
JICA	Japan International Cooperation Agency
KaZARDI	Kachwekano Zonal Agricultural Research Development Institute
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MbaZARDI	Mbarara Zonal Agricultural Research Development Institute
MoFPED	Ministry of Finance, Planning and Economic Development
MuZARDI	Mukono Zonal Agricultural Research Development Institute
NAADS	National Agricultural Advisory Services
NabuIin ZARDI	Nabuin Zonal Agricultural Research Development Institute
NaCORI	National Coffee Research Institute

NaCRRI	National Crops Resources Research Institute
NaFIRRI	National Fisheries Resources Research Institute
NaFORRI	National Forestry Resources Research Institute
NaLIRRI	National Livestock Resources Research Institute
NARIs	National Agricultural Research Institutes
NARL	National Agricultural Research Laboratories
NARO	National Agricultural Research organization
NARP	National Agricultural Research Policy
NARS	National Agricultural Research System
NaSARRI	National Semi Arid Resources Research Institute
Ngetta ZARDI	Ngetta Zonal Agricultural Research Development Institute
NGOs	Non Governmental Organisations
PATTEC	Pan African Tsetse and Trypanosomiasis Eradication Campaign
PMA	Plan for Modernization of Agriculture
WHO	World Health Organisation
UBOS	Uganda Bureau of Statistics












OVERVIEW

Since its inception, the National Agricultural Research Organization (NARO) has made significant achievements especially putting in place mechanisms to operationalise efficient management systems, and generation and dissemination of technologies. The Director General NARO (in the foreword) indicated that NARO has generated over 1000 agricultural technologies, innovations and management practices in all sectors of crops, livestock, fisheries and forestry. Generation and acquisition of these technologies are a result of scientists working hard to respond to challenges in the agricultural sector.

Despite the apparent success that NARO has registered, no concerted efforts have been made to systematically document these achievements for benchmarking and dissemination. Even where there have been attempts to document, the efforts are not recognized by many intermediate and end users. A substantial proportion of the stakeholders are not aware of the role NARO plays in the socio-economic transformation of the country. If the status quo is maintained, then NAROs relevance is put at stake.

The overall objective of this compendium, therefore, is to document some of NARO's success stories towards supporting agricultural and national development. We are bringing into the limelight NARO's important role in agricultural technology generation and dissemination, and how they have uplifted livelihoods in Uganda. We also highlighting some of NARO's efficient management systems that other government agencies may wish to adapt to improve their delivery. It is important to that this is not comprehensive, only a

few outstanding technologies and efficient management systems were documented due to resource limitations. We recommend that periodic documentation of NARO's success stories is carried out to have a complete record.

In this compendium, a "success story" is defined as evidence of the benefits from an agricultural technology, system or policy on the livelihoods of the beneficiary and their surrounding communities. Outstanding interventions were selected based a clear role of NARO in the intervention, adequate time from release of technology to allow for causing impact, availability and accessibility to information to demonstrate significant benefits (socio-economic and environmental, where ever provided) and scope and size of the benefits.

The proceeding chapter discuss the genesis of NARO as described by key informants that were involved in the establishment of the organization plus Executive Directors of some organizations that partner with NARO to advance agricultural development in Uganda. Thereafter, we share the successes, challenges and future plans of some of NARO's management systems. Research progress.

GENESIS OF NARO



PROF. JOSEPH MUKIIBI

THE FIRST DIRECTOR GENERAL OF NARO



> We lit the flame, they should keep it burning and add more fuel

EVERY milestone in our human existence has a beginning that must have led to it. Such a beginning, however, cannot be talked about in isolation.

Until 1894, Uganda was part of the British East Africa; it became a British Protectorate from 1894 to 1962 and was designated as Uganda after 1962. The first step was to establish the Entebbe botanical gardens in 1898 to test adaptability of commercial crops like Arabica coffee, rubber, sugarcane, cocoa and cotton to the Ugandan soils. It should be noted that the colonial government intentionally missed introducing food crops.

In 1924 a team of government scientists was appointed to conduct research at Bukalasa and Serere experimental stations (entomologist, a cotton officer, a coffee planting inspector, a plant breeder, a mycologist and an agricultural chemist). Bukalasa experimental station was established to promote production of crops in Central and Western while Serere experiment station was set up to cater for Northern dry areas. At both stations cotton was one of the major research focus with the aim of coming up with varieties resistant to local pests and diseases.

Ugandan agricultural research, until World War II, focused on exportable crops and commodities favoured by European. After World War II, the government policy changed to focus on exploiting agriculture to support a market economy and to meet domestic food requirements. This was also spurred by the outcome of the war and the famine in 1943. In 1945, some crop researchers were transferred to a new facility called Kawanda Agricultural Research station and veterinary research laboratories were set up in Tororo.

Kawanda Agricultural Research station was established to focus on coffee research because coffee had become an international crop. A major focus of the research was to increase the bean size and yields of Robusta coffee. Arabica coffee was later

By Ronald Kalyango and Barbara M. Zawedde

introduced and promoted at Buginyanya in Bugisu and Kachwekano in Kabale.

With independence in 1962, all the national agricultural research agencies were transferred, with few disruptions, to the new independent government. It was observed that a number of important commodities or research areas had not been adequately provided for, hence efforts were made to establish research stations to cover food crops and to compliment cash crops. Prof. Mukiibi joined Kawanda in 1963 but he was not fully qualified. They mostly worked with British expatriates. In 1972, when Idi Amin expelled Asians, the British withdraw their staff leaving very few local people to do the research.

In 1980s, the Government under the structural adjustment programme funded by the World Bank, set up committees to streamline management of its activities in different ministries. The agricultural committee noted many deficiencies and made recommendations including establishment of the agricultural research and extension systems, and capacity building.

> After World War II, the government policy changed to focus on exploiting agriculture to support a market economy and to meet domestic food requirements

In early 1990s, Uganda took important decisions to streamline agricultural research with several Acts of Parliament. One of these Acts was the National Agricultural Research Organisation (NARO) Act of 1992. A milestone in the context of Uganda's agriculture journey and aspirations towards research-based agriculture was achieved by the establishment of NARO.

Prof. Joseph Mukiibi is very proud to be one of the pioneers of NARO. Prof. Mukiibi, who holds PhD in Plant Pathology, has been justifiably baptized the Founding Father of NARO in consideration of his long association with the organization that he has paddled to the pedestal of agricultural research.

As NARO's first Director General in 1994, Prof. Mukiibi recalls that its formation originated from the Economic Reform Program, a government programme whose core objective was to generate ideas on how agriculture research would be reformed to make it autonomous from the Ministry of Agriculture Animal Industries and Fisheries (MAAIF).

"The idea was to make research an independent body administered by researchers," he says, adding: "To achieve this, we embarked on formulation of policy drafts to Cabinet, and upon approval, the Bills were sent to Parliament to enact the enabling laws."

Decentralizing NARO institutes

During his reign, Prof. Mukiibi in furtherance of the organization's objectives ensured that the various institutes became semi-autonomous so that they make their own decisions, especially in respect of finances and research.

"For example, every research station makes its own budget, depending on its needs. Budgets are later consolidated by NARO Secretariat and submitted to the Ministry of Finance for approval,"

he explains, adding: "Equally, research decisions are taken at research stations."
Of particular importance to Prof. Mukiibi, at the inception of NARO, was re-awakening the position of coffee as Uganda's number one cash cow. It is in light of this that together with his team they undertook to revive and revamp the coffee research infrastructure in Kituza, Mukono district, elevating it to a national coffee research station in 2015.

Decentralization, he says, was also in terms of areas of specialization by allowing institutes to specialize in commodities they had a comparative advantage in. "For example, Serere Research Station was mandated to do research on millet, sorghum, cowpeas, sesame, and groundnuts to cater for the semi-arid areas of Uganda," Prof. Mukiibi pointed out.

For purposes of transparency and equal access to employment opportunities in NARO, Prof. Mukiibi is said to have introduced the recruitment of staff through advertisement rather than headhunts. "This improved quality and reduced the risk of nepotism in recruitment. We made NARO an equal opportunity organization," he avers.

Despite such verifiable successes, Prof. Mukiibi says a lot more needs to be done to scale up NARO to soaring levels. He, for example, points out that poor remuneration and facilitation of researchers has been prohibitive to quality research.

"Researchers need fair salaries, problems identified should be tackled with adequate funding, the masses should be educated about the entire agricultural value chain, and most importantly, more practical works, especially in universities and other higher institutions of learning should be given the adequate attention they deserve," he advises.

Prior to joining NARO, Prof. Mukiibi was a Dean of the Faculty of Agriculture, Makerere University. He competitively won US$10m USAID grant for building capacity of agricultural scientists.



> Poor remuneration and facilitation of researchers has been prohibitive to quality research

Some of scientists who pursued MSc. and PhD degrees under this project were staff of NARO, while others joined NARO after completing their programs.

Arguably, it is in light of his insightful and developmental works that the then Minister of Agriculture Animal Industry and Fisheries—Hon. Victoria Sekitoleko—in 1988 asked him to join the Ministry to help re-vamp the agricultural research.

Subsequently, Prof. Mukiibi joined the Ministry as the secretary for research. Luck smiled upon him, again, and his team won a World Bank grant whose biggest share went towards developing human research capacity at post graduate level.

Notably, by the time Prof. Mukiibi left NARO, at least 30 PhD holders, and a substantial number M.Sc. staff had been trained. Prof. Joseph Mukiibi worked tirelessly to build capacity of NARO.
As a result, he notes "The organization was well staffed, efficient and respected. It was publishing a lot of scientific papers and had generated a lot of technologies."

Prof. Mukiibi recognizes the dedication of his team without whom nothing or little would have been achieved. He highlighted the unceasing knowledgeable efforts and unwavering involvement of scientists like Prof. Otim Nape, Dr. Theresa Ssengooba, Prof. Samuel Kyamanywa, among others, with whom he served to establish NARO. "We lit the flame, they should keep it burning and add more fuel" he mirthfully says.

Prof. Mukiibi noted that when the Government came up with several agencies, coordination became a problem. This caused in the biggest challenge the country is facing that is poor service delivery, and this must be addressed.



HON. VICTORIA SEKITOLEKO

FORMER MINISTER OF AGRICULTURE (1986 TO 1995). CURRENTLY BOARD CHAIR, UGANDA AGRIBUSINESS ALLIANCE



> **Government should increase NARO's budgetary allocation to research.**

Talking about Uganda's Ministry of Agriculture through the years, Hon. Victoria Sekitoleko is one such personality you cannot easily forget. She was the Minister of Agriculture from 1986 to 1995, and it was due to her clarity of vision that during her ministerial tenure NARO was established. In following excerpts, Hon. Sekitoleko is delighted to share her experiences on how NARO was birthed.

Qn. NARO came to life during your ministerial tenure, what necessitated its creation in 1992?

We used to have an agricultural research department, headed by a secretary, within the Ministry of Agriculture. Everything concerning the country's agricultural sector, including research was planned and handled by the Ministry. I remember we used to have top management meetings, and what came out of these regular meetings was that research was a misfit in the system that we were using. For that reason, we resolved to make research a little bit more autonomous. So in 1992, through an Act of Parliament, NARO was born to undertake guidance and coordination of all agricultural research activities in the country.

By Ronald Kalyango

Qn. After 25 years of service, would you say the decision you took was right, and any other person in your capacity would have reasonably done the same?

As a former Minister for Agriculture, and in my current position, I have interacted with very many farmers. They appreciate NARO technologies like quick maturing and high yielding crops that NARO scientists have worked tirelessly to generate through research. Commendably

> **Many people are complaining about the FHIA bananas varieties, but recently I visited a farmer in Masaka minting money by making wine out of these bananas**

Uganda in this day, and age of science advancement, has its own distinguished researchers who compete at regional and global level for available agricultural research resources and management positions.

Qn. Do farmers have any reason to celebrate NARO's existence and research interventions?

Through my regular interaction with farmers, I have found out that farmers appreciate NARO's commendable interventions in respect of crops and livestock research. Irish potato farmers, for example, having been exposed to improved varieties are capable of harvesting 15 tonnes from just an acre of land compared to 1-2 tonnes they were getting before. With such positive results, farmers cannot ask for so much more. Similarly, maize varieties like Longe 5 and 10H have also genuinely ascribed their achievements to NARO.

Notably, many people are complaining about the FHIA bananas varieties, but recently I visited a farmer in Masaka minting money by making wine out of these bananas. I do not usually take wine because they add preservatives like sulphur. But I enjoyed the one produced out of the FHIA bananas. I want to commend NARO for having persisted with their efforts despite the negative forces.

In Teso sub-region, NARO has conducted research on the green grams and sorghum varieties. Also, Uganda Breweries is contracting farmers to produce Epuripur sorghum on a large scale. Scientists based at the National Semi-Arid Resources Research Institute (NaSARRI) in Serere district have worked in tandem with the farmers, and they are appreciated for helping them to sustain their businesses and livelihood.

Qn. The Biosafety Bill was recently passed by Parliament, what is your opinion about this decision?

I am extremely happy that the 10th Parliament has finally passed the Biosafety and Biotechnology Bill. For many years, Government has invested in building capacity in biotechnology. We have biotechnology training programs in many universities including Makerere University. How do we intend to use all the capabilities without the Law? I am really glad that Uganda has seen the light. Now Uganda can prioritize how to use biotechnology to find solutions to its unending agricultural challenges.

Qn. Any shortfalls NARO must work on to perform better?

Agriculture research is the foundation of the agricultural industry, yet NARO has suffered insufficient funding in the execution of its core mandate of undertaking agricultural research. Obviously, this has limited NARO's solid research potential in so many ways. For blockbusting agricultural research to be executed, the government should adequately fund NARO. I am so saddened that there is no research about the orphaned crops like yams, sugarcane among others. We are also currently encouraging young graduates to intern with research organisations. To build a bigger body of agriculture researchers, it is important that a fund is established to support young graduates to intern with NARO's different institutes in their final year, and subsequent years after graduation.

Qn. What are your views on the zoning strategy, and what is that burning appeal, if any, you would convey to NARO?

For the longest time and in so many ways, Uganda has been zoned, and I am happy

that NARO has also responded by setting up zonal research centres to address challenges in particular regions.

I, however, appeal to NARO to strengthen linkages with farmers such that the generated technologies can easily be accessed by the end users. The country is still grappling with the weak agriculture extension system, and that is why there are stories of little impact being felt in the villages neighbouring NARO research stations. As a way forward, NARO in its project plans should include a budget on facilitating community interfaces.

Qn. For 25 years now, NARO has cut an unparalleled edge in agriculture research, which is not a mean achievement. What are your concluding remarks?

I commend NARO for the job well done. They have really explored new areas like food processing. It is in light of such explorations that the government should increase NARO's budgetary allocation to research. The fact that government is encouraging science subjects, NARO should be supported to support young Ugandans who graduate from the various universities in the country.



HON. DR. KISAMBA MUGERWA

FORMER MINISTER FOR AGRICULTURE (1999-2004). CURRENTLY EXECUTIVE CHAIRPERSON OF NATIONAL PLANNING AUTHORITY



> **We need to invest more in research and support dissemination of NARO's technologies**

Prior to ascending to the current mantle of Executive Chairperson of the National Planning Authority (NPA), and Chancellor Ndejje University, Hon. Dr. Wilberforce Kisamba Mugerwa served as director of International Food Policy Research Institute's division in Addis Ababa. Prior to that, he had a five-year reign as Minister of Agriculture, Animal Industry, and Fisheries. Hon. Dr. Kisamba Mugerwa commends NARO as excerpted below:

Qn. NARO's core mandate is agricultural research, and how important is this to Uganda's agricultural sector?

NARO is so centric in agricultural development so much that through its evolvement the organization has developed and released quite a number of research driven agricultural technologies. Thus, it is through research that farmers access reliable agricultural inputs or technologies in terms of seeds, grains like beans and maize.
Therefore, it is pleasing that NARO has scored breakthroughs, especially with new crop variety releases. Notably, NARO registered great strides in the cassava sub-sector when I was the minister.

The scientists worked tirelessly to find solutions to the cassava mosaic disease that was ravaging farmer's gardens in the countryside. During my tenure we started the outreach programs having realized that the generated foundation seeds needed to be accessed by farmers for multiplication purposes given that we could not multiply them at the research stations.

Considering that majority Ugandans undertake agriculture as a source of income, NARO will remain a relevant institution for social economic transformation through provision of agricultural technologies.

By Ronald Kalyango

Qn. The biotechnology laboratory at Kawanda was launched during your tenure, does Uganda need biotech crops?

Looking at conventional research, scientists have ably developed high-yielding crops. But, that we are increasingly confronted by the challenges of climate change such as increased pest and disease attacks, we tasked scientists to embrace biotechnology as a panacea to the challenges before us. Certainly, it gratifies me that we have not slid back, and with biotechnology legislation in place, NARO will release crop varieties currently confined in the field trials. It exceedingly baffles me that those against the biotech crops are looking more at the longevity of Ugandans than their survival, yet majority of our people still go to bed hungry. If through biotechnology scientists can develop crops with shorter gestation periods, they should be given a chance to do so.

Qn. It has been said that during your tenure you rallied massive coffee distribution, what could have been the motivation behind this?

As a repercussion of our past political turmoil, most coffee farmers lost their plants, and the few that remained did not fetch as much as the farmers had anticipated.

> **NARO registered great strides in the cassava sub-sector when I was the minister**

It is on that backdrop that conceived the need to provide farmers with clean coffee seedlings. We secured the seedlings from our own effectively supervised nurseries. This practice, unfortunately, waned with time – today several people own nurseries whose provision of proper seedlings is not guaranteed. The Uganda Coffee Development Authority (UCDA) should cure the coffee sector of this mess by supervising and guiding nursery operators against supplying fake planting materials. UCDA should also train farmers on increasing yield per tree to enable the country achieve the 20 million bags (60kgs) export target by 2020.

Qn. Several ambitious agriculture-related programmes aiming at increased production and subsequently poverty alleviation, have been tried over the years, and yet did not fully take off, what could have been the problem?

When I became Minister of Agriculture, I started with the Entandikwa revolving funds, which were rolled out between 1994 and 2002. However, the programme was grossly abused by a population which believes in handouts. When I joined the agriculture ministry, I introduced Plan for Modernisation of Agriculture (PMA) because I wanted research to have value. PMA had seven pillars and in my own view, I think we needed to fund all the pillars for agriculture to have a resounding impact. I am now heading NPA, and under the vision 2040, we recognize that for the country to develop, we need research, technology and innovations as key pillars for the country's social economic transformation.

Qn. In your opinion, how can NARO increase it achievements?

NARO has developed high-yielding and drought resistant crops, positioning it as still relevant to the country. Even with such achievements a lot remains to be

For research to remain relevant, we need to disseminate the generated technologies and supporting information



done – the scientists, for example, should go a notch higher regarding banana and cassava bio-fortification just as they have done with the beans and the orange fleshed sweet potatoes. They also need to carry out research on commercial crops like sugarcane whose fate right now is in the hands of the private sector. Also, of urgent consideration should be the fact that majority Ugandans have ventured into poultry keeping. I think we also need scientific knowledge to be translated in a form that can be used by farmers to transform Uganda's agriculture.



The administrative structure also needs to be improved. Having been behind NARO's formation my argument was that the different institutions needed to be independent of the other, but with only one council to supervise all the activities of the research institutions and to make them competitive. This, however, was messed up when every research institution was allowed to have an advisory board. I am not sure of the numbers, but certainly NARO has more board members supervising a few senior scientists.

Qn. With 25 years of agricultural research now in NARO's bag, what is your patting word?

For research to remain relevant, we need to disseminate the generated technologies and supporting information. We need to invest more in research and support disseminations of NARO's technologies to increase agricultural production. Therefore the NARO Governing Council and Top management should lobby for more funds.

DR. SAMUEL MUGASI

EXECUTIVE DIRECTOR, NATIONAL AGRICULTURAL ADVISORY SERVICES (NAADS)



For purposes of effective governance, National Agriculture Research Organisation (NARO) has a council as the top most governing body comprising distinctive personalities whose understanding of NARO's core mandate is beyond reproach. Dr. Samuel Mugasi, the Executive Director of the National Agricultural Advisory Services (NAADS) Secretariat below gives his valuable views on NARO:

> Research is the foundation of any agricultural value chain.

Qn. **Being the Executive Director of NAADS induces the conclusion that you have superior understanding of the agriculture sector in Uganda including agricultural research. What is your view of NARO's relevance and performance?**

There are two major public functions in agriculture, one is agricultural research and the other is agricultural extension, of course, without forgetting other functions, like regulation, supervision and quality control. So if you talk about NARO, you are talking about research, which is the core of agriculture. Research is the foundation of any agricultural value chain. For any country to develop, it needs a sustainable and profitable agricultural value chain, and the starting point is agricultural research. We need research to come up with improved seeds and animal breeds. So, NARO is one of the key agencies in the agricultural sector that needs to be supported.

Qn. **Considering what you have said, certainly you and NARO have a relationship that spans years, would you like to let us know when you first interfaced with the organisation?**

I first interfaced with NARO as a partner under the Agricultural Technology and Agribusiness Advisory Services (ATAAS) project, a World Bank funded project that started in 2011. The project sought to address the weak linkages between the different actors involved in agricultural research and development in the country. In particular was seeking to strengthen the linkage between research (NARO)

By Ronald Kalyango

and advisory services (NAADS) to scale up technology service delivery, and to promote integration of smallholders in value chains.

Qn. Taking an objective look at NARO, would you say it has some easily identifiable solid strengths it is riding on to soar higher?

Of course, we have limitless pride in NARO, especially the undeniable fact that over the years NARO has unstoppably amassed a formidable body of some of the finest scientists in the region. These scientists have commendably immersed themselves in solution-based crop and livestock research out of which our Uganda farmers have enjoyed the fruity benefits of access to newly released crops like cassava mosaic and brown streak tolerant varieties. Because of their steadfast research interest and unwavering efforts, NARO today deservingly hosts Regional Centre of Excellence for Cassava and groundnuts. Inevitably, it can be said that the cassava centre broadly illuminates NARO's capacity.

Notably, NARO's capacity has, for example, manifested in the release of quick maturing and nutritious crops like bananas, beans, groundnuts, simsim among others. It is comforting to say that a lot of research is also being undertaken in the livestock sub-sector. So in terms of capacity and importance, NARO is a strategic institution for this country whose thirst for more funding should go unfettered. In doing so, Uganda's agricultural sector will be substantially transformed.

> "For agricultural extension services to be helpful to the farmers, they must be supported by good agricultural research"

Qn. You talked of increased funding to NARO as a conduit to substantial agricultural sector transformation. Apart from the limited government funding, are there other avenues that the organization should utilise to raise enough resources?

First of all, the government has the will to fund research in the country, but the resource envelope is very competitive and limited. It is also a fact that research attracts funds from development partners. What would significantly give agricultural research a quantum leap, is the involvement of the private sector. We really need the private sector to fully embrace funding of the agricultural research just as the case is other countries.

Qn. Much as NARO has an irrefutable clean sheet of agricultural research scores, it cannot be said all that there is for it to do is done, what are some of the sticky points you feel need improvement?

Laudably, NARO has a strategic plan whose full realization has been held back by financial shortfalls. As a matter of fact, the government must invest a lot of resources in agricultural research and enumeration of its human resource at all levels. It is equally pertinent that the existing weak extension system is strengthened. For agricultural extension services to be helpful to the farmers, they must be supported by good agricultural research. Both agricultural extension and agricultural research have the characteristics of public goods, because dissemination of agricultural knowledge from one farmer to another means that social benefits exceed private benefits

thus research and extension need to be subsidized. There is no reason why the generated technologies are not accessed by farmers.

Qn. Any recommendation to NARO in light of its 25 years of devotional agricultural research services?

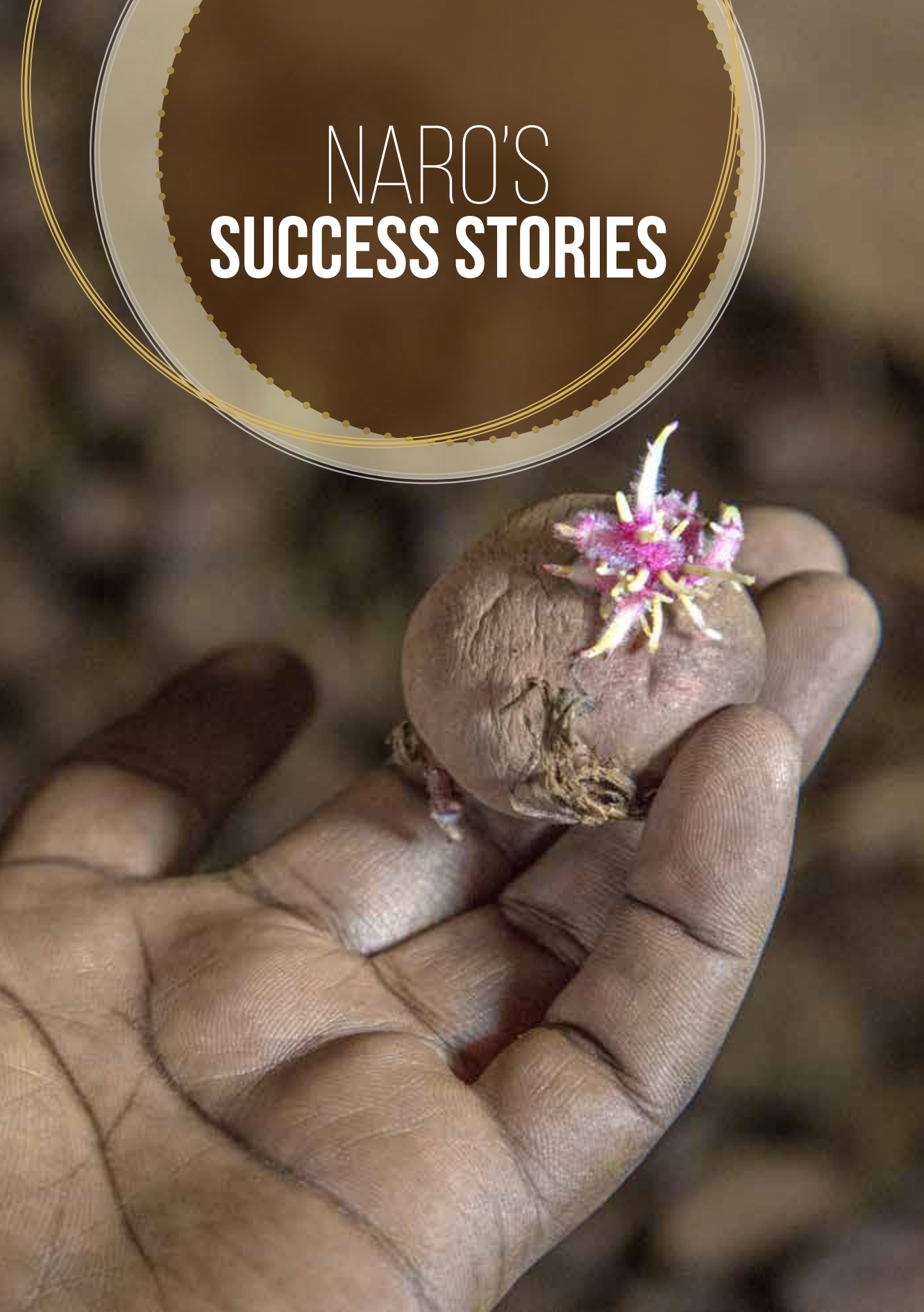
Well, 25 years is such a long time when you have nothing to do, but a very short time considering the challenges NARO had to expeditiously deal with. They have been years of resistless research in a bid to satiate the better food and livestock variety demands of the country, and obviously NARO in the last 25 years has had to dutifully measure up to the occasion. We are, therefore, gratified by the work they done. We are immensely proud of our scientists who are doing a commendable job. It is for such reasons that we want policy makers to throw their weight behind NARO to enable the organization to pursue and implement its strategic plans.



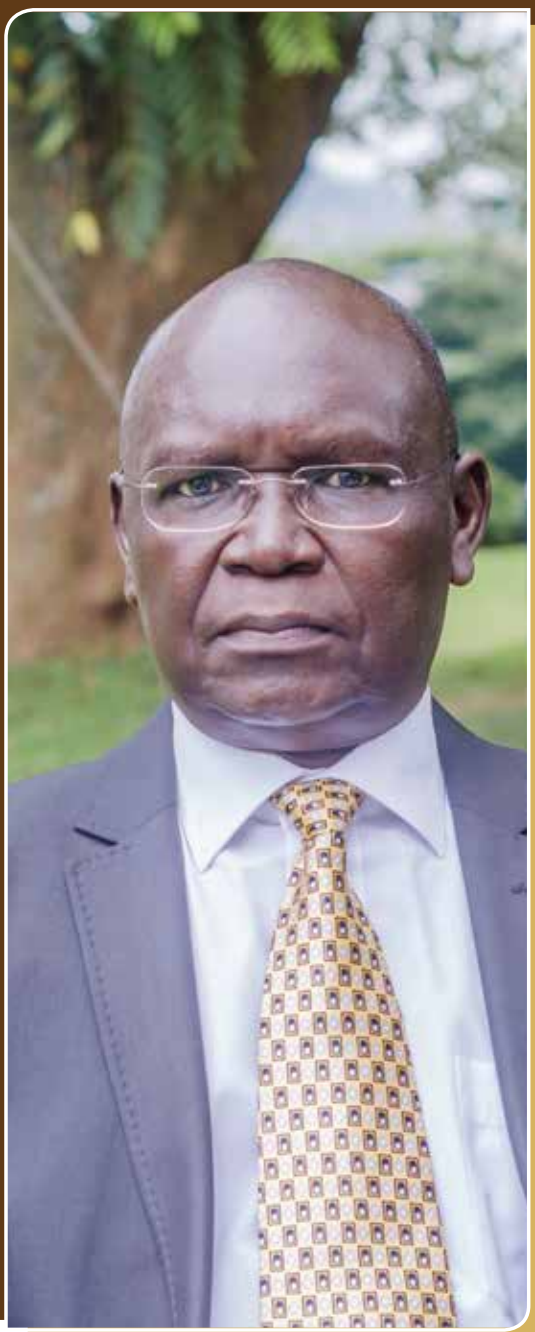
NARO today deservingly hosts Regional Centre of Excellence for Cassava and groundnuts



NARO'S
SUCCESS STORIES



NARO'S GOVERNANCE SYSTEM
IS A DRIVER TO ITS MANAGERIAL EXCELLENCE



PROF. JOSEPH OBUA,
CHAIRPERSON NARO GOVERNING COUNCIL

NARO's success is attributed to supportive policies, formulated by the Governing Council, that have allowed for enabling environment to conduct research and to strengthen human resources.

Prof. Joseph Obua joined the National Agricultural Research Organization (NARO) in 2012 after his appointment as Chairperson of the Governing Council, 16 member team of prominent Ugandans

"NARO's success is attributed to supportive policies, formulated by the Governing Council, that have allowed for enabling environment to conduct research and to strengthen human resources.

By Chris Berdana and Ronald Kalyango

> **NARO has undergone restructuring process to improve service delivery**

drawn from different disciplines that oversees and guides implementation of NARO's activities.

The team includes representatives from the farming community, the private sector, Non-governmental Organizations; Universities, Public Agricultural Research Institutes, Private Agricultural Researchers entities and local authorities nominated by the Uganda Local Government Association.

Other members of the council include the Permanent Secretary of Ministry of Agriculture, Animal Industry and Fisheries, the Permanent Secretary Ministry of Finance Planning and Economic Development, the Executive Director of National Agricultural Advisory Services and the Executive Secretary of Uganda National Council for Science and Technology.

The NARO governing council has four committees namely Users Committee, Science Committee, Audit and Risk Committee and Finance and Human Resources Committee.

Prof. Obua explains that NARO follows very strict guidelines provided to them by the National Agricultural Research Act 2005 and development partners like the World Bank among others. "The council also takes cognizant of the regular consultations and discussions of issues raised by NARO's management," he collaborates.

Institutional development

Under institution development, Prof. Obua explains that the research body boasts of seven National Research Institutes with National Coffee Research Institute (NaCORI) being the latest to be added in 2013.

At the zonal level, there are nine Zonal Agricultural Research and Development Institutes that are mandated to serve the needs of farmers within the agro-ecological zones. Overall, the research activities are manned by a team of 889 scientists, technicians and support staff out of the required 995 staffs.

Institutional Restructuring

Prof. Obua explained that the NARO has undergone restructuring process to improve service delivery. The process, he explains, resulted into creation of the Directorate of Agricultural Technology Promotion; the National Invasive Species Coordination Unit; and creation of new senior positions: Commercialization and Incubation Officer, Intellectual Property Officer, Knowledge Management Officer, and Principal Public Relations Officer among others.

Monitoring and Evaluation

Under this docket, there is timely approval of annual work plans and budgets, regular visits to all the institutes as part of governance monitoring and evaluation and supervision.

Support to management

The NARO governing council has also kept a watchful eye on management which has ensured that NARO gets a clean sheet

of performance evaluation reports annually, which is coordinated through the office of the Prime Minister. The Council has been very instrumental in supporting the NARO management in implementing its commitments to the national programmes and initiatives like Operation Wealth Creation (OWC).

PPP's have helped to leverage support and resources that make commercialization of the technologies possible for different stakeholders

Role of enabling policies

Prof. Obua attributes NARO's success to its enabling policies that have allowed the establishment of a public private partnership with the private sector. The policies have provided an enabling environment to conduct research and strengthen the human resources. NARO also boasts of a financial and institutional management capacity to deliver on its research outputs.

Recently, a Strategic Plan for the next 10 years (2018 to 2028) and Competitive Grants Scheme Implementation Guidelines 2016, Intellectual Property Rights Policy and Gender and Diversity Strategy were developed and approved.

Others policies include Performance Management Policy and Appraisal Guidelines, Internship And Volunteer Policy, Internal Audit Manual, Internal Audit Charter and Audit Committee Charter, Communication and Knowledge Management Strategy, Public Private Partnership Policy, Biometric Research and Support Guidelines, Council Charter and Levy On Off-Budget Projects for central that support research.

Partnerships and collaboration mechanisms

He is optimistic that as a result of good governance, NARO has been able to attract and maintain a number of development partners from the governments of Japan, Korea, USA and World Bank.

Others are regional institutions and organizations like; Association for Strengthening Agricultural Research in East And Central Africa (ASARECA), Forum for Agricultural Research in Africa (FARA) among others who are committed to supporting agricultural research.

The Council and Management have fostered partnerships with various CGIAR centres, Universities, private sector, local governments for support of agricultural research, dissemination of technologies and capacity building.

He singles out the World Bank for its continued support to the agricultural sector. Notable among the projects include The Agricultural Technology and Agribusiness Advisory Services (ATAAS) and the East Africa Agricultural Productivity Project (EAAPP).

Other partners include Agricultural Technology Foundation (AATF); Bill and Melinda Gates; The Integrated Seed Sector Development Programme, Malaysian Agricultural Research & Development Institute (MARDI), JICA, KOICA, Food and Agriculture Organisation (FAO) and World Food Programme that works with NARO to organize and commemorate WFD on 16th October every year. NARO hosts it in rotation amongst the institutes.

He believes that the PPP's have helped to leverage support and resources that make commercialization of the technologies

possible for different stakeholders. All this is backed up by a well thought out business plan which is the framework that guides NARO in doing business.

Through these partnerships NARO has been able to build the capacity of staff and other stakeholders and also to improve its research infrastructure.

Future plans under NARO Governing Council

Prof. Obua notes that their concentration in the coming years will be to ensure that NARO's mandate stretches beyond production of foundation seed. "We need to certify, multiply and commercialize the good quality seed that is being generated. This will guarantee quality assurance to the end users. We believe that the seeds can be generated and marketed by the same institution," he collaborated.

The Council also looks forward to strengthening the linkages between NARO and the Ministry of Agriculture's top management especially with the Directorate of Extension to ensure that the research body increases its impact through the extension of the generated technologies to the end users for greater impact.

"We need to have a stable extension system which will help us disseminate the generated technologies among the grass root farmers,"

Also top on the agenda, is to review NARO's Act, an undertaking he believes will make NARO more efficient in conducting agricultural research, business and better management.



NARO'S RESEARCH COORDINATION



DR. YONA BAGUMA,
DEPUTY DIRECTOR GENERAL

NARO'S TECHNOLOGY PROMOTION



DR. IMELDA N. KASHAIJA,
DEPUTY DIRECTOR GENERAL

NARO'S SUCCESSFUL FINANCE MANAGEMENT SYSTEM



CPA MARY KIGGUNDU, DIRECTOR FINANCE

NARO's financial performance was greatly improved by strengthening the linkage between the technical staff and the finance team.

NARO is one of the agencies of government of Uganda under the ministry of agriculture animal industry and fisheries. It is made up of 16 Public Agriculture Research Institutes with a Secretariat that coordinates research in Uganda. NARO is funded by government under Vote number 142 and other development partners through loans and grants. Funds from government and the major development partners are centrally received by the Secretariat and disbursed to the 16 institutes on a quarterly basis through the integrated financial management system (IFMS).

> **NARO has instituted a budget committee that reviews the priorities of the annual research agenda and allocates the available resources accordingly**

By Mary Kiggundu and Barbara M. Zawedde







The IFMS is one of the reforms that have been introduced by government to enhance transparency, speed and accuracy in government payment system and reporting.

NARO has instituted a number of internal controls, which include but not limited to the commitment control forms that shows how the appropriated amounts on expenditure codes are disbursed, tired approval electronic transfers are being made from most of the project accounts, leading to fast disbursement of funds. The budgeting process is achieved through a web based program budget system (PBS)

Accountability for these funds on the other hand is reviewed at the institutes by both the Internal Auditors and the Office of the Auditor General. In additions the physical performance is monitored by a dedicated Monitoring and evaluation team as well as the Budget and monitoring and Accountability unit of the ministry of finance.

The Public Finance and Accountability Act (PFAA) 2003 guided financial systems within the country from 2003 to 2015 when it was replaced by the Public Finance and Management Act (PFMA) 2015. On the record keeping and reporting NARO has been using the Microsoft Dynamics Solomon accounting package to capture financial data and produce financial statements for both government of Uganda and to the development partner's transactions since 2005. Before this, NARO used to produce her financial statements using Microsoft excel worksheets after filling n of the manual cashbooks and vote books. A process that was time consuming.

In 2011 NARO published the NARO Financial Management Manual that outline on how budgeting, payment, procurement and reporting matters are implemented. It has been an effective guideline for both management and staff in ensuring compliance to financial procedure.

NARO has continued to lobby government for increased funding under the Medium Term Expenditure Framework (MTEF) which has risen during the years as shown in the funding table below. NARO has groomed and encouraged her scientists into writing winning proposal to the international competitive grants there by boosting the funding resource base.

On the reporting front, NARO is among the first 10 votes every quarter to submit the financial statements to Treasury in Ministry of Finance.

Challenges:
NARO has faced some challenges in the Finance directorate starting with getting the technical staff to get to recognize the support staff as an integral part of the research agenda. To overcome this, finance has participated in the quarterly performance reviews and have come to blend in with the scientist by sharing the financial information and the expected financial discipline for effective research delivery.

The general accounting expenditure codes of government of Uganda is used by all the vote functions in the country. Some of these expenditure codes have been classified as consumption codes and therefore the amounts allocated by a vote to these expenditure codes are prone to reduction by Ministry of Finance before they even get to be discussed by Parliament.

The limited funding basket from the Ministry of Finance. Many a time NARO's budget performance had gone as low as 50% of the approved budget. This would lead to the institutes discarding the planned activities.

Originally the staff did not follow the government of Uganda budgeting cycle, and therefore the implementation of the work plan was almost no existent. Currently NARO has instituted a budget committee that reviews the priorities of the annual research agenda and allocates the available resources accordingly.

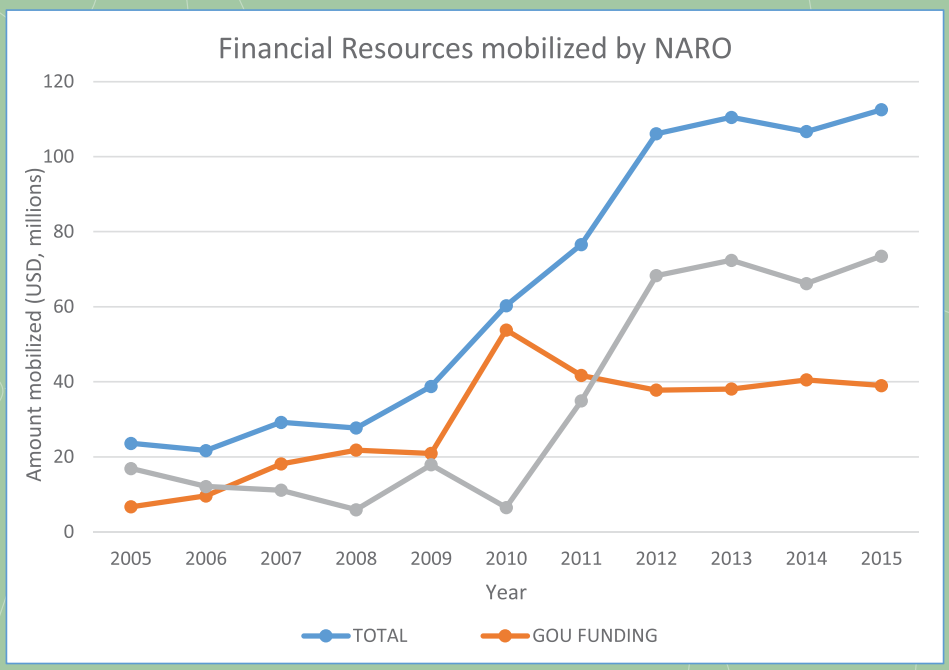


Figure 1: Trend of financial resources mobilized by NARO

NARO TAKES PRIDE IN HER
HUMAN RESOURCE MANAGEMENT SYSTEM



MR. ROBERT BAGONZA
DIRECTOR HUMAN RESOURCES

> the required number of core staff for NARO to effectively deliver on its mandate is yet to be achieved

"Over the years, NARO has built competitive capacity in scientific fields, and established strategic partnerships, that has enabled delivery of technologies relevant for our farmers'.

Undertaking quality research requires a highly trained human resource base. Fully aware of this factual need, NARO has commendably strived to respond and satiate this need in the past decades.

The organization's agricultural research mandate within Uganda and beyond is currently informed and manned by a commendable base of both MSc and PhD holders having started with a hand full in the 1990's.

By Victoria Mbigidde and Barbara M. Zawedde

It is worth noting that all staff who were working under various agricultural research stations, including fisheries, forestry, livestock, crop, coffee, soil, laboratories, to mention a few, were taken on by NARO after the 1995 reform which came with merging of these institutions.

NARO staff fall under three major categories namely; scientists, technicians and support staff. While scientists deal with core research, technicians work closely with them, offering them technical support. The support staff on the other hand offer mainly administrative services such as planning, financial management, auditing, transport, and procurement, among others.

"Although these functions sound professional, here we categorise them as support since NAROs core business is to conduct research," notes Mr. Robert Bagonza, director Human resource.

In relation with career development, NARO pays utmost attention to academic qualifications and progress. For one to be considered a scientist, the entry point is a Master's degree, except in a few cases where there is limited human resource trained to the desired level.

In such a case, first class degree holders are considered and later trained on the job so as to build the desired competence and confidence in their work. At this point, they are considered research assistants while masters' degree holders are recruited as research officers, and PhD holders are senior researchers. Over the years, NARO has recruited and/or trained staff to attain the required competence (Figure 2).

By 1997, NARO had a total of 742 core staff including 189 scientists, 183 technicians and 370 support staff. By September 2017, NARO had 881 core staff in addition to over 1000 the project-based staff based at NARO Secretariat and majorly at the institutes where core research is conducted and the numbers continue to grow. Male comprise 70% of the current core staff composition (Figure 3).

It should be noted that the required number of core staff for NARO to effectively deliver on its mandate is yet to be achieved. NARO requires 995 core staff including 22 Directors, 280 scientists, 280 technicians and 413 support staff.



Over the years, NARO has built competitive capacity in scientific fields, and established strategic partnerships, that has enabled delivery of technologies relevant for our farmers

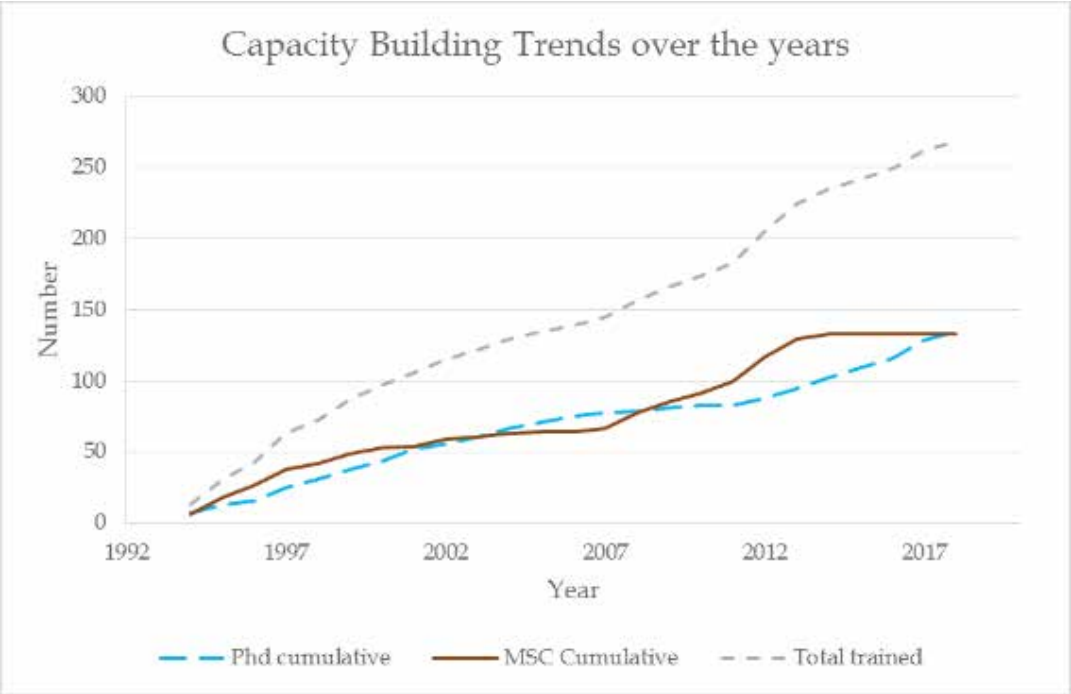


Figure 2. Trends in NARO staff status over the years

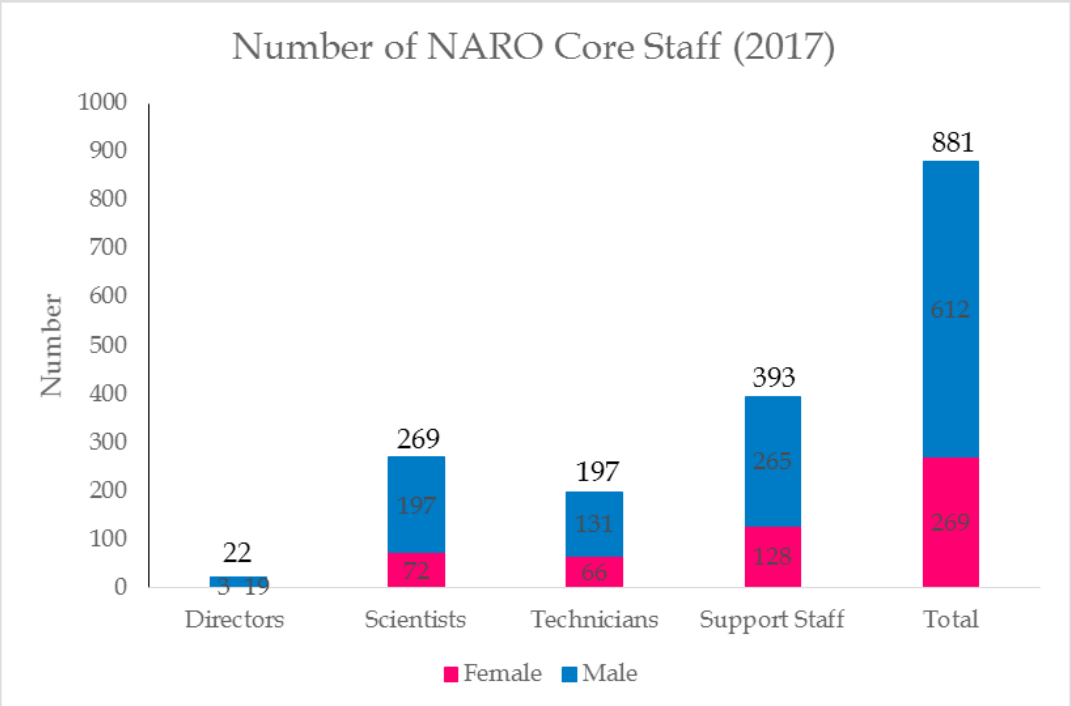


Figure 3: Number of NARO core staff by September 2017.

CORPORATE SERVICES



PROF. JUSTUS RUTASIRE,
DIRECTOR CORPORATE SERVICES

By Mary Kiggundu and Barbara M. Zawedde

MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY AND FISHERIES



MR. OKAASAI OPOLOT,
DIRECTOR CROP RESOURCES

> **Creation of NARO changed the agricultural research** agenda to focus on farmers-oriented needs and demands

Please share your experience with NARO

My experience with NARO date prior to establishment of NARO. Then agricultural research was a division in the Ministry of Agriculture, hosted in Kawanda. Prior to 1992, the research division was headed by a Chief Research Officer called Mr. Mawule. I was a bacteriologist and I sat directly opposite the current Director General of NARO, Dr. Ambrose Agona who was the entomologist. A few desks away was the current Deputy Director General in charge of Technology Promotion, Dr. Imelda Kashaija. Then, we were all officers of the division.

Prior to establishment of NARO, the research agenda was conceived through collaboration between the research and extension divisions. There was limited input from the farmers, therefore it was a top-bottom approach.

In 1992, through the Act of Parliament, the NARO was created. Creation of NARO raised the status of research in the ministry because the agency became autonomous with its head becoming an accounting officer to the Executive. Prof. Joseph Mukiibi was recruited as the Head of NARO, and many staff from the research division moved to NARO. A few of us who were risk averse remained in the ministry.

Establishment of NARO changed the agricultural research agenda to focus on farmers-oriented needs and demands. The farmer became the key stakeholder of agricultural research.

Research was given more priority to take-up the ministries infrastructure. Many research centres of the ministry including Kawanda, Namulonge, Serere and Tororo became national agricultural research institutes (NARIs). Some district farmers' institutes (DFIs) were also converted into research centres (currently known as Zonal Agricultural Research and Development Institutes —ZARDIs) depending on their location and appropriateness for research. Namarere Research Center was shared by the ministry and NARO's mechanization unit.

Prior to NARO, the Head of Kawanda Research Center was Mrs. Elizabeth Rubaihayo. After establishment of NARO, a Director of a NARI was expected to be a PhD holder thus Dr. Kibirige Ssebunya became the first Director of Kawanda.

Recruitment of staff of NARIs triggered transformation of research. Previously research was guided by thematic areas like entomology. Each thematic area had a Head. After establishment of NARO, staff were recruited based on prioritized commodities. Commodity-based research eased engagement of key stakeholders, and resulted in formation of multi-disciplinary and inter-institutional teams.

This approached improved the technologies generated by research. However, there was a de-link with



extension. While very good technologies were generated they did not effectively get used by the farmers because of limited extension support. NARO created an outreach program and the first Director of this Program was Mr. Ojachor a retired Director in the Ministry of Agriculture. Later, the program was institutionalized and Dr. Otim-Nape become the Director. Around 1998, each institute was given an outreach officer. This widened the gap between NARO and the extension division of the Ministry.

In 2001, after the on-set of the Plan for Modernization of Agriculture (PMA), the National Agricultural Advisory Services Organization (NAADS) was created as part of the extension service reforms. This "killed" the extension division in the ministry. A new directorate of Crop Resources was created with Mr. Wilson Otage as the Head. The Ministry of Animal Industry was dissolved and two directorates was created under the



ministry to cater for animal industry and fisheries. The ministry was renamed to Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

MAAIF and her agencies (NARO and NAADS) wrote a project proposal to World Bank. The project name was Agricultural Technology and Agribusiness Advisory Services (ATAAS), which was a five year project that started in December 2011. One of the major goals of the project was to strengthen the linkage between research and extension through joint planning and implementation of activities. This never happened, each agency instead focussed on their principal mandate with little collaboration. This was such a missed opportunity!

Recently, the mandate of NAADS was revised and a Directorate of Extension Services created in MAAIF. The ATAAS project was moved back to MAAIF. In my opinion, this provides an opportunity to recreate the linkage between research and extension. ATAAS has closed but there is a new project under development. The upcoming new project can be used to build a strong linkage between research and extension.

Qn. What was NARO's greatest achievement?

1. Changing the focus of the research agenda to address farmers' needs in line with specific commodities.
2. Creating multi-disciplinary teams to holistically handle a farmers' challenge.
3. Establishing new research centres in different agro-ecological zones to handle specific needs of the surrounding communities.

Qn. As NARO celebrates 25 years of agricultural research, what are your recommendations to improve delivery on its mandate?

First, I want to recommend that NARO turns its NARIs into centres of excellence for specific competences. For example, all top notch scientists in the field of biotechnology should be moved to the National Agricultural Research Laboratories in Kawanda so that they work together to generate innovations that will increase the competence of Uganda. Commodity experts should be reallocated to institutes working on their respective commodities. Experts with thematic areas that are cross-cutting can be assigned responsibility across commodities.

Secondly, there is need to strengthen the pathways for technology transfer and the outreach following technology dissemination. Research-extension link officers should be provided for in the coming financial year. This is important to support all the relevant technologies generated by NARO to get to the end-users and to make sure they are used properly.

Thirdly, there is need to move the focus from just problem solving to developing products. We need research to support value addition and product development. Getting products to private sector is another way of increasing absorption of the technologies generated. For example, if NARO partners with private sector to generate protocols for developing different products from cassava then the demand for cassava will increase. This in turn will prompt farmers to adopt modern NARO technologies for mass production of cassava.

I recommend that NARO implements strategies to support internal generation of research fund to ensure sustainability. There are many options available to NARO: public-private partnerships result in obtaining research funds from industry through client-oriented research; and processing patents for some of the unique innovations. The latter will require NARO to catalogue all the generated innovations and technologies.

Finally, to improve the linkage between NARO research institutes and the technical directorates of MAAIF requires developing and implementing a clear strategy to institutionalize linkage between research and regulation. I propose recruiting or posting zonal regulations officers of MAAIF to be based in NARO's ZARDIs working closely with NARO staff. In the long-term, there is need to transform leadership of institutes to integrate extension and regulation.

> The upcoming new project can be used to build a **strong linkage between research and extension**



INFRASTRUCTURAL CAPACITIES



Cassava Regional Centre of Excellence at NaCRRI - Namulonge

NARO is a center of excellence in research and ICT applications in ECA sub-region. Its transformation into a frontier of scientific innovation in agriculture has involved a dedicated drive to build and consolidate infrastructural capacity at all its Public Agricultural Research Institutes (PARIs).

Some of the existing facilities include offices, conferencing facilities, screen houses, stores, staff houses, warehouses for farm implements and machinery, and laboratories. The availability and spatial locations of laboratories throughout the country have improved research laboratory services and reduce the distance our diverse community of partners such as academic institutions, private and development partners travel to access these services. It has also enhanced collaboration with both public, private and development partners. And, positioned NARO better collaborate with international partners.

Proudly, NARO has established capacity in rare but common laboratory research and services facilities. First, the functional mineral analysis and nutrient profiling laboratory connecting research

> With support from the Government of Uganda and development partners, NARO over the years has progressively improved and increased its infrastructural capacities at various PARIs

By Joshua R. Muhumuza and Barbara M. Zawedde

to food industries. To date, consumers appreciate features such as better taste and healthier food. In rural communities, NARO has capacity to help improve livelihoods through raising agricultural productivity and training using tailored and targeted practices such as soil testing and micro-dosing techniques.

Second in crops sector NARO has unrivalled capacity to use conventional breeding techniques as well as modern biotechnology to provide farmers with the best choice for high yields and quality that meets the standards of growing number of supermarkets across the country. By developing new varieties of major staple food (maize, beans, rice) alongside crop protection and bio fortification line-ups, NARO is now a leader and will continue moving forward to address productivity improvements and nutrition at many levels.

Third, in the fisheries sub-sector, NARO has new laboratories including a fully equipped analytical laboratory for testing water quality, as well as an aquarium.

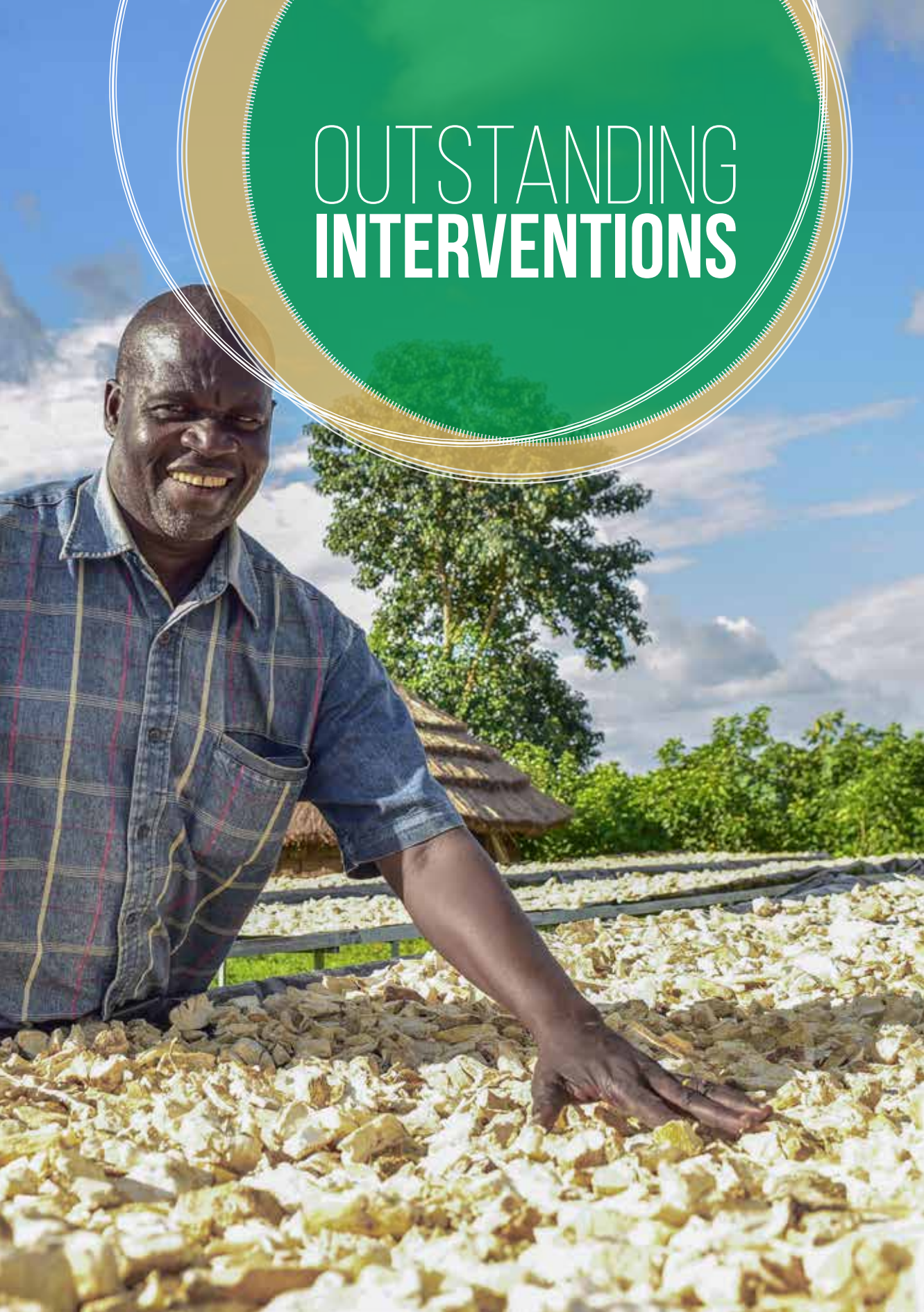
Other capacities include a carpentry workshop, an animal health and animal nutrition laboratories, plant genetic transformation platforms for banana and cassava, among other crops and animal resources.

A Biosciences Center equipped with modern laboratories for Cell and Tissue Culture, Molecular Biology, Plant Germplasm Conservation, Nutrition and Bioanalytical, as well as controlled drought screening facility, greenhouses, a confined field trials village and biosafety level II screen houses. Such facilities have considerably reduced the cost of research by limiting outsourcing to private and/or international research institutions for some of the services.

Such facilities have considerably reduced the cost of research by limiting outsourcing to private and/or international research institutions for some of the services



OUTSTANDING **INTERVENTIONS**



FARMERS HAIL NARO FOR RESUSCITATION OF BANANA PRODUCTION



THE COUNTRY'S AVERAGE BANANA CONSUMPTION STANDS AT 220KGS, MAKING IT THE HIGHEST IN THE WORLD



For years, engaging in banana (matooke) farming was a vain attempt that expectedly attracted no plausible returns due to the seemingly perpetual onslaught of Banana Bacteria Wilt (BBW), which left most farmers resignedly helpless.

In its wake BBW occasioned destruction of whole plantations in many parts of the western and central region of the country, subsequently slimming down farmers' subsistence lifestyles and livelihood since most of them looked up to and depended on banana farming as their cash cow. The farmers' teary plight, however, after some time did not go unabated – the intervention of the National Agricultural Research Organization (NARO) was not only timely, but a panacea to the BBW fangs that sucked the farmers' financial life dry.

It is due to such interventions that farmers such as Charles Kagombe, Hajati Zubeda Kaganda, Alex Mukiibi and Claudio Binomugisha have justifiably joyful testimonies.

Kagombe, a farmer in Nyakayojo village, Rwampara county hails his collaboration with NARO for rekindling his flickering interest in banana farming.

"The collaboration helped me to restore my output from 150 bunches in 2011 to 500 bunches a week from 100 hectares of banana plantation," he states as a smile of satisfaction struts across his face, emphatically adding: "I am currently even producing more." At the current market prices, proceeds from his banana sales amount to an average of UGX 5 million per week.

Hearing from Kaganda, a farmer in Kakondo village, Mbarara district, lifts NARO to the pedestal of admiration. Much as the embers of BBW destruction scalded her, her hope is steadfastly anchored in the collaboration between NARO and extension workers which she says has significantly helped them to fight the disease in Bukiro sub-county.

"We were on the verge of total hunger," she sadly recalls, testifying that the collaboration decisively resuscitated her banana production to 300 bunches a month. This amounts to over 3 million shillings in banana sales.

Similarly, Mukiibi, chairperson Kikona Daily Market in Ruti, Mbarara districts recalls a reduction in matooke in the market that resulted in the price of banana raising up to UGX 20,000. Currently, the market current receives and sells between 5,000-10,000 bunches in a day at prices between UGX 8,000 and 15,000.

Nostalgically, Bainomugisha, a farmer in Mirambi village Mbarara district, recounts the days he used to harvest 300 bunches per month from 10 acres before BBW struck, he is currently harvesting only a paltry 180 bunches per month.

Deep in the storm of this production setback and associated financial slump however, Bainomugisha is emboldened by a tide of hope that his pre-BBW production prowess will resurface with NARO's intervention.

by the end of 2015 **BBW disease incidence at national level had reduced to less than 5%,** with yield recovery of 72% (UGX 336.6 billion) from previously affected fields

Banana Consumption Patterns in Uganda
With the production increments for farmers such as Kagombe, Kaganda and Bainomugisha, bananas remain a major food crop for 58% of Uganda's population with the country's average banana consumption standing at 220kgs, making it the highest in the world, according to Prof. Wilberforce Tushemereirwe, Director of the National Agricultural Research Laboratories (NARL) Kawanda.

Such consumption underscores the apprehension that any significant and resultantly prohibitive effect on banana production portends severe food insecurity and diminished income for the farmers, affecting livelihoods in the long run.

The losses due to Banana Bacteria Wilt disease were estimated at a staggering UGX 600 billion annually between 2000 and 2019 if banana bacterial wilt is not controlled according to IITA.

To appreciate the magnitude of devastation caused, the virulent disease was baptized crazy names by the farmers. It was called toduula literally meaning "Don't Brag" in Rakai, central region, and kajunde meaning 'Rot' in Ankole region (Bushenyi and Mbarara).

Banana research in Uganda
Aware of the food security potential of bananas, it was only pertinent that as early as 1991 research activities were expedited to contain the ravaging effect of BBW. Other challenges targeted included; nematodes, high incidence of black sigatoka and banana streak virus, local varieties of banana not tolerant to prolonged drought, as well as poor yields and short plantation life span.



By Christopher Berdana, Joshua R. Muhumuza, Barbara M. Zawedde, and Jerome Kubiriba*
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Studies were conducted to identify and estimate the extent of the challenges, and to carry out taxonomy characterization. Research focused on response to black sigatoka, yield, food acceptability, and identifying better yielding varieties.

Flowing from the years of NARO research were a number of varieties released, for example, M9 (Kabana 6H) in 2010, M2 (Kabana 7H) in 2011 and NAROBan 1, 2, 3, & 4, in 2017. These hybrid bananas bore characteristics such as resistance to black sigatoka, tolerance to nematodes and weevils, and to prolonged dry spells with highly acceptable food given its good taste as confirmed by the testing panel.

Disturbingly, the released varieties were not immune to BBW, rudely elbowing the scientists at NARL into studying BBW manifestation. As a result, they identified crop management options to curb the disease. The bacteria, states Dr. Geoffrey Arinaitwe, a banana breeder at NARL, are transmitted by farm tools and insects that visit the banana flowers and move from plant to plant.

BBW manifests by premature yellowing of the banana fruit, oozing of pus-like fluid from brown stems when cut, yellowing of young leaves, and often looks like the plant has been burnt by fire. This limits the amount of photosynthesis necessary for the plant and the fruit cannot be eaten.

Research focused on response to black sigatoka, yield, food acceptability, and identifying better yielding varieties

the released varieties were not immune to BBW, rudely elbowing the scientists at NARL into studying BBW manifestation

To contain it, Dr. Jerome Kubiriba, the head of the National Banana Programme (NBP) at NARL, reveals that farmers have been furnished with the necessary procedures to follow. For example, he advises farmers to cut the diseased plants from the base, chop the stems and then let them rot while the diseased part is exposed to the sun, noting that the bacteria die as the plant rots.

To establish if suckers have BBW, Kubiriba says farmers should wait for three (3) months because research has shown that sometimes the suckers look healthy though they may have the disease. Three months is the incubation period of the disease.

In case a farmer is re-energised to re-establish a plantation in a previously ravaged area, the scientists recommend a resting period of six (6) months.

In the same sense, cutting off of the male buds to stop the spread by insects that visit the male buds, is advisable, and farmers have equally been advised to disinfect their gardening tools with jik or heating. Minimized movement of farm tools among farms is also recommended.

"We are currently recommending cultural controls where you manipulate the environment to the disadvantage of the bacteria," he says of the cultural control methods also referred to as phytosanitary measures.

Grassroots fight against the disease
Much as the fight against the disease was spearheaded by NARL, the attendant successes admittedly sprouted from its collaboration with district and National Agriculture Advisory Services (NAADs) extension workers.



For example, Vincent Mugabi an extension worker at Bukiro Sub-county, Mbarara district, and who was a member of the task force from 2011-2014, avers that NARO trained them on how to identify diseased plants, mixing of jik, timely removal of male buds and seed selection.

Political and local leaders in parts of Mbarara district also passed bylaws to punish stubborn farmers who were not adopting the recommended protocols, especially timely removal of the male buds.

Four years after the intervention, the results are loud enough to be heard – banana production has risen to pre-BBW in the main producing areas of western Uganda. This has translated into banana production recovery of 40%.

According to Dr. Kubiriba, by the end of 2015 BBW disease incidence at national level had reduced to less than 5%, with yield recovery of 72% (UGX 336.6 billion) from previously affected fields.

The control of banana bacterial wilt, demonstrates that with appropriate technologies and timely engagement of stakeholders, certain plant disease epidemics can be effectively controlled. In the case of BBW, farmers have requested scientists to provide a longer-term solution that does not entail punishment due to failure to abide with the bylaws. For this reason, there is on-going research to identify alternative control measures, including development of disease-resistant varieties using biotechnology tools.



Farmers have equally been advised to **disinfect their gardening tools with jik or heating**

NARO INCREASES FARMERS' INCOMES AND NUTRITION THROUGH RELEASE OF IMPROVED BEAN VARIETY



UGANDA IS THE SECOND LARGEST PRODUCER OF BEANS IN AFRICA WITH PRODUCTION ESTIMATED AT 929,000 METRIC TONS ANNUALLY

By Ronald Kalyongo, Barbara M. Zawedde, and Stanley Nkalubo*
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Eighty (80) percent of bean production is consumed locally and the rest exported to neighbouring countries including Kenya, Rwanda and South Sudan



For a long time, certainly due to lack of knowledge and meaningful exposure, most people, especially in Uganda, have always misconstrued eating beans to be poor feeding, and subsequently associated it with poverty, thus disdainfully dubbing beans the poor man's meat considering that few people could afford livestock or buying fresh meat. Conversely, such people have unknowingly mistaken eating meat and related fatty foods to be good feeding and wellbeing.

With such misdirected thinking, most meat consumers have developed not only costly, but irreversible health conditions that have almost drained them of their financial resources.

According to the USA National Institute of Health report of 2015, there is increasing evidence of negative effects of eating a lot of red meat on our health. Beans are increasingly being recognized as "healthy meat". According to Dr. Michael Ugen, a lead scientist at the National Agricultural Research Organization (NARO), beans are full of fibre, potassium, folate, iron, manganese and magnesium, and are cholesterol and fat-free. Comparing meat and beans underpins the need, therefore to eat for nutrition and not for the taste

Uganda is the second largest producer of beans in Africa, with production estimated at 929,000 metric tons annually. Eighty (80) percent of bean production is consumed locally and the rest exported to neighbouring countries including Kenya, Rwanda and South Sudan
.
In Uganda, beans are grown country-wide because of the favourable climatic conditions, and climbing beans grow very well in the highlands.

Farmers thirsty for quality seeds.
Certainly, it is due to the nutritious value of beans that every planting season, seed companies and communities in Lwengo district and beyond trek to Kyazanga Farmer's Cooperative Society to access quality bean seeds.

The cooperative society, which began as a small farmers' group in 1997, has over the years built a reputation as a quality seed producer. This solid reputation, argues Joseph Asiimwe, the society's coordinator, would not have been amassed without the support and training of its members by the National Crops Resources Research Institute (NaCCRI) and National Agriculture Resources Organisation (NARO) since 2007.

> From bulking 70 tonnes of beans in 2014, CEDO bulked about **180 tonnes per season in 2016, and expected to bulk 250 tonnes** in 2017

Therefore, by working closely with NaCCRI scientists, and the Netherlands funded Integrated Seed Sector Development, the cooperative, which currently comprising 1,086 members, is engaged in bean seed multiplication, in addition to other activities such as savings and credit.

The society produces newly released bean seed varieties, including the NABE 14,15,16,17, Narobean1, 2 and 3, which are said to be ready for harvest in two months after planting.

"NABE 17 is most nutritious because it contains more iron. The new bean varieties are believed to be more drought and disease tolerant, fast maturing, nutritious and have a good taste," asserts Asiimwe.

Just as hard work has been associated with fruity gains, the society's production potential has increased over the years due to hard work, despite fluctuations in output occasioned by various factors. It is in consideration of this commitment to work that 50 metric tons is the projected produce for 2017. As a measure of success, after following the recommended agronomic practices the Cooperative members reported an average of 800kg per acre in 2017 from 300kg per acre in 2013. A gross income of UGX 320 million was expected by the cooperative.

To boost its production potential, the cooperative is working with a team of about 10 village agents in Kyazanga. Similarly, quite a sizeable number of agents have been recruited to cover Masaka, Sembabule and Lyantonde districts.

Arguably, with such dedicated village teams increased production will be realized, but with increased production comes the concomitant need for increased storage space – it is for this reason, therefore, that the cooperative is constructing a 300 tons storage facility.

The new facility, estimated to cost about UGX100 million, will undeniably position the cooperative as the leading bean producing organization in the region.

It is due to such clarity of purpose, an identifiable sense of direction and potential and seriousness with seed multiplication



> A gross income of **UGX 320 million** was expected by the cooperative

of several varieties that NARO, according to Dr. Stanley Nkalubo, a NARO bean breeder, partnered with the cooperative. NaCCRI cemented the partnership by training and mentoring the cooperative's staff on good agronomic practices in respect of the released bean varieties.

Rural women eke a living from beans NARO has irresistibly interested rural women in bean farming. Hamidah Nabatanzi, one of the bean farmers under the Kyazanga Farmer's Cooperative Society, joyously shares that upon joining the cooperative in 2014. She was advanced 10kg of NABE16 bean seeds that she planted and harvested 250 kg after 2 months.



After receiving training and applying the recommended agronomic practices, Nabatanzi harvested 650 kgs from 10kgs of seed in the follow-up seasons.

To this effect, Community Enterprises Development Organization (CEDO), a NARO partner and a farmer-owned organization, is helping its members to produce beans. "We have taken beans to the next level. We provide members with quality seeds of bean varieties like Nabe5, 14, 15, 16, 17, 19, Narobean1, 2 and 3," says Charles Katabalwa, CEDO's program officer, boasting: "People know we have quality beans, so they come to us."

Through Gertrude Birungi's attestation, CEDO, which operates across 15 districts dealing with farmer's groups of 15 to 20 members and cooperative society settings comprising between 20 and 100 members, does not end at seed provision, but also ensures farmers obtain the most from their sweat through securing satisfactory prices. Birungi, who is CEDO's member and a bean farmer for the last three years in Kyandaza village, Byakabanda sub-county, Rakai district, says the beans take a shorter duration for growing and cooking, compared to ordinary beans.

The 50-year-old started by growing Nabe14 bean variety, and later benefited from Nabe15, 16, RWR, and Q145, harvesting in 2016 over 2,000kg. "Through NARO's trainings, we now plant beans in straight lines and are able to identify and manage insects that attack our produce" she explains, noting, however, that the increasing frequency of persistent dry spells is her biggest challenge.

Given such quality seeds and proper planting practices, bean production has surged up, explaining why from bulking 70 tonnes of beans in 2014, CEDO bulked about 180 tonnes per season in 2016, and expected to bulk 250 tonnes in 2017.



Resty Nasazi, an extension worker, says CEDO and the NARO's interventions have greatly changed the livelihood of the farmers – many have expanded beyond planting crops to adding value to their produce and embracing several income-generating activities.

In addition to supporting farmers, CEDO has warmed up the purse strings of a section of women through paid work – about 80 to 120 women are contracted for four months in a year to sort the beans, earning UGX7000 per each 100kg bag sorted.

Notably, CEDO, despite currently having 20,000 farmers up from seven in 2000, observes Katabalwa, has not produced the required bean volumes set by CEDO because of limited access to quality seed in time for planting. CEDO appeals to NARO to decentralize the multiplication of foundation seeds, depending on the different agro-ecological zones so that farmers access the right seed at the right time and price.

New bean varieties nipping anaemia in the bud

Every celebrated moment is preceded by difficult times. In the same way, the current production of nutritious bean varieties and stability of supply was, for example, preceded by hard times – between 1997 and 1998, bean production was frustrated by bean root rot, a strange and destructive bean disease.

"The effect was so severe that farmers were registering zero yields in some regions. The most affected region was South-western Uganda, where the disease presence was very high," says Dr. Nkalubo.

This, Dr. Nkalubo recalls, called for immediate intervention by NARO. "We wanted to restore resistance in the indigenous bean varieties and develop new genotypes with acceptable consumption and market qualities," he explains.

Subsequent to the intervention, NARO has released 32 bean varieties, 23 of which are bush beans for low land and nine climbing beans targeting the highland districts.

"A series of bean varieties including NABE 13, NABE 14, NABE 26C, NABE 27C and NABE 29C 9C have since been released to counter the root rot epidemic," he enumerates.

Alarmingly, the 2016 National Demographic and Health Survey of Uganda, indicates that 53% of children

aged 6-59 months, and about 32% of women aged 15-49 years are anaemic. The eastern, northern and the West Nile regions have the highest prevalence.

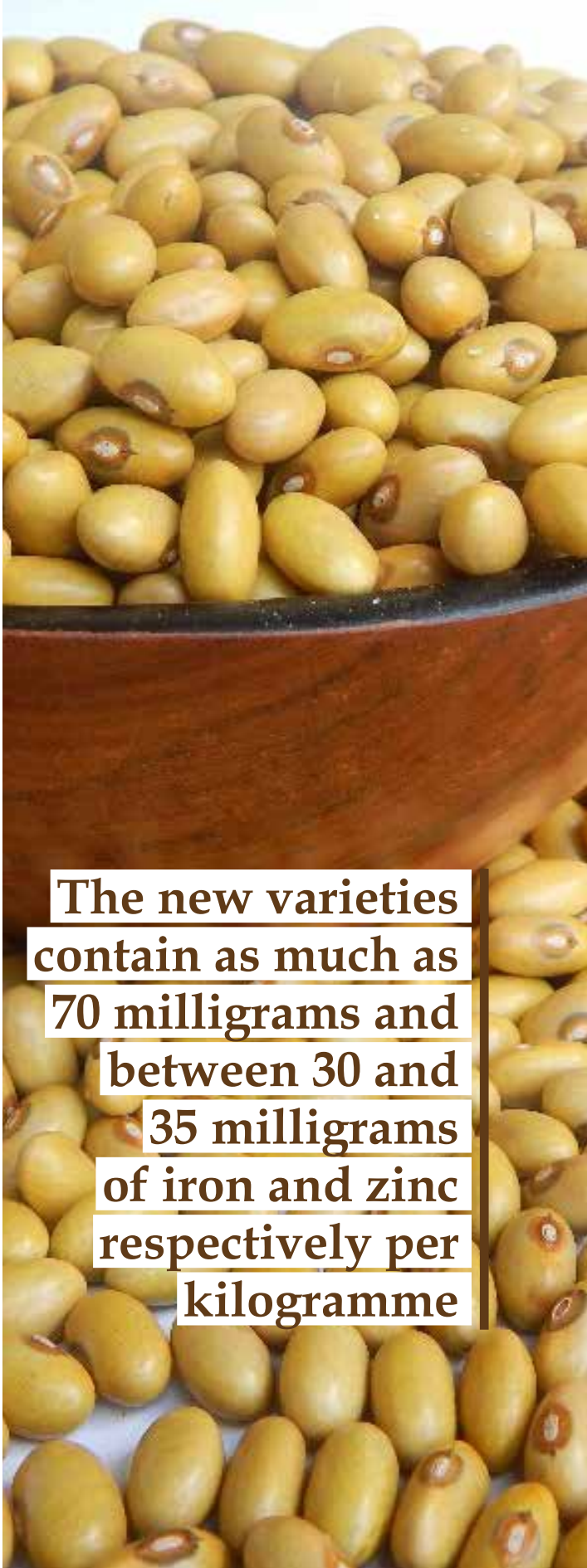
It is, therefore, in the face of such disturbing statistics that NARO's research breakthroughs have in various circumstances become relevant through provision of practically sustainable and affordable solutions to various agriculture-related dilemmas.

NARO, for example, in partnership with International Center for Tropical Agriculture (CIAT) recently released bean varieties that have higher iron and zinc micro-nutrients content. Iron is required for the production of red blood cells, and also forms part of haemoglobin (the pigment of the red blood cells).

Additionally, it facilitates transportation of oxygen from the lungs to cells in body, while Zinc is key in strengthening the body's immune system, and as a matter of relevance, these bean varieties have been found to reduce anaemia in pregnant mothers, as well as improving food security.

Dr. Nkalubo ascribes the beans' anaemia reducing potency to the fact that whereas the common bean varieties contain 40 to 50 milligrams and 15 to 20 milligrams of iron and zinc, respectively per kilogramme, the new varieties contain as much as 70 milligrams and between 30 and 35 milligrams of iron and zinc respectively per kilogramme.

"This is a very good development because one strategy cannot address anaemia in the country. We are currently giving pregnant mothers tablets rich in iron to boost their immunity, but only 2 per cent complete the dose of 180 tablets," Agnes Chandia, a nutritionist with the Ministry of Health, attests.



The new varieties contain as much as 70 milligrams and between 30 and 35 milligrams of iron and zinc respectively per kilogramme

CURTAILING LAKE VICTORIA FISH DEPLETION THROUGH CAGE FISH FARMING



IF NOT FOR NARO INTRODUCING CAGE FISHING THROUGH NAFIRRI, WE WOULD BE OUT OF BUSINESS DUE TO DEPLETION - **MAJIB MAGUMBA, FISHERMAN**

By Prossy Nandudu, Barbara M. Zawedde, Victoria Mbigidde, Alice Endra and Phillip Rwezawula *
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Fish is one aquatic resource that for some years in Uganda was abundantly available and affordable for most households, but became nearly depleted due to industrial demands and unacceptable fishing methods and tools, among others.

As a response to fish scarcity, aquaculture through cage fishing emerged as one of the solutions to the high demand, but low supply conundrum. As a direct result of cage fish farming, the demand for fish feeds highly ebbed, resulting in the onset of commercial fish feed mills.

Jinja-based Masese Cage Fish Farmers' Cooperative Society, comprising 70 cage fish farmers, traders, and input dealers such as boat makers and fish cage makers, is one of the biggest producers of fish – the society has about 500 cages of 5x5x5, each holding close to 10,000 fish and cages of 3x3x3 that hold about 5000 fish.

Majid Magumba, who has been depending on the Lake Victoria for fish all his life, reveals that had it not been for NARO introducing cage fish farming through NaFIRRI, we would have been jerked out of fishing due to depletion.

Forking Money from Cage Fish Farming

In 2008, the National Agriculture Advisory Services (NAADs) working together with NaFIRRI, trained farmers in cage fish farming.

"When the team came to Masese, they asked us for the enterprise of our choice. We said cage fish farming," Magumba says. He added that "at that time, fish stocks had reduced from the lake due to our bad fishing practices. We requested for trainings on how to farm fish using cages. We mobilized members, formed a group and after the training, we were given two cages as a demonstration with 5000 fish."

Reinvigorated by the trainings, the group embarked on cage fish farming, and with continued trainings, the farmers had not only acquired 11 cages by 2011, but also learnt how to feed and identify the right feeds for the fish by monitoring their growth patterns.

Besides Magumba's group, other famers such as Salome Gimono too have a reason to smile in respect of NARO/NaFFIRI's work.

Gimono, intimates that she learnt of cage fish farming at the annual agricultural show in Jinja in 2013, where she met the Masese fish farmers exhibiting the technology. On expressing interest, group members invited her to join them by registration.

"That same year, I mobilized UGX 7 million to start. With this money, I bought 5000 fingerlings, the cages and feeds. Part of the money was for paying the feeders". Gimono has since multiplied her stock to four cages each with 10,000 fish holding capacity.

At harvesting, if the fish is well fed, Gimono harvests about 7 to 8 tonnes, translating into a gross income of about UGX 60 million, depending on the season. From her incomes, she has obtained land, paid school fees for her siblings,



At harvesting, if the fish is well fed, Gimono harvests about 7 to 8 tonnes, translating into **a gross income of about UGX 60 million**, depending on the season

and children together with her husband. Revealing in similar financial gain like Gimono, **Franco Kijambogo lauds the profitability of cage fish farming.** "Fish farming is profitable despite the challenges. If you farm 10,000 fish and feed it well, you can get 700grams to 800gms of each fish, but feeds remain the number one challenge," warns Kijambogo

"From 10,000 fish in a cage, one is capable of producing between 7 to 8 tonnes. Kijambogo notes that this can only be achieved if government develops interest in regulating the fish feed manufacturers. This is because some farmers get fish discouragingly weighing between 250 to 300gms due to poor quality but expensive feeds" – notes Kijambogo.

It is said that no human situation presents just one opportunity, but numerous, thus whereas most fish dealers took on cage fish farming, Charles Mubiru saw an opportunity in being a fish feeder, and underwent training by NARO/NaFIRRI. "After the training, our bosses who own fish cages on the lake employed us to feed fish, and officials from NaFIRRI check on us continuously. This job earns me a monthly salary of between UGX 100,000 and 150,000," Mubiru explains.

Fish Farming through the Years

After its introduction in Uganda in the early 1950s, aquaculture remained a rural subsistence agricultural activity mainly to supplement household nutrition through improved intake of animal fish protein. The lack of quality commercial fish feeds that has characterized subsistence aquaculture has been the biggest challenge to investing in commercial aquaculture.

In Uganda aquaculture is said to have started in 1953 with the establishment of the Kajjansi experimental station to address nutrition security among the rural livelihoods. By the late 1960s, 11,000 ponds were operational countrywide. The aquaculture candle, however, burnt out due to the 1980s political instability that engulfed the country, resulting in the drop in annual production from 40 to 30 metric tonnes.

From 1992, NaFIRRI and partners began improving aquaculture yields through improved feeding by using by-products of agricultural processing. From 1992-2002, NaFIRRI investigated the potential of sunflower oil cake, which was found to be rich in protein and plant oil, both as a feed and a pond fertilizer. The adoption of this technology increased pond yields from less than 0.05 kg/M^2 to 0.75 kg/M^2.

Improvements in pond yields through the use of chicken offals from Ugachick Poultry Breeders Ltd were later realised. These were found to be 80% protein and resulted in yields as high as 2.4 kg/M^2 in on-station catfish culture. Starting in 2002, NaFIRRI commenced development of formulated fish feed by sourcing for ingredients, analyzing their nutritional composition and qualities, formulating and testing of the feeds.

The promising results from these experiments attracted collaboration with private sector (Ugachick Poultry Breeders Ltd) that resulted in the production and availability of commercial fish feeds in Uganda in 2003. The collaboration was strengthened with support from USAID and GoU resulting in the production of floating fish feed in 2005. To advance the impact of this initiative, NaFIRRI provided a database of local ingredients that had been identified, initial formulations and performance results of the formulated feeds.

Inadequate Knowledge Addressed

In the same vein, NaFIRRI trained prospective fish farmers and fisher communities in key cage aquaculture concepts. This was aimed at addressing issues related to inadequate knowledge, which happens to be major factor curtailing prospective fish farmers from embracing the technology.

In addition, NaFIRRI conducted participatory feed testing, focusing on growth performance of Nile tilapia fed on feeds sourced from various local producers. The aim of the testing was to generate input from fish farmers and feed manufacturers on the best feeds. More trials are on-going to determine appropriate stocking densities under specific conditions, including cage size. These trials are replicated at selected NARO Zonal Agricultural Research and Development institutes (ZARDIs).

Technology Adoption

The availability of commercial fish feeds led to a significant upturn in total aquaculture production from less than 3,000 metric tonnes in 2000 to over 10,000 metric tonnes in 2005 and then 95,000 metric tonnes in 2010. Also, pond yields increased from 0.95 Kg/M^2 to 1.7 Kg/M^2 with proper feed use and water quality management. Evidently, aquaculture has recently become much more attractive, judging by the number of investors, and availability of quality floating feeds which has facilitated the adoption of more intensive cage aquaculture.





How does one access the technology?
To get cages, farmers have to buy the cages from the landing site. The fingerlings or fish seed is usually bought from SON Fish Farm Ltd based in Jinja, and Ugachick. Accessing the technology and inputs is made much easier if you are part of a fish farming association.

Despite the inroads made, challenges such as the prohibitive cost of feeds call for arming farmers with their own feed making machinery. This is expected to slice the cost of fish farming by 50%. Apart from cost-related challenges, cage fish farmers are equally grappling with uncertainty of the fish market**.** At the moment, most fish traders in the region look up to Rwanda as the biggest fish market. However, this has been infiltrated by Chinese who sell fish at cheaper prices.

The Chinese fish farmers have lower production costs because they make their own feeds and have access to good equipment like refrigerators. **C**ontinuous refining and improvement of available guidelines and best practices with new knowledge and capacity building is vital in addressing the challenges facing cage culture.
Currently, there are about 2,000 emerging commercial farmers with close to 5,000 ponds. In addition, there are approximately 28 registered cage fish farmers' associations in Uganda with 2135 cages and each farmer produces an average of 180 metric tons per year (Swaibu et al., 2017). With this, current aquaculture production increased to 111,023 metric tonnes per annum by 2016. This was due to entry of commercial aquaculture producers, management of stocked communal water bodies and adoption of high density fish culture technologies.

Considering the unregistered farmers operating cage fish farming, and yet to be documented data, it is possible that the national production is much higher than that on record.

> NaFIRRI provided a **database of local ingredients** that had been identified, initial formulations and performance results of the formulated feeds











CASSAVA RESEARCH INTERVENTIONS DRIVING SOCIAL AND ECONOMIC DEVELOPMENT IN UGANDA

By Peter Wamboga, Owen Singura, Barbara M. Zawedde and Anton Bua*
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IN THE FACE OF INCREASING DROUGHT PERIODS, CASSAVA IS A GOOD OPTION SINCE IT IS DROUGHT TOLERANT

Weighed down by banana bacterial wilt which ravaged his banana plantation in 2008, steeping his banana production from 2000 bunches per month, to zero by the end of 2011, Emmanuel Kamara, who quit his job at National Forestry Authority and concentrated on farming in Kyembogo sub-county, Kyenjojo district, seemed a man precariously stuck at the crossroads.

Unavoidably, he wept about the enormity of his loss, but not forever. He lifted himself up and treaded a new path in cassava growing.

Kamara's new found path, however, not a smooth stroll – brown streak disease pulled his strides back when it ravaged the old cassava varieties such as Bukalasa, Kitenge, and Mwakambili, that he was growing, further adding insult to the injury of his loss.

Crestfallen but still hopeful, he went to attend the July 2011 Agricultural Show in Jinja. Little did he know that this would trigger the genesis of a new tide in his farming career.

At the show, his inquisitive search for



answers led him to National Crops Resources Research Institute (NaCRRI) researchers who introduced him to Akena and NASE14 cassava varieties, which he planted in the following seasons.

"A few years of cassava growing and trading, has transformed my income – in months alone this year, I bagged UGX100million gross income from sale of cassava planting materials alone," he boasts.

Having been identified in 2015, by CHAIN Uganda—a non-governmental organization contracted by NARO to multiply and distribute clean planting material, Kamara was trained with other farmers to produce clean cassava planting materials.



With the help of Juliet Nyakaisiki, an extension worker, Kamara started as a basic seed multiplier, having received disease-free foundation stems of NASE 19 that he planted initially on 2.5 acres and later expanded to 8.5 acres.

In 2016, Kamara harvested 150 bags of cassava stems per acre that he sold at UGX 25,000, per bag. "We earned UGX 31.75million gross income in one season," he says as a smile of satisfaction illuminates his face.

Similarly, Ibrahim Kabambwe, a farmer in Mukono district, is eternally grateful to NARO. His relationship with NARO started when Mabira, an Agricultural Officer in Kyampisi sub-county, introduced him to the NARO cassava variety—TME 14, commonly known in the area as *Nankinga.*

Much as this variety succumbed to virus diseases after three years, the misfortune ironically elbowed

> I bagged **UGX100million gross income** from sale of cassava planting materials alone

him into better farming. NARO invited him in 2007 to participate in the Cassava Seed Entrepreneurship (CSE) training, after which he was given NASE 14 and 19 varieties he planted on 8 acres. It is on account of such huge cassava acreage that Ministry of Agriculture Animal Industry and Fisheries (MAAIF) in 2015 inspected and certified Kabambwe as a high-quality basic cassava seed farmer.

His fortunes got even better when Operation Wealth Creation officials upon visiting his gardens, granted him a 5-year contract to supply cassava seeds.

"In the second season of 2016, I supplied 480 bags each at UGX 50, 000, earning UGX24million," he happily states, adding: "In the third season, I harvested 2,352 bags from 10 acres of newer and better varieties for higher stem production. From NAROCAS1, I got 1,020 bags, while from NASE14 and 19, I got 1,332 bags, selling at UGX50, 000 per bag.

I earned over 117million from cassava proceeds."On the other hand, before the Eastern Africa Agricultural Productivity Project (EAAPP) and Cassava Seed Systems (CSS) project from NARO, with their partners like the Agricultural Technology Transfer (AGRITT) and the

> Uganda now hosts the regional **Cassava Research Centre of Excellence** (CRCoE)

African Innovations Institute (AFRII) came into Kigumba sub-county in Kiryandongo district, cassava growers were planting disease-prone and poor-quality types such as Nyaraboke.

"We were suffering and remained subsistence peasants," recalls David Onya, who first received 22 bags of NASE14 stem-seed in May 2016. This served as basic seed for further multiplication. AGRITT on recommendation of AFRII, gave him a contract to produce 1,000 bags of seed that they bought at UGX 40,000 each. "I received UGX 40 million on my bank account. It was utterly unbelievable. I had never dreamt of earning such money from cassava of all crops!" says Onya, beaming with joy.

Energized by this financial windfall, he planted 50 acres of NASE 14, 19 and NAROCAS 1, supplying 3,200 bags to NARO's Buginyanya Zonal Agricultural Research and Development Institute (BUGIZARDI) between March and April 2017. "I sold a bag at UGX50, 000, earning a gross of UGX1 60million," Onya says, narrating that he used the proceeds to expand his planting area to 100 acres of NAROCAS 1.

With the supply of improved cassava varieties by NaCRRI and increased farmer involvement by increasing acreage, cassava, introduced in Uganda by the Arabs in the 1800s, is the second most important staple food crop in Uganda after banana. In the face of increasing drought periods, cassava is a good option since it is drought tolerant.

According to Dr. Anton Bua a NARO senior socio economist, Uganda's cassava production stands at about 8.8 million metric tonnes. "Cassava has attained industrial status in Uganda majorly producing Ngule Beer, industrial ethanol, biscuits and commercial production of potent gin referred to as Lira-Lira in Lango Sub-region of Uganda." Says Dr. Bua

Cassava's commercial viability and food security role would not have been possible had it not been NaCRRI's research-based involvement which has unceasingly improved the crop amid a spate of disabling diseases.



Huge foreign exchange loss caused by cassava diseases

The first major threat to cassava was bacterial blight identified in 1977 by Professor Otim Nape, then a junior scientist at Serere Agricultural Research Station.

"It devastated West Nile, including President Idd Amin's cassava farm," says Otim Nape. Following the directive of the then Chief Agriculture Officer of the Ministry of Agriculture, Otim Nape and his team started the first cassava breeding programme at Serere. They sought assistance from Columbia, Nigeria and Zaire (now Democratic Republic of Congo) that had more advanced cassava research programs.

With support from the Canadian International Development Research Centre (IDRC), the team acquired breeding materials from other countries which he crossed with our landraces to develop blight resistant varieties.



"Bacterial blight went down because of the new varieties that we released," he recalls, adding that IDRC continued to support breeding, agronomy, entomology and pathology cassava research in Uganda. "This was phenomenal in the production of cassava in Uganda" says Dr. Anton Bua, a NARO senior socio economist.

This breakthrough was, however, as short-lived as morning dew. A strange disease that destroyed cassava in the Central, Teso and West-Nile regions, confronted the scientists in 1987. It was identified to be Cassava Mosaic Disease (CMD). The most visible signs of this viral disease include; leaf mottling and stunted growth.

All affected cassava uprooted

As a frantic intervention, researchers advised farmers to uproot all CMD affected cassava and replace it with the Ebwanateraka variety clean materials mobilized mainly from Busoga, temporarily restoring food supply to about 20% amid the crisis with the virus spreading at a speed of 25 km per year. There was need for a more sustainable solution. Thus with support from the United States Agency for International Development (USAID), the agriculture ministry in 1989 launched a cassava mosaic disease (CMD) eradication program.

All the infected cassava was burnt and the researchers ferried 650 metric tons of clean cassava stems to Nakasongola and Nakaseke sub-county farmers to plant. At first, the varieties were resistant for a few weeks, but succumbed to the disease. White flies were all over the fields. "I almost died of shock," says Otim Nape.

Albeit the setback, the scientists did not throw in the towel. With the support of the International Institute of Tropical Agriculture (IITA), Uganda acquired breeding materials and set up the first nursery of 300,000 plants to select for

resistance. As a result, cassava mosaic disease tolerant varieties such as NASE 1, NASE 2 and NASE 3, were released in 1993. Urgently, Otim Nape's team started a network of extension workers, farmers and civic leaders to disseminate the resistant varieties, thwarting the disease effectively by 2002.

"An impact study conducted in 1996 revealed that over 70% of the farmers growing cassava were growing the improved varieties. Therefore, the USD2.5 million invested in research throughout this time finally resulted in increased cassava production worth USD 40 million," says Dr. Bua Anton, a NARO socio-economist.

Participatory research approach

Starting in 1996, a farmers' participatory research strategy was used to select preferred varieties. With this approach, the breeding program released NASE 4, 5, 6, 7, 8 and NASE 9 by 1999. These were equally well adopted and a study conducted in 2000 revealed an adoption rate of 80% and the net present value increased to USD 131 million.

According to Dr. Robert Kawuki—a cassava breeder of NARO— the National Root Crops Program has so far released 21 cassava varieties and several appropriate management technologies. The latest of these are NAROCAS1 and 2 which are resistant to CMD and more tolerant to cassava brown streak disease (CBSD).

Success attracts World Bank and other partners' funding

The success scored by NARO researchers attracted more funding for research from the World Bank, in addition to funding from the government of Uganda and other development partners with the cassava research capacity base standing at over USD 50million.

The National Root Crops Program has evolved in terms of both infrastructural and human capacity, boasting over ten regionally and internationally recognized senior scientists in cassava research and development.

With the current existence of state-of-the-art tissue culture, high-tech molecular, bioanalytical, conservation and biosafety facilities, the team is now focusing on consolidating capacity in using high-tech science, including modern biotechnology, to locally hasten research on CBSD resistant varieties.

Uganda now hosts the regional Cassava Research Centre of Excellence (CRCoE), serving East Africa, Ethiopia and South Sudan, and has also received international recognition. For example, it was acknowledged with the Queen's Royal Anniversary Award from the University of Greenwich and acknowledged by Bill and Melinda Gates Foundation for implementing successful projects.

> **Cassava has attained industrial status** in Uganda majorly producing Ngule Beer, industrial ethanol, biscuits and commercial production of potent gin referred to as Lira-Lira in Lango Sub-region of Uganda

NARO SAVES THE COFFEE INDUSTRY











THE NEED FOR WILT-RESISTANT VARIETIES WAS CRITICAL FOR THE SURVIVAL OF THE COFFEE INDUSTRY

By Peter Wamboga, Owen Singura, Barbara M. Zawedde and Barbara Nambozo
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Uganda is Africa's number one coffee exporter and second producer after Ethiopia. According to the Uganda Coffee Development Authority (UCDA), Uganda's coffee export earnings are estimated at 4.2 million 60kg bags, most of it going to Europe. Coffee is the third most important national income earner after tourism and foreign funding. Over 80% of the coffee produced in Uganda is Robusta, a variety that is most grown in the low land areas.

Robusta coffee under attack

In 1993, a new coffee disease was reported in Mukono district, Central Uganda. The Coffee Wilt Disease (CWD) threw many farmers in panic because all the Robusta varieties were succumbing to the strange disease. According to UCDA annual reports, the disease led to coffee export reduction from 4.2 million 60kg bags of green beans in 1996/97 to 2 million bags in 2005/06. This translated into annual loss of between USD 80-270 million.



The need for wilt-resistant varieties was critical for the survival of the coffee industry, and to sustain the livelihoods of 1.7 million Ugandans who directly depend on the coffee sub-sector. In 1997 scientists at the Kituza-based NARO institute, Coffee Research Centre (COREC) initiated a breeding programme to develop CWD-resistant Robusta coffee varieties of acceptable farm and market traits.

Research to combat coffee wilt disease

Researchers started with understanding the disease spread and effects countrywide through intensive surveys. The findings were crucial for stakeholders' sensitization and developing control strategies. NARO developed a CWD management package that emphasized cultural methods, including uprooting and burning infected coffee trees, limiting movement of infested plant materials, and sterilizing farm tools by flaming after working on an infected plant. A network of Government agencies, NGO's and farmer organizations joined NARO in the nation-wide sensitization drive.

In 2009, COREC (now NaCORI) released seven CWD-resistant varieties named; Kituza Robusta 1 to 7 (KR1-KR7). The Uganda Coffee Development Authority (UCDA), NARO, private sector and development partners embarked on multiplication and distribution of the CWD-resistant clones countrywide. Through these collaborations, over 2 million CWD-resistant seedlings were distributed countrywide starting with the most severely affected districts. There was a sigh of relief.

NARO with partners trained certified coffee nursery operators on how to

> **Over 80% of the coffee produced in Uganda is Robusta,** a variety that is most grown in the low land areas

multiply clean clones. The varieties have since proved effective and are now a favorite for over 90% of Robusta famers in Uganda and across borders. Currently, NaCORI supplies about 50,000 CWD-resistant cuttings annually to the Uganda Coffee Development Authority (UCDA) to avail farmers and the Operation Wealth Creation (OWC) programme. It has also provided starter materials to over 150 nursery operators in more than 40 Robusta coffee-growing districts.

In July 2017, NaCORI released three (3) more CWD-resistant varieties; NARO KR8, NARO KR9 and NARO KR10, to cater for the diverse ecological concerns in coffee-growing areas in the country. These varieties produce better yields — average yield of 3,719kg of hulled coffee beans per hectare per annum. They are resistant to CWD, leaf rust and red blister diseases. They have desired sensory tastes and relatively large bean sizes. With funding from UCDA, the institute built a modern bio-technology laboratory to enhance production of quality and clean planting materials from about 100,000 to one million seedlings annually using tissue culture tools.

NUCAFE benefits from NARO's coffee interventions

NAKASEKE, Central Uganda—Nkandu, a farmer in Semuto village, Nakaseke district, Central Uganda is one of those who have prospered because of NARO's coffee interventions. He narrates how he received the CWD resistant seedlings free of charge from NARO in 2010, with help of NARO scientists—Dr. Pascal Musoli, Dr. Africano Kangire and Dr. Godfrey Kagezi. Planting these varieties greatly reduced the cost of production, which was crucial for his farm's success. As a leader of the National Union of Coffee Agribusinesses and Farm Enterprises (NUCAFE), Nkandu encourages many farmers to work closely with NARO. "You're able to see the benefits of working with research because you get true-to-type planting materials" he says.

NUCAFE, a national coffee farmers' organization, was founded in 2003 as a successor of the Uganda Coffee Farmer's Association (UCFA). By numbers, it is made up of 198 member farmer organisations, associations and co-operatives representing over 200,000 farming households, having over one million individual smallholder farmers in the 5 coffee-growing regions in Uganda.
Nkandu and NUCAFE have taken an extra mile in the coffee value-chain by empowering rural small-scale farmers to sell graded coffee. "When the farmer sells graded coffee; their income per kilogramme increases by 250 percent," he notes. "There is no money in selling coffee at farm gate prices," reaffirms Nkandu. "Keeping the quality is keeping the market" he emphasizes.

From the seedling to cup……

NUCAFE facilitates higher outputs for members by getting engaged in coffee value-addition. Coffee prices increase towards the end of the value-chain. That is why NUCAFE established a modern coffee processing plant in Namanve-Mukono district. This was achieved with additional funding from partners such as Agricultural Business Initiative (aBi)

There is no money in selling coffee at farm gate prices. **Keeping the quality is keeping the market**



trust. NUCAFE processes the coffee for the farmers; it produces and packages its own coffee. It links farmers to both local and international markets, and also runs a café under brand name, omukago.

Challenges

Drought was a very problem until he started irrigating. As a leader, Nkandu expressed concerns of other farmers who wish to grow CWD resistant varieties but cannot access them. Nkandu believes that, the new biotechnology laboratory will be of great help to farmers who need CWD resistant coffee. "NUCAFE is ready to work with NaCORI to multiply and distribute the new varieties" he said.

Tribute to NARO

He commends NARO for the work well done. "We as coffee farmers are happy that NaCORI is doing all it takes to ensure that it responds to what coffee farmers need" says Nkandu.

Coffee is my retirement plan, income and health-insurance

BUWAMA, Central Uganda—Mzee Ntambi Muligie is a dedicated coffee-farmer in Jjalamba Parish, Buwama sub-county in Mpigi District."I have survived because of coffee_since I was a child and I am now over 70 years old. Coffee is a source of school fees for my children, health-insurance and family income,"he says. "For 30 years now, I've been growing and selling coffee and I've witnessed things change. Coffee quality, quantity, access and types [varieties] have tremendously improved through continuous research guided by the Government via the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)," says Muligi.

More importantly, he adds, it is NARO's National Coffee Research Institute (NaCORI) in partnership with Uganda Coffee Development Authority (UCDA) through research, promotion and farmer education that has greatly changed the coffee industry. Muligi has seen coffee quantities rise to meet the ever-rising demands of international market and is optimistic that Uganda will be able to supply over 20 million 60Kg bags, as target Uganda Government, by 2020.

Miligi has 68 acres of coffee—15 are plantations with an old mother-garden of 300 plants each. "I operate mother-gardens



and nurseries, which to multiply and distribute better-yielding clones of coffee with bigger berries. I produce annually 4,000-5,000 plantlet, which I sell at Shs 2,000 each (amounting to UGX 8-10million per season). I thank NARO for the seven (7) coffee wilt-resistant lines that are providing to farmers to get higher outputs," says a proud Muligi.

Achievements

From the coffee incomes, Muligi has educated all his children— up to university level. "At one time I was able to spend up to 6,000 Pounds Sterling (about UGX40m/=) a semester for my son, for further studies in accountancy in the U.K." he says "I don't play with coffee. Whatever I desire or need, I acquire thanks to coffee incomes," Ntambi bragged. For the community, Muligi provides higher-quality, cloned coffee-seedlings from his nurseries and employs workers, especially youth, each earning UGX 10,000 a day. Looking ahead he says he is investing into coffee processing as a response to Government's calls for value-addition. "I'll start processing my own coffee into finished high-quality, tasty cup of coffee that will be officially approved by UCDA" Muligi says.

Challenges

CWD-resistant varieties are expensive for some coffee farmers. Coffee is a heavy-feeder, requiring more fertilizers, hence they require intensive replenishment of soil fertility.

Recommendation

NARO and UCDA should train more nursery operators, promote the culture of drinking coffee among Ugandans, so that we do not only produce for export markets. Those farmers who cannot export, should have a home-grown market like that enjoyed by sorghum and cassava farmers through beer consumption.

AILING GROUNDNUTS INDUSTRY REVAMPED BY NARO RESEARCH

By Umar Kyeyune, Joshua R. Muhumuza and David Okello Kalule*
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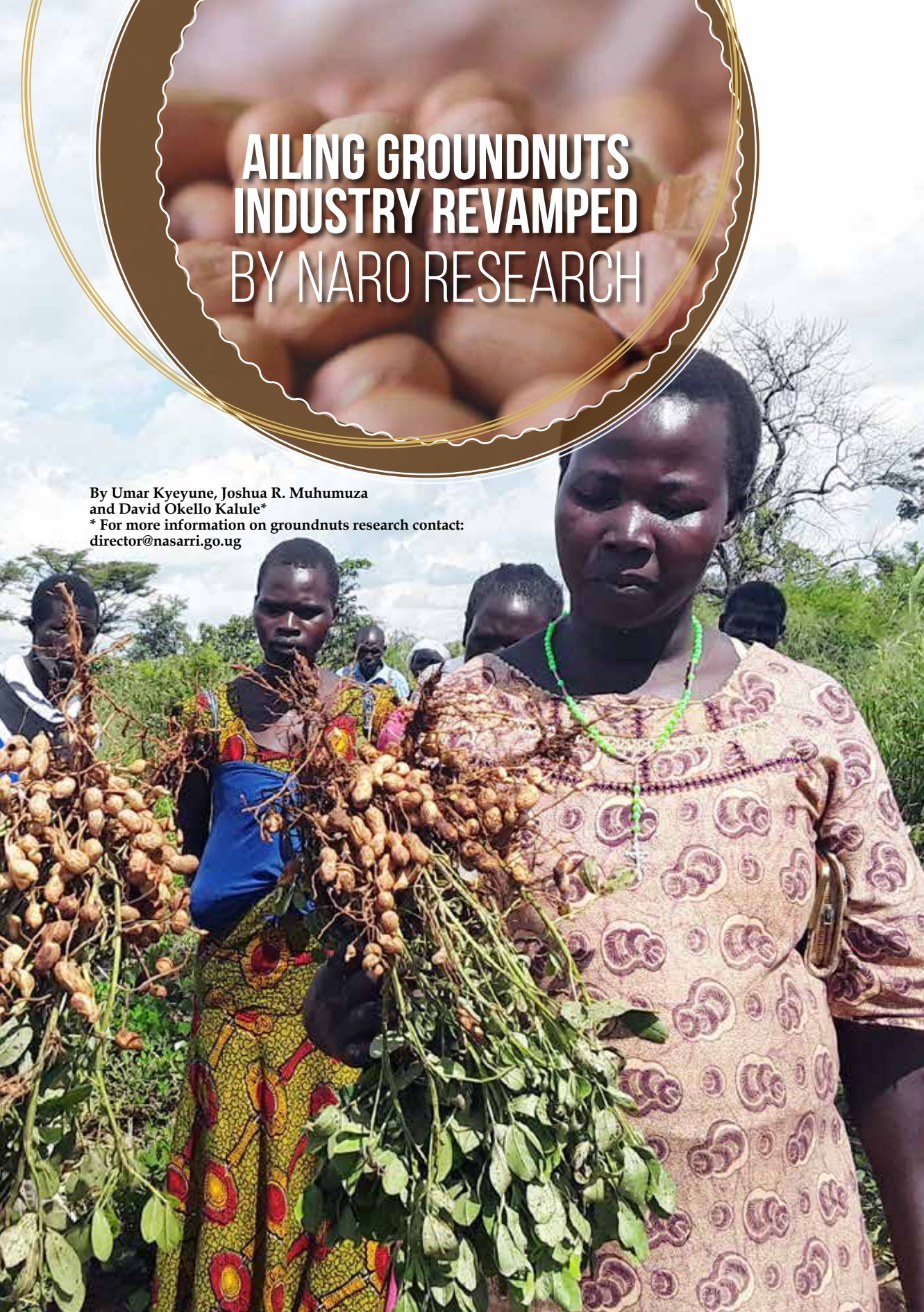

Groundnut was introduced around 1862 by early Portuguese traders and travelers. Its adoption in Uganda was initially slow owing to scanty knowledge on its production and utilization. Today, groundnut is a very popular crop, especially in the Eastern and Northern regions of the country. Now cultivated on 6.01 of the country's total arable land, groundnut/peanut is presently the second most important legume after beans.

Numerous factors mainly pests, diseases and drought threatened groundnut productivity in the country. This prompted NARO's intervention through National Semi-Arid Resources Research Institute (NaSARRI) Serere Groundnut Improvement project. Over the years, several better adapted, pest, disease and drought resilient high yielding groundnut varieties have been released.

Groundnuts research in Uganda

Research started at Serere in 1930 with the collection and introductions of landraces followed by agronomic studies. The most popular variety then was known by various local names like Itesot and Amasoga, and it is still grown to date.

In 1980s groundnut research was shifted from Serere, to the National Crop Resources Research Institute (NaCRRI), Namulonge. This followed the insurgences experienced in Serere in the late 70s and early 80s. Serenut 1R, 2, 3R and Serenut 4T were consequently released to address pressing productivity demands. The main source of introduced breeding materials for testing and evaluation has been ICRISAT India.

While there was a steady recovery of groundnut production throughout the 1980s, production in 1991 was just over 60% of the highest peak recorded in 1972. The average national yield of 0.8 t/ha of dried pods was significantly lower than 3 t/ha in other growing countries.



> Over the years, several better adapted, pest, disease and **drought resilient high yielding groundnut varieties have been released**



Current Research at a Glance

Presently, groundnut research is back in NaSARRI. The focus is on developing varieties with high yielding potential, high quality, resistance to major pests and diseases, short to medium term maturity periods and tolerance to drought, together with improved production packages.

Yields per hectare are still low, due to a combination of factors; unreliable rains, drought, traditional small-scale farming with minimal mechanization, low input use, pest and disease outbreaks, use of low-yielding seed varieties and increased and/or continued cultivation on marginal land. Political instability and the often-unsupportive oilseed policies have also played their role in curtailing groundnut productivity. Major diseases in Uganda include rosette, early and late leaf spot, rusts and aflatoxins. Important pests include aphids (vectors of groundnut rosette disease), leaf miners, thrips and termites. Such pests and diseases significantly reduce yield and quality while increasing the cost of production countrywide.

It is noteworthy that Uganda is home to three globally known groundnut rosette disease hotspots; Serere, Nakabango (Jinja) and Iki-Iki (Pallisa). These hotpots have become a regional hub for testing advanced varieties for rosette resistance for Sub-Saharan Africa.

Since 1930s, a total of 24 varieties have been released by research. As part of its intervention to revive the ailing groundnut industry, NARO released 14 commercial groundnut varieties (Serenut 1-14) between 1998 and 2011. Owing to the desirable traits in NARO's released varieties, 60% of groundnuts cultivated in the country today are improved varieties. About 6.01% of the national total arable land is under groundnuts being grown by 1,024,691 resource poor farmers. The adoption rate of improved varieties is over 60%.

Several of NARO's varieties including Serenut 5R, 6T, 9T, 8R, 11T, 14Rare grown and traded in South Sudan, Kenya, Rwanda and other neighboring countries. This trade in groundnuts has boosted livelihoods and contributed to foreign exchange for the country. Yield, agronomy, Integrated Pest Management (IPM) and soil health studies have complemented productivity of NARO's varieties in the groundnuts subsector. Management and wide adoption of groundnut rosette resistant varieties is expected to fetch USD 440 million in sales revenue from raw (non-value added) product.

NARO has also facilitated research capacity internationally by sharing their released and pre-release materials with research centers in countries such as Ethiopia, Malawi, Mozambique, Ghana, Mali, Haiti and the USA among others. NaSARRI is now considered a Center of Excellence for groundnut research on the continent.

Future plans for groundnut research in Uganda

Dr. Kalule Okello, a senior groundnut breeder at NaSARRI Serere recommends that future research should address other pertinent issues including solutions for leaf miners, drought, use of advanced breeding technologies like marker assisted selection and biotechnology all these interventions must be adapted in a diverse and changing climate. Further, he advises consideration of alternative seed systems such as community seed banks, soil health and plant density studies, routine value chain studies, variety nutrition profiling, value addition and sustainable crop genetic conservation studies.



> **Research should address other pertinent issues** including solutions for leaf miners, drought, use of advanced breeding technologies like marker assisted selection and biotechnology











FARMING AS A BUSINESS
BIRTHS UNLIMITED PROFITS FOR MAIZE FARMERS

By Owen Singura, Peter Wamboga, Barbara M. Zawedde and Godfrey Asea*
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Commercialization of maize led to **demand for higher yielding, disease resistant and quick maturing maize**

In most schools, families and Uganda's prisons, posho, a product of maize, is widely eaten, not only for its starch nutrients, but certainly due to its affordability in terms of production and purchase price. It has often been humorously labeled the poor man's bread.

The Uganda Prisons Service (UPS) is one of the biggest maize consumer in Uganda. This is a result of the huge consumption demand created by the ever increasing number of inmates received by the institution every day. To meet its mammoth food demand, UPS has grown to become one of the most efficient farming government owned institution.

According to Amos Turyashaba—the officer in-charge of Rwimi Prisons farm—prisons' farms are one of the highest producers of maize in western Uganda. The three major prisons farms are Rwimi, Ibuga and Mubuku Government Prisons farms.

The secret behind the high production on these farms is the successful collaboration between UPS and the National Agriculture Research Organisation (NARO) with the latter providing technical advice and technologies.

For example, Rwimi, which is 300km west of Kampala in Bunyangabu district and employs over 1000 people directly and indirectly, grows a number of crops. But, according to Amos Turyashaba-the officer in-charge, its flagship crop is maize.

For six years (2010-2016), Turyashaba reports, the farm grew the Longe 6H maize variety mainly to feed prisoners, wardens and their families. "Currently, the farm has 9000Kgs, which can feed the entire prisons community for a month. This is good food security," he commends.

He recounts that NARO has been supportive to the farm through provision of various services. "The NARO engineering team from Namalere has on several occasions trained our staff on machinery handling and maintenance.," Turyashaba states.

This, he reasons, has greatly improved efficiency and reduced machinery breakdowns, revealing that NARO also provided knowledge



on building and maintaining proper storage facilities for both seed and grain. This knowledge, optimistically asserts Turyashaba, will cure the burden of post harvest handling losses which have affected not only the prisons farms but other farmers in the country.

Multiple beneficiaries smiling

NARO's involvement has not only benefited inmates but also prison staff and their families. By adopting maize production as a business, they have raked money to educate their children, dress them better, feed better and provide other essential needs such construction of family houses.

"The inmates leave the prison with modern farming knowledge and many resort to farming as a source of income," says Turyashaba.

> Since 2002, the farmers have mastered hybrid maize seed multiplication, **multiplying various NARO varieties**

Hybrid seed multiplication to commence

Following the advice of President Yoweri Museveni in 2016, Rwimi Farm planned to engage in hybrid maize seed multiplication and do further research on a superior NARO maize variety, the UH5051. The farm expected to supply other farms with high-quality hybrid seed as a way to generate more revenue and impact more lives.



About 20 Km from Rwimi is Mubuku prison. It grows 250 acres of Longe 5 maize which is commonly known as Nalongo. Longe 5 is an open pollinated variety (not hybrid), but relatively high yielding (about 4-6 tonnes per hectare) because it tends to produce two cobs per plant.



"After acquiring Longe 5, our yields were boosted and production improved,"

Nalongo is also relatively drought tolerant compared to other open pollinated varieties. It contains higher levels of Lysine and Tryptophan, some of the most essential amino acids/proteins. These attributes make it an ideal variety to feed inmates and staff with more nutritious meals. The fact that Nalongo is an open pollinated variety means that its seed can be saved and replanted by farmers more times than hybrid seed, benefitting farmers in the long run as Godfrey Kumakech, the prison officer-in-charge testifies.

"We used to have challenges of buying maize grain to feed inmates, prison staff and their families. After acquiring Longe 5, our yields were boosted and production improved," he affirms, emphasizing that the general welfare of prisons warders and inmates has subsequently greatly improved. Since 2002, the farmers have mastered hybrid maize seed multiplication, multiplying various NARO varieties

Besides the prison services, other maize growing players such as Basaija Kweyamba, which started as a cooperative, and is now a registered limited company comprising 160 farmers in Kasese district, have drank from NARO's chalice of



dedicated professional service.

Since 2002, the farmers have mastered hybrid maize seed multiplication, multiplying various NARO varieties. They are currently growing Longe 10H and FH 5160, which were bred by the cereals programme at the National Crop Resources Research Institute (NaCRRI), on 850 acres.

With such a wealth of knowledge, the cooperative, which employees over 500 casual labourers, produces 250,000 metric tons of maize per season. Of this, only 200,000 metric tons is seed-grade. The rejected maize is milled into high quality flour and animal feed. After grading, seed companies pay the cooperative, which later pays the farmers, explains Frank Twinamasiko, the former chairperson of the cooperative. He says farmers are realizing high financial gains because they have considered farming a business that needs serious dedication. "With that in mind, farmers do not do any other business apart from farming. Agriculture is their sole source of income," Twinamasiko explains.

Virus and drought-resistant Varieties

The farmers on the other hand have benefitted from Longe 10H and other Longe series, which derive their names from Namulonge research institute, where they were bred and released in 2009, and FH 5160 released in 2012, because they are drought tolerant, resistant to maize streak virus (MSV), Northern leaf blight (NLB) and Grey Leaf Spot (GLS).

That Longe 10H yields more compared to open pollinated varieties, according to Sibomaana Vienne, a NASECO company extension worker, necessitated investment in it. A farmer can harvest between 2 and 2.5 tonnes of seed grade maize per acre per season. This translates into UGX 3,400,000 to 4,250,000 when a farmer sells at an average price of UGX 1,700 per Kilogram.

Hybrid maize at a glance

Considering its economic potential and wide consumption, hybrid maize is one of the commodity crops that the Government of Uganda has encouraged farmers to grow for reliable income generation.

Since the release of hybrid maize, explains Dr. Godfrey Asea, a maize breeder and current director of NaCRRI, production has soared from a few a thousand tons to the current 4 million tons annually. He links this sharp leap to the existing positive partnerships between the researchers and the private sector. While the breeders put much emphasis on developing the foundation seed, Dr. Asea notes, the private sector, mainly the seed companies, are in charge of seed-multiplication and distribution. "And most important, is the strong maize value-chain that is providing opportunities at the different stages," he adds.

Unwinding the clock of history

Peering back at the clock of history not only presents the tough journey that Maize researchers have trudged, but that the crop was introduced in Uganda in 1861, and by 1900, it was already fully established in the country. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) ranks maize among the top three crops cultivated in Uganda in terms of area planted and volume produced in addition to bananas (matooke) and cassava.

Before 1961, when White Star was released from Kawanda Research Station, Uganda largely depended on imported seed from South Africa, Kenya and Tanzania. It was followed by release of Western Queen in the same year and then Kawanda Composite A in 1971. There was no new variety released until 1991. The lag was caused by political instability as well as lack of research expertise, funding, and breeding material.

Maize research and agricultural research in general were revamped in 1984 by United States Agency for International Development (USAID) funding for capacity development under the Manpower for Agriculture Development project.

The International Maize and Wheat Improvement Centre (CIMMYT) and International Institute of Tropical Agriculture (IITA) provided breeding materials and invaluable technical support to Ugandan researchers during this period. For example, Kawanda composite A variety was taken to IITA in Nigeria to improve its resistance against maize streak virus (MSV) disease. The result of this effort was the release of Longe (short for Namulonge) 1 in 1991. Commercialization of maize led to demand for higher yielding, disease resistant and quick maturing maize.

This high demand understandably nudged NARO maize researchers at the then Namulonge Agriculture and Animal Research Institute (NAARI) therefore, to hasten research for hybrid maize, says Dr. Asea, consequently producing Longe 2H, the first hybrid. It had a yield of between 6 and 8 tons per hectare, was resistant to Maize streak virus (MSV), Northern leaf blight (NLB), Grey Leaf Spot (GLS) and tolerant to storage pests. "NARO did not halt research on OPVs. Research for both hybrid and OPVs is still being conducted concurrently, to give farmers more options to choose from," he explains.

Dr. Asea, however, cautions farmers against re-planting hybrid maize seeds because their potential yield will keep reducing with subsequent planting, but he encourages replanting OPVs up to 5 times although they are not high yielders. Since its inception in 1992, NARO has released over 50 maize varieties, including hybrid varieties, not to mention hundreds of field and post-harvest management technologies.

NARO BOOSTS AGRICULTURAL MECHANIZATION

Although it has been neglected especially developing countries, mechanization is a crucial input for agricultural crop production. Factors that are well known to reduce the availability of farm power compromise the ability to cultivate sufficient land. Increasing the power supply to agriculture translates to more tasks being completed at the right time, leading large areas farmed to produce equally large quantities of crops while conserving natural resources. In this regard, applying new technologies that are environmentally friendly enables farmers to produce crops more efficiently by using less power (FAO).

In the same spirit, NARO has over the years made its contribution through a number of interventions to bridge the felt gap especially through developing technologies which lessen the labor burden on the farm along the value chain. The technologies are commodity specific as profiled below.

The lightweight Rice Thresher: was birthed as a result of huge post-harvest grain losses, aflatoxin contamination of rice, lack of appropriate rice thresher in communities, long duration of heaping rice without threshing and the urgent need to relieve women from drudgery. Although designs were ready by 2013, it was only released to farmers for use in 2014 after testing its prototypes Rice growing areas of Doho and Otek-okile rice irrigation scheme leading to more agronomic and economic evaluation for the machine.

Funded by Global Affairs Canada (GAC) through AfricaRice, the NARO lightweight Rice Sheller draws its name from its unique attributes. According to Eng. Candia Alphonse, the thresher is very light (138kg) compared to similar previous threshers which weigh between 300 - 1,000kgs, mobility is easy and also gender sensitive since it is user-friendly for both women and youth. The technology beneficiary target is justified by the fact that women play an important role in many farming based communities, and in some countries, up to 80 percent of the total farm labour comes from women. This implies that power sources (human, animal or motor-based) need to be adapted to such necessities from an ergonomic, social, cultural and economic point of view, (FAO).

The reduction of drudgery is a key element of sustainable mechanization and contributes to reducing women's hard workload by taking into consideration technologies apt to their needs and improving their access to appropriate forms of farm power. Since its launch, the thresher had benefited over five hundred farmers (500) in rice growing districts including Lira, Butaleja, and Amuru.

Having this machine in place has not only led to creation of employment and increased income to communities but has also reduced grain loss from 4.78% to 0.1%

By Victoria Mbigidde, Eng. Alphonse Chandia, Eng. Florence Kiyimba *
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translating to more income and food. In the event that the thresher will be used by all rice farmers, the country will be able to save USD 5.92 million (17,760 tons of paddy) annually. Those farmers who hire their threshers out to others at a fee earn additional USD 540 – 1,505 (1.890 - 5.267 million shillings) per year. Similarly the youth that they employ earn additional USD 170 – 200 (595,000 – 700,000) per month.

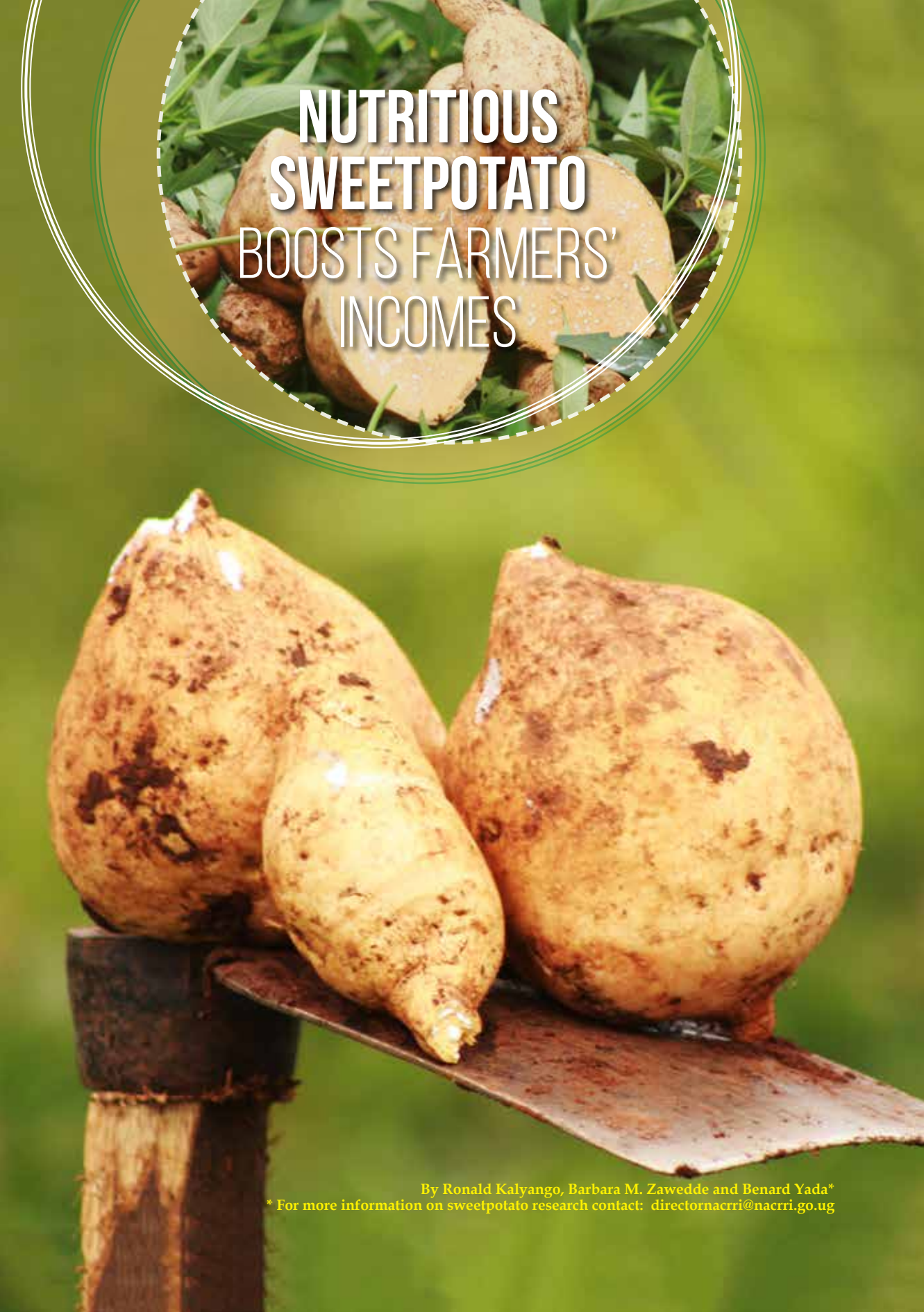
Treadle water pump

The AEATREC Treadle water pump was first introduced to communities in 2006. This initiative was spearheaded by NARO while responding to difficulty in accessing water by small scale vegetable growers and farmers in the dry cattle corridor. With a sample sourced from Food and Agriculture Organisation (FAO), evaluations were conducted; modifications were carried out and customized to fit the local environment and farmers.

The pump has several unique features tailored to serve the intended purpose. Although it is a manual, it requires minimum maintenance and it is made from locally available materials (scrap materials of vehicles).

The technology registered success in Kiruhura and Mbarara districts where over 200 farmers benefited. Soroti, Busoga, Burundi and South Sudan equally benefited from this initiative.

Other NARO generated machinery: both motorised and hand cranked maize shellers in addition to a manual forage chopper.



NUTRITIOUS SWEETPOTATO BOOSTS FARMERS' INCOMES

By Ronald Kalyango, Barbara M. Zawedde and Benard Yada*
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Total blindness or visual impairment is one of the health-related conditions afflicting Ugandans. This condition, to a certain extent, is attributed to vitamin A deficiency (VAD) in the body.

Worryingly, VAD, states the Uganda Nutrition Action Plan (2011-2016), affects one out of every five children and women of reproductive age, resulting in reduced body immunity and severe cases of blindness and can result in death. The World Health Organization (WHO) now classifies Uganda as having a moderate public health problem with VAD. To stem the deficiency, the body must be fed on nutrient-rich foods such as OFSP. Notably, Uganda, Nigeria and Tanzania are some of the biggest sweetpotato producers in Africa.

Farmers harvesting money

Cognizant of the need to fight malnutrition and the centrality of the sweetpotato in vitamin A provision, the National Agricultural Research Organisation (NARO) scientists developed the OFSP varieties, which have high amounts of beta-carotenoids (pro-vitamin A).

Dr. Benard Yada, a NARO sweetpotato breeder based at the National Crops Resources Research Institute (NaCRRI), Namulonge, explains that sweetpotato's resilience to climate change effects such as drought has made it a priority food security crop. This is evidenced by the increasing per capita consumption of 85 kg, ranking third after banana (Matooke) and cassava.

To facilitate wider dissemination and adoption of the crop, NARO partnered with the National Agricultural Advisory Services (NAADS), the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Food and Agriculture Organization (FAO), HarvestPlus, Makerere University, BioCrops Ltd and the International Potato Center (CIP).



Orange-fleshed sweetpotato (OFSP) is very nutritious (high pro-vitaminA) and helps reduce child blindness

Following the partnership, a substantial number of farmers has been trained and supported to become suppliers of clean planting material, minting not only money from seed multiplication, but improving livelihoods in rural households.



"The crop has also transformed from being just food to non-culinary purposes like production of industrial starch and animal feeds," says Dr. Yada, emphasizing: "This makes it an important source of income."
For example, having been among the first farmers identified for spearheading the cultivation of OFSP, Vincent Lwanyaga, a resident of Kikoota-Nnindye village in Nkozi sub-county, Mpigi district, has become an evangelist for the OFSP. Through training fellow farmers, he has helped HarvestPlus and NARO to promote high production of OFSP varieties in Mpigi and beyond.

"For the last five years, I have sang about the OFSP; how it is good, how it is fed to children, and showing recipes so that they use them correctly," says Lwanyaga. The multiplier effect and benefits of Lwanyaga's and other farmers' efforts are evident in the roadside markets and other rural markets, where piles of OFSP are brought for sale. "This sweetpotato is healthier," one of the sellers, Winnie Nalumansi, avers, explaining: "It has more vitamins. These are the sweetpotatoes that people want to eat, now. That's why I grow and sell them. They're more profitable."

About 200 farmers in Mpigi district now grow OFSP varieties, Lwanyaga says, and with proper agricultural practices, Lwanyaga's OFSP vine harvests have shot up to over 5,000 bags per season.

With a bag sold at UGX 10,000, he earns a gross of at least UGX 50 million per season just from vine sales. From the profits, Lwanyaga has constructed a new permanent house and has ably paid school fees and met other needs for his children and dependents.



Innovative and hardworking as he is, Lwanyaga has invested part of his profits into animal feed production with sweetpotato materials as part of the ingredients. Further, taking advantage of his close association with NARO scientists, he has relied on their advice to venture into fish farming. Just like Lwangaya, 49-year-old John Tebandeke equally extols OFSP, which he has grown since 2014. "What we like about this OFSP is that when we eat it, we do not fall sick often. We stay healthy, even our skin looks good," he affirms.

Tebandeke, who is a resident of Buyiisa village in Kirumba sub-county, Rakai district, acquired the skills of rapidly multiplying sweetpotato vines after his farmer's group, Balikyewunya, joined CEDO. CEDO is a non-government organization that partnered with NARO to train farmers in good agronomic practices in Rakai district and surrounding areas.

He initially received 30 bags of vines, which he planted on two acres, harvesting 900 bags, which he sold back to the organization at UGX 14,500 per bag. Since 2014, the partnership has continued to blossom and today he ably produces up to 1,500 bags of vine cuttings in a season.

Looking at mature sweetpotato roots, between UGX 50,000 and UGX 100,000 per bag, flows into Tebandeke's pocket, depending on the quantities and time of sale. Driven by the desire for improved production, and subsequently, more income inflows, Tebandeke has invested his profits in building a screen house, enabling him to boost production of clean vines per unit area. In the same measure, a women's farmer's group in Kikandwa village, Nakaseke district, says their households' livelihoods have improved through consumption and sale of OFSP. They attribute their change of fortune to the support from NARO's Mukono Zonal Agricultural Research and Development Institute (MuZARDI).

The farmers, have not only gained knowledge on growing OFSP but also gained from NARO given knowledge on producing other crops like maize, beans and cassava.

Low market prices a hiccup

Despite the good harvests associated with the NARO intervention, all has not been rosy especially in respect of prices and market availability. "We want to sell the vines, but farmers within our proximity offer low prices. We want to grow the crop thrice a year, but the prices derail our efforts," reveals Rose Nansamba, a farmer in Nakaseke.

As a solution, the farmers believe they can harvest more money with better prices if the government, NARO and its partners identify and enable them access other buyers. Additionally, it is their request that they are supported to start up medium to large scale processing units for their OFSP roots. This, they assert will enable them to absorb the bumper harvests at the end of the season and minimize the unacceptable post harvest losses incurred. Observably, with such commendable farmer involvement and attendant income-related benefits, despite the challenges, OFSP production has increased annually, and it is projected that over 237,000 households will plant it in 2018. However, a lot more needs to be done considering that even with the 2018 production estimation, Uganda will still be operating below its production potential. For example, the country is said to be producing 1,863,000 metric tons annually, with an average harvest of 4.2 tons, against a production potential of about 25-30 tons per hectare.

> "Between **UGX 50,000 and UGX 100,000** per bag, flows into Tebandeke's pocket, depending on the quantities and time of sale

Tracing sweetpotato research in Uganda

Initially, earlier sweetpotato research in Uganda was entirely about agronomic performance and adaptability of materials introduced in the country from the International Potato Center (CIP) and local collections.

Uganda had less specialized capacity for sweetpotato research according to Dr. Yada. It should be noted that serious breeding of sweetpotato varieties began in 1992 when NARO was established. Its first research conducted was in response to the sweet potato virus disease (SPVD) and weevil challenges.

In 1995, after three years of unwavering hardwork, NARO scientists led by Dr. Robert Mwanga released and widely promoted varieties including Wagabolige, Tanzania, Bwanjule, Sowola, New Kawogo and Tororo 3. These varieties were believed to have had moderate resistance to SPVD. Not satisfied yet, the scientists released six new Namulonge sweetpotato varieties (NASPOT 1 to NASPOT 6) in 1999, five (NASPOT 7 t10 and Dimbuka-Bukulula) in 2007, one (NASPOT 11) in 2010, and in 2013, two OFSP varieties (NASPOT 12 O and NAPOT 13 O) were released. Recently, five new sweetpotato varieties (NAROSPOT 1 to 5) were released in 2018.

Presently grown by more than 80% of Ugandan rural farmers, sweetpotato is a staple food for most regions in the country, but the white-fleshed varieties were the more commonly consumed. Due to the persistent incidences of VAD, especially among children and pregnant women, the Uganda Government prioritized bio-fortification as a sustainable strategy for

> “It is projected that over **237,000 households will plant it** (Orange Freshed Sweetpotato) in 2018



combating ‘hidden’ hunger. Dr. Yada explains that as a mitigation measure, the Ministry of Health first opted for the distribution of Vitamin A capsules. However, with the challenge of insufficient supplies of the capsules, the need for distribution of Vitamin A bio fortified food came in handy.

“Artificially fortified foods are not affordable by the majority of Ugandans especially in the rural areas, who depend on starchy foods,” explains Dr. Yada. Breeding for vitamin A rich sweetpotato was, therefore, prioritized because the crop was already a staple in most parts of Uganda and the breeding materials were available.

In collaboration with CIP, funding from Uganda Government and other development partners, NARO has since promoted and/or released nine OFSP varieties. These include Ejumula, Kakamega (SPK 004), NASPOT 5, NASPOT 7, NASPOT 8, NASPOT 9 O (Vita), NASPOT 10 O (Kabode), NASPOT 12 O (Gerald) and NASPOT 13O (Joweria).

Scientists not resting on their laurels

One would have expected NARO scientists to rest on their laurels and bask in satisfaction in respect of the sweetpotato research successes so far garnered. The scientists, however, according to Dr. Yada, are currently bent on ensuring that customers’ demands are met by, for example, prioritizing improvement of the taste and increasing the dry matter content in OFSP for table stock and processing into various value added products.

Developing modern genomic, genetic, and bioinformatics tools to speed up crop improvement, developing and testing advanced pest and disease management technologies and value-addition for higher output, and developing a sustainable seed system are the other ongoing sweetpotato research activities in NARO.











IMPROVED POTATO RESEARCH
MEETING URBAN DEMAND FOR FAST FOODS

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It is hoped that r**oyalty-free late blight resistant potato varieties** will be released to farmers by 2021

One of the characteristic features of Uganda's ever growing and widening urban areas is the emergence of fast food restaurants as a response to the ever changing feeding habits and lifestyles of the country's high-end urbanites. Mostly present in the culinary productions of these classy fast food establishments is chicken and French fries, commonly known as chips, a luscious delicacy that is equally produced by even the low-end fast food shacks dotting most roadsides to the country sides.

Besides ease of production and preparation, potato contains a wealth of health benefits; the humble spud is a very good source of low-fat carbohydrate, Vitamin B6, minerals and dietary fibre (when served with skin). The fast foods have inevitably emboldened the demand and marketability of Irish potato. By inevitable extension, this has meant more cash for Irish potato farmers, especially in Kigezi sub-region where 60% of Uganda's potato is produced. One such farmer is Charles Byarugaba a resident of Nyabyumba village, Kamuganguzi sub-county in Kabale district, whose Irish potato farming supported by the National Agriculture Research Organisation (NARO), has financially rewarded him.

Like many famers in the region, he used to grow low yielding potato cultivars. "We used to grow potato without any other objective apart from food until 1998" recalls Byarugaba. However, with the coming of NARO, a new approach to Irish potato farming was adopted – NARO in collaboration with the International Potato Centre (CIP) and AfriCare gave each member in Byarugaba's farming group five bags of 80kg each and also trained them on best agronomic practices for best yield performance. NARO, CIP and Africare spearheaded the establishment of Nyabyumba Farmer Field School. The intervention was aimed at equipping farmers with practical skills in commercial potato farming.

Immediately after graduating as a community based facilitator in 2000, Byarugaba acquired three bags of potato seed on loan from Uganda National Seed Potato Producers Association (UNSPPA). "From this input I earned UGX1.5 million," reports, saying this earning anchored him deeper into potato seed multiplication, committing over 40 acres of land on different hills of Kabale to his potato growing business.

Riding on Byarugaba's success and passion for potato growing, the International Fertilizer Development Center (IFDC) partnered with him to build a modern screen-house for seed multiplication. For that matter, he is proud to have contributed to reduction of potato diseases in Kabale through producing disease-free seeds.

Walking in Byarugaba's footsteps is a mid-aged Henry Magara Nkuba. On the highest hills of Bukinda, Henry Magara Nkuba has dug a fortune from the Victoria potato variety that earns him at least UGX15 million per season. "Thanks to the partners from Netherlands and NARO who brought my ambitions to life" commends Magara Nkuba while giving us a tour of his modern green house, where he multiplies potato for seed, technically referred to as pre-basic seed.



"I used to have a banana plantation but I was poor," he recalls, justifying: "With potato, I have managed to educate my children to the highest levels of education." He also owns 6 acres of land in the highly fragmented hills of Bukinda. Magara Nkuba believes that there is no better crop than potato for his region and beyond. In the past decades, potato growing was only suitable for the highlands, commonly Kigezi. To increase production, NARO developed Victoria variety which can perform well even in low lands. It's for this reason that Magara Nkuba calls upon all Ugandans to venture into potato farming.

It has not been a smooth ride though

Although there are such inroads paved in Irish potato growing, all has not been a smooth sail mainly due to potato late blight disease that extensively bedevils the leaves, stems and tubers, causing between 40 and 60% yield loss. Unfortunately, the cool-humid weather in Kigezi favours the growth and spread of the late blight causing fungi, jerking farmers into spending 20-25% of their total revenue on fungicides.

As a stop-gap measure, one of the most current breeding projects at Kachwekano Zonal Agriculture Research and Development Institute (KAZARDI) is focusing on developing late blight resistant potato starting with the *Victoria* variety. In collaboration with International Potato Center (CIP), researchers have identified biotechnology as one of the best options for providing lasting resistance against the disease. Genes for late blight resistance were acquired from a wild potato relative and put in *Victoria*.

Field testing of the performance of the improved varieties commenced in 2009 and it is hoped that royalty-free late blight resistant potato varieties will be released to farmers by 2021. "We would wish to have a potato that one only plants, weeds and harvests without applying any fungicide," envisages Abel Arinaitwe, a NARO scientist at KAZARDI,

optimistically revealing that confined field testing of the improved potato has shown extreme resistance to the disease and with outstanding yield.

On account of such assuring revelations, it is only understandable that Friday Herbert, a small-scale potato farmer, in Rubanda district looks forward to receiving the improved potato so that he can save the up to UGX 1.5 million that he spends on fungicides every season.

Over 300,000 households grow potato

According to the research carried out by KAZARDI in 2015, potato is grown by more than 300,000 smallholder households, producing a total of 800,000 tonnes on 112,000 hectares. However, the demand for potato was more than one million tonnes.

Potato was introduced in Uganda around early 1900's probably by missionaries from Congo. The crop performs best in highland areas – so it flourished well in the cool undulating hills of Kigezi sub-region in south western Uganda. The rapid population growth in the region, increased pressure on land, pests and diseases has created a need for higher yielding, pests and disease resistant potato varieties. The initial popular variety was *Malirahinda* which was released in 1974.

In 1991, *Victoria, Kabale* and *Kisoro* varieties were released by Namulonge Research Institute. *Victoria* became a very popular variety because it was tolerant to late blight and bacterial wilt. Even though its tolerance to late blight disease failed over time, *Victoria* variety is still a popular variety because it can tolerate marginal soils, matures fast (80-90 days) and grows on mid and low altitudes.
It is a good choice for farmers in non-traditional potato growing areas [Kigezi]. "*Victoria* is good because it can be grown three times in a year," says Charles Byarugaba, a seed potato farmer in Nyabyumba, Kabale district.



Researchers have identified biotechnology as one of the best options for providing lasting resistance against the disease

The other popular varieties released by NARO included *NAKPOT* and KACPOT series. *NAKPOT* is an abbreviation for Namulonge-Kalengyele Potato. These series were higher yielding with a potential yield of up to 28 tons per hectare under optimal conditions.

KACHPOT stands for *Kachwekano* potato, and were famous for their ability to produce good crisps and chips compared to *Victoria*. This naming followed the decentralization of NARO to take services nearer to farmers, whereby Kachwekano ARDC and later ZARDI was created and spearheaded research for southwestern highland agro-ecological zone in the year 2000.





Potato research in Uganda has been supported by partners, including the International Potato Centre (CIP). The CIP-NARO partnership has led to development and release of over 15 varieties and accompanying production technologies.

The latest being *NAROPOTs 1* to *3* which are tolerant to late blight and high yielding (18 – 24 tons per hectare) compared to average potato yield (6.5-7 tons per hectare). This yield gap has been attributed to poor quality seed, limited use of improved agro-inputs, variety degeneration, pests and diseases, among other constraints.

Such constraints hindered farmers from meeting the ever-increasing demand for potatoes in Uganda and beyond. "We used to plant any kind of potato seeds we came a cross, but most could not yield," says Charles Byarugaba, a seed potato farmer in Nyabyumba, Kabale district

The constraints did not, however, push NARO scientists off the road to finding sustainable solutions – Kachwekano Zonal Agriculture Research and Development Institute (KAZARDI) undertook several initiatives to address the challenge of limited certified quality seed potato.
Thus several farmer groups were trained and empowered to form UNSPPA. Through this arrangement, organised farmers were given contracts to supply seed potato and linked to markets in the Mbale and West Nile regions.

In addition to empowerment, NARO also helped the potato farmers to produce quality potato and market their produce to Uganda Industrial Research Institute, Tomcris Enterprises, a potato crisp processor, NANDOs, and Deepa Industries LTD. In 2009, Deepa Industries signed a contract with 350 farmer households belonging to the Nyabyumba United Farmers' Association whom it is still engaging in business to supply it quality potato.

Expectedly, the contracts have increased farmers' incomes given the better prices offered to the farmers and easy transportation. Also, farmers are also accessing better credit facilities, regular extension services, and development of small cottage processing industries in the region operated by 150 women. These farmers on average earn 600,000 per month

from sale of potato through this partnership.

In the same sense, the International Fertilizer Development Centre (IFDC) assisted in training and providing six screen houses for UNSPPA members.

A total of 156 farmers (84 males, 76 females) were trained in mini-tuber seed production focusing on handling of tissue culture potato plantlets, soil sterilization, screen house maintenance, establishment and management of potato crop in screen house, and post-harvest handling (storage and management) of mini-tubers across the site areas, where the screen houses were being hosted (Maziba, Bukimbiri 1, 2, 3 and Kisoro).

As a result of a better seed potato production system and market linkages, 67 seed suppliers were created and over 350 potato farmers and 36 potato traders came together for better synergy as well as three processing companies joined the potato value chain.

> These **farmers on average earn 600,000 per month** from sale of potato through this partnership





RICE: A FORMER RICH MAN'S FOOD TURNED TO A NATIONAL GOLDEN GOOSE IN BUTALEJA DISTRICT

By Prossy Nandudu, Barbara M. Zawedde and Jimmy Lamo*
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The cost of transporting a metric ton of rice together with other logistical arrangement is $350 (UGX1.2m), excluding the actual cost of the rice.

Since time in memorial, rice has been a preserve of the rich and high-end eateries such as restaurants and hotels, making only yearly appearances in most poor households on special days such as Easter and Christmas or at parties and other forms of cerebration. It's at these rear occasions that poor folks had the rare opportunity to gleefully taste it.

Today, however, with increased farmer population and improved farming practices and technologies, rice is easily available and affordable – it is a common item on most household menus. This positive shift in rice consumption has its roots anchored in the timely intervention of the National Agriculture Research Organisation (NARO) in areas like Butaleja district, among others where rice cultivation is widespread. Its noted that over 67% of rice produced in the country comes from Eastern Uganda, and more than 80% of the region's farmers into rice production grow lowland rice varieties – observes Dr. Jimmy Lamo.

Improved Varieties Improved Yields

NARO's intervention illuminates in Fred Munyaga, a resident of Mazimasa A village and represents a group of 50 rice farmers under the Mazimasa Rice Farmers' Association (MARIFA). Notably, Munyaga and other farmers, who have been growing rice but yielded little changed their farming practices in 2012 upon interacting with the staff Buginyanya ZARDI, a NARO station. The farmers were working a lot but yielded little, yet the consumer demand was increasing, notes David Nanfumba a NARO staff.

Propelled by the need to increase rice production, NARO scientists obtained soil samples and tested for fertility, acidity, pests and diseases, among others. Basing on derived results, NARO gave farmers Winter 9 rice variety whose purple colour they complained about, and were instead given Winter 9 White - David Nanfumba.

"These have proved to be good till today with minimal challenges," he commends, explaining: "We get more kilos and many people are coming to us for seed and to learn how we are planting it. Previously, we were getting about 1200 kilograms per acre with the old varieties. With Winter 9 White we get between 2000 and 2500 kilos."



Good Agronomic Practices Imparted

Improved seed varieties alone could not have been enough to guarantee improved production. In its wisdom, NARO's intervention package included training farmers on Good Agronomic Practices (GAP), such as proper use of fertilizers, good agricultural practices and spacing, according to Dr. Jimmy Lamo, a rice breeder at the National Crops Resources Research Institute (NaCCRI) – Namulonge. "Under GAP, farmers are trained to transplant rice as early as 14 days, and to properly level the fields to avoid flooding. They are also trained how to control the plant population by planting in lines, seedling management, timely weeding, timely harvesting and proper fertilizer application," he enlightens.

To benefit from GAP, farmers must access high quality seed of the appropriate varieties first because seed companies are not producing lowland rice seed – farmers can only get new seed from NARO or community-based seed growers - states Lamo.



Guarding against Possible future Virus Outbreaks

Well aware of a possible future outbreak of rice viruses and Uganda being a hotspot for the rice mottle virus, NARO scientists thought ahead of time and released Komboka, a more virus resistant variety. "Komboka is an aromatic rice for areas with lower pressure from the virus. It yields lower than Winter 9, but has high grain quality and attracts a higher market," says Lamo, adding that the fertilizers applied must have Zinc and silica – which are essential for the balance, growth and grain filling under irrigated conditions.

He advises that timely weeding is important, and NARO has developed mechanical weeders that can easily be fabricated, but there is more demand for motorized weeders and the researchers have embarked on developing prototypes to address this demand.

GAP Not a Smooth Stroll Though

Much as GAP is laudable, it is not a smooth stroll – Munyaga bemoans that it is tiresome and time consuming. "One has to make rows and plant along the rows which is time consuming. Therefore, farmers adopt the varieties without using GAP and they do not get the expected yield," he laments. On the other hand, Munyaga says yields for Winter 9 tend to decline after the 3rd and 4th planting session, and adds that sometimes farmers are stuck with the old seed because there is no ready seed or seed multiplier, hence the need for NARO to teach farmers how to produce seed.

NARO's Upland Rice Cuts into Export Market

As eastern Uganda is consolidating its gains in lowland rice growing, the northern, on the other hand, has a firm grip on upland rice farming, making it a major income generating crop considering Omer, Vinayak and Amatheon agri farms, whose commercial performance emanates from embracing NARO rice varieties such as NamChe 1 and NamChe 3.

Amatheon Agri Farm, established in 2014 and currently covering 3000 acres in Amuru district, has adopted the NamChe series consideraing their high yields (three tonnes per acre, every season) and tolerance to drought. To satisfy its demands, Carl Bruhn, the farms chief executive, says their production has been boosted by 61 out-grower groups, each comprising between 70 and 100 members, who are trained on crop management for purposes of quality rice production.

With the training, the farmers have subsequently become conveyors of knowledge to other farmers, who have in the long run appreciated the improved rice varieties, resulting in increased income generation.

"Our partnership with NARO is productive. More effort, however, should be placed on sensitizing the farmers on improved diseases, pests, and drought tolerant seeds," Bruhn advises, adding: "The government should set policies that support local rice producers by limiting rice importation."

The cost of transporting a metric ton of rice together with other logistical arrangement is **$350 (UGX1.2m),** excluding the actual cost of the rice



In Nwoya district, Vinayak Agro Farm, reports Y. P. Peshwa, the farm director, undertakes commercial rice growing on 4200 acres of land. With recommendation by NARO/NaCRRI, the farm grows the drought tolerant NamChe1 and NamChe 3, yielding between 3000–3500 metric tonnes annually.

With such yields, the farm has established a rice mill which processes 50 tonnes daily in addition to cleaning and automated seed packing. To boast their quantities, Vinayak Agro Farm works with over 50 out-growers. The farmers are supported by lending them farm machinery such as tractors during planting and harvesting.
Omer Farm on the other hand was established in January 2015 in Gulu district and sprawls on 6000 acres of land. Like Vinayak and Amatheon farms, Omer takes pride in NAROs technologies, focusing more on the NamChe 3 rice variety and the Longe 10H maize variety.

NamChe-3, which is drought-tolerant and fast maturing, is cultivated on about 1500 acres while Longe 10H covers 2500 acres. The farm harvested 2.5 tonnes of Longe 10H per acre in the first planting season of 2016, anticipating that the yield per acre would impressively shoot to up 6 tonnes.
The farm which has a 1500 tonnes storage facility of maize, rice and beans, and dryers of 25 tonnes per hour, has ripe plans of expanding the storage facility to 2500 tonnes per silo. With a little support from Government to local rice farmers and increased acreage of the improved NARO rice varieties, the proprietors of the above farms have no doubt that Uganda has the capacity to grow enough rice to replace what is imported from Pakistan and Vietnam.

For example, according to the Uganda Revenue Authority (URA), Uganda annually spends over UGX 360 billion in importation of rice from Pakistan. Every month, URA receives 300,000 and 25,000 metric tonnes of rice imported from Pakistan and Tanzania, respectively, yet the cost of transporting a metric ton of rice together with other logistical arrangement is $350 (UGX1.2m), excluding the actual cost of the rice.

Rice now a Major food security Crop

Introduced by Indian traders in 1904, rice was originally a preserve of the rich in Uganda. Decades later, the crop gained popularity in the 1940s when its cultivation gradually picked up at subsistence level with farmers growing varieties such as Cakala, Matama, Kawemba, Kigaire and Siena introduced into the country through Mwanza, Tanzania.

Rice production in 2008 was 165,000 metric tonnes and national consumption was 225,000 metric tonnes, the deficit costing the country US$30 million (UGX 108b) in import revenue. Currently, the national production rates have impressively shot up to an estimated 680,000 metric tonnes, making rice to rank high both as a food security crop and income earner for over 76,868 small holder households, according to the 2011 report of the Uganda Bureau of statistics.

Rice Research efforts in Uganda

Despite significant gains in popularity, the country's rice industry has had enough share of setbacks. From pests and diseases to unfavourable weather conditions and miserable harvests, the grain that had quickly captured farmer's hearts was bound to fail. Luckily, Government had picked interest in rice as a potential food security crop in the 1950s and subsequently large scale production of irrigated swamp rice was initiated at Kibimba in 1966 through a partnership between the Uganda government and the People's Republic of China.

This initiative resulted in increased smallholder rice production mainly in Eastern and Northern Uganda with emphasis on lowland rice varieties. Commercial rice growing was also initiated at Doho in 1976 and later Olweny Irrigation Scheme. The two are nuclear farms uniting smallholder rice farmers - Dr. Jimmy Lamo.

> "Uganda annually spends over **UGX 360 billion** in importation of rice from Pakistan

Promotion and Research Support Increased

From 1970 to 1990, lowland rice was being promoted mostly under irrigated production system. During this period two major irrigations schemes—Doho and Olweny—were established. Research was mostly restricted to irrigation schemes.

Owing to increasing conversion of swamps into rice production areas in the 1980's and 1990's, Government instituted a program to promote upland rice. Research to develop rice varieties suitable for rain fed upland conditions was initiated in 1992 with support from Republic of North Korea. Subsequently, two upland rice varieties—Abilony and UK-2—were released in 1995.

Later, supported by the Rockefeller Foundation, the Cereals Program at NaCRRI in collaboration with stakeholders notably farmers, Africa Rice, seed Companies and Makerere University, conducted research, leading to the release of NARIC 1, NARIC 2, and NARIC 3 upland rice varieties in 2002. NARIC 3 also known as NERICA-4 is a popular variety on the Ugandan and regional markets.

However, all these varieties suffered severe yield losses due to drought stress. Consequently, a breeding program to develop drought-tolerant upland rice varieties was initiated in 2006. This resulted into release of two upland varieties namely—NERICA-1 and NERICA-10—in 2007.

NERICA-1 has since then gained importance in the market due to its aromatic properties while NERICA-10 is widely preferred due to its short growth duration that enables it to escape drought.

In 2013, drought-tolerant NamChe-1, NamChe-2, NamChe-3, NamChe-4, NamChe-5 and NamChe-6, were released following years of breeding by NARO scientists, and are among the varieties that have been exported for testing in Cameroon, Burkina Faso, South Sudan, Ethiopia and Democratic Republic of Congo (DRC).

Agoro, Okile, NERICA-6, Komboka and Winter 9 were five lowland varieties released by NARO in 2014.

> We were getting about 1200 kilograms per acre with the old varieties. **With Winter 9 White we get between 2000 and 2500 kilos**





POOR MAN'S CROP TURNED TO FARMERS' GOLDMINE; THE STORY OF UGANDA'S SORGHUM



By Umar Kyeyune and Joshua R. Muhumuza
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Over 30,000 households in are involved in sorghum production mostly because it has quickly become a key cash crop

Grown on approximately 399,252 hectares of arable land, sorghum ranks second among the most important staple cereal crops in Uganda, after in terms of production and area (UBOS, 2010). It is mainly grown for food and brewing.

Despite the key contributions of sorghum to the livelihoods of farming communities in northern, eastern and western Uganda, several constraints had made it difficult for communities to optimally exploit the potential of the crop.

For example, according to Dr. Geofrey Lubadde, program leader Dry Land Cereals Research at NaSARRI, the average on-farm sorghum yield was only 800kgs per hectare compared to 4,000kgs per hectare obtained at the research institute.

Widespread use of indigenous cultivars that are low yielding, late maturing, and plant diseases, insect pests, striga and low soil fertility are largely responsible for the low productivity of the crop. Consequently, the crop was increasingly being abandoned in the 1990s as it was considered a poor man's crop with limited uses such as local brewing and food only.

Sorghum Research in Uganda

With commencement in 1957, of aggressive research on sorghum, with the aim of developing high yielding drought and other biotic stress resilient varieties which had diverse application, the crop's production was resuscitated through the release of *Serena* varieties in 1960.

In order to cater for market demands, the sorghum research pipeline ventured into developing varieties with diverse utilization in 1970. Subsequently, *Lulu Dwarf, Lulu Tall, Dobbs* and hybrids such as *Himid, Hibred, Hijack and Seredo,* were released in the 1980s.

In an attempt to revive the crop as a contributor to improving food security and incomes, especially among the rural households, National Semi-Arid Resources Research Institute (NaSARRI), enhanced efforts to generate and disseminate a number of relevant technologies and varieties, thus improved varieties such as *Sekedo* and *Epurpur* were released in 1995.

As a solution, the advent of the Striga pandemic led to the release of *SESO1, SESO2* and *SESO3* in 2011 that targeted brewing and food security.

To address climate change challenges and increasing demand for the new improved varieties, *NAROSORGH-1* (cream white, good for brewing), *NAROSORG-2* (red and desirable for food), *NAROSORGH-3* (chalky white, good for brewing and resistant to sorghum midge) and *NAROSORG-4* (brown and good for food when blended with cassava flour), were released in 2017.

These varieties are tolerant to drought and Striga, and have good grain qualities such as low tannins and large grains with grain color desired by farmers.

Varieties Praised by Farmers and Consumers

It is on account of NARO's intervention that *Epurpur* and *SESO1*, among the earliest varieties of sorghum released in Uganda by NaSARRI mainly for commercial beer production, according to Joseph Kawuki, a manager with Uganda Breweries Limited, have been praised.

"These varieties mature early compared to indigenous cultivars (*epurpur* matures in 110 days and *SESO1* in 90 days). They are drought-tolerant, and also have low tannin content that makes them the preferred option for any brewer," he praises. On the other hand, Ojira James Peter, a farmer with Akukuranut Farmers'Group in Kumi, started growing *Epurpur* in 2010 and has believable reasons to value the crop.

"It has been tolerant to diseases, drought and Striga. NaSARRI introduced this variety to us and we found that it has a number of advantages over our local varieties like high yield, shorter maturity time and drought resistance," he says, adding: "This crop is what I rely on for income. It has helped to take my children to school, build another house, and fight poverty in my home."

Participation of end-users in selection, improved seed systems, innovation platforms with producers, seed companies and processors have facilitated rapid adoption of the NARO varieties. Furthermore, public private partnerships have enhanced dissemination and value addition.

The success of this intervention is attributed to the utilization of the sorghum value chain approach, targeting gender and specific end-user segments such producers, seed companies and processors. According to Vincent Ogule, the Serere district production officer, originally farmers cultivated traditional varieties, but since they started growing the improved varieties like *Sekedo*, *Seredo* and *Epurpur* released by NaSARRI, the production of the crop shot up rapidly.



He notes that farmers' adoption of the improved varieties was inspired by high yield, pests and disease resistance and importantly high demand from the brewing industry. Ogule reports that over 30,000 households in Serere are involved in sorghum production mostly because it has quickly become a key cash crop.

Farmers Harvest Money

The introduction of improved varieties with excellent brewing qualities was a timely boost to Uganda's brewing industry because they provided a cheaper local source of raw materials. Uganda breweries and Nile breweries, which were initially importing all their raw materials, were quick to switch to a cheaper locally grown sorghum. Nile Breweries Limited, a leading beer company in Uganda, is manufacturing Senator and Eagle Lagers using the new NARO sorghum varieties. This has been reported to increase direct income for farmers involved in the local raw materials support program due to improved quality and productivity of sorghum. The new varieties have continued to command higher prices over the years from UGX 300 per kg in 2002 to UGX 1,100 per kg in 2012. Total income to farmers consequently increased from only UGX 180 million in 2002 to UGX 8.7 billion in 2012/2013.

Over 2 million farmers plus a combined 15,000 agents—transporters, cleaners, brokers, agro input dealers, machine operators and agriculture extension staff in seed companies, brewing companies and NGOs—have benefitted from this intervention. The other brewing company helping farmers reap from NARO's sorghum is Uganda Breweries Limited (UBL). The biggest benefit for farmers growing sorghum for UBL is ready and steady market for their grain at a known price. The sorghum value chain has a significant impact on the lives and social welfare of rural farming households as they enjoy stable incomes from growing sorghum.

According to Joseph Kawuki, Agricultural Manager UBL, small-scale farmers generally grow between 2-5 acres of sorghum at an average yield of 800kgs per acre. This provides a farmer with an average income of UGX 3.5million based on UBL's current price of UGX 1,310 per kg. In the 2016 season alone, UBL paid UGX 3.7 billion in direct purchases of sorghum from farmers. These figures are expected to double in 2017 according to UBL predictions. This revenue is directly injected into the local economy where sorghum is grown.

Presently, NARO's sorghum varieties have diverse applications which include sorghum cake, sorghum bread, popped sorghum and sorghum composite flour, for nutritious porridge and brewers mash-sorghum stover mixture for livestock feed. The successful implementation of this initiative is now being used by the government of Uganda as a reference for public-private sector partnerships to achieve objectives set out in its Poverty Eradication Action Plan, Plan for Modernization of Agriculture, Operational Wealth Creation and Vision 2040.

> "Farmers' adoption of the improved varieties was **inspired by high yield, pests and disease resistance**

IMPROVING FEEDS AVAILABILITY FOR LIVESTOCK FARMERS











NALIRRI EMBARKED ON A PROMOTION PROGRAM FOR KEY FORAGE AND FEED TECHNOLOGIES TO AMPLIFY FEED AVAILABILITY

By Chris Berdana, Owen Singura, Victoria Mbigidde, Barbara M. Zawedde, Joshua R. Muhumuza and Jolly Kabirizi*
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Widely practiced in the south-western, central and north-eastern parts of Uganda, livestock keeping, both cultural and business-driven, has significantly cured both the nutritional and employment needs of most people, especially rural folks practicing small scale zero grazing for dairy production.

The sector also has bigger players such as the 500-acre AGDI Dairy Farm in Kiruhura district whose potential for soaring production is beyond doubt. It has however been held back by feeds shortages arising from weather vagaries.

Having started in 2008 with 160 cows (100 mature cows plus 60 heifers and calves), the managing director Rtd Col. Dick Bugingo, has navigated past the inhibitive food shortages by partnering with NARO through the National Livestock Resources Research Institute (NaLIRRI).

NaLIRRI provided AGDI with technical advice, especially on farm health among other technologies, translating into increased production of up to 80% of quality milk. Relying on the advice, AGDI is currently conserving feeds that can be fed to cows for more than six months.

> Otto and her group members have been **equipped with skills** on formulating homemade rations like multi-nutrient mineral blocks, hay and silage

The farm's membership currently comprises 10 partners, Bugingo reveals. He has established a farmer training center, where farmers are trained on cattle breeding, management and entrepreneurship. "The trainings run for four days on a monthly basis. Each participant pays UGX 35,000 accommodation inclusive," notes Col. Bugingo, boasting: "The impressive training facility has benefitted over 570 farmers."

His innovativeness has not been in vain. Bugingo was awarded Best Uganda Dairy Cattle Farmer for Western Uganda in 2014. His success is linked to adoption of NaLIRRI's dairy cattle technologies such as pasture improvement, herd health, forage conservation, pasture seed production and feed supplementation.

Increased Income from Sales

Presently, the farm has four hectares each of Lablab purpureus and Bacharia mulato, two hectares of Guatemala grass, 10 hectares of Chloris gayana and 10 hectares of Longe 5 maize. Expectedly, the efficacy of the technologies manifested in AGDI's increased income from conserved forages (silage and hay) sales. For storage, the farm has acquired a 300 ton silo of silage, in addition to hay production of 2,000 bales every season. The farm makes 30kg bales and sells each at UGX 20,000.With increased feeding capacity, the farm has increased capability to handle up to 500 heads of dairy cattle from 160, increasing the market for their heifers. "I sell heifers to northern Uganda projects, each heifer at UGX 5,000,000," Bugingo says.

Gulu Farmers Fetching UGX1200 per Litre

Eating from the same plate of NaLIRRI's technologies just as AGDI, is Gulu Community Dairy Farmers Association (GCDFA), a women-dominated group that is earning big from milk, according to Jessica Otto, a small holder farmer and the association's founding member.





Receiving a dairy cow in 1995 from the governments Poverty Alleviation Program, Otto's interest in dairy farming not only got kick-started, but has never dwindled. Her herd over the years has expanded with support from the American Embassy through Church of Uganda, and through engagements with NaLIRRI's researchers.
Subsequently, Otto was in 2009 one of the first to be trained on better pasture production and feed rationing by NARO livestock feeds scientists, such as Dr. Jolly Kabirizi, who introduced better pastures like Calliandra, Lablab, Napier grass, and Tithonia diversifolia.

Tithonia diversifolia, commonly known as the wild sunflower, is a non-leguminous shrub that grows wild in many parts of Uganda, and can also be used as fodder for cattle, goats and sheep.

The farmers were trained on harvesting and preparing the wild plant for feeds. "We did not know that tithonia can be a delicacy to cows," says Otto, adding that with such feeds came not only with improved animal health, but also increased mild production by four litres.

"Our animals rarely fall sick – they are healthier," she emphasizes, noting that the leguminous pastures like Calliandra and Lablab have improved her soil fertility through nitrogen addition. For sustainability, Otto and her group members have been equipped with skills on formulating homemade rations like multi-nutrient mineral blocks, hay and silage.

Hellen Kilama, a farmer in Gulu, and Dream Farm in Nyakashashara sub-county, Kyakabunga village in Kiruhura district, have reported increased milk production due to the programme.

"I now get 20 litres per day from my two cows," Kilama says with a smile, explaining that from the income derived she has taken her children to school and built a permanent house. Otto and Kilama are part of the 186 farmers who have benefited from NARO interventions through GCDFA, which owns a modern 5000 litre milk processing plant in Gulu town, and members sell their milk and yoghurt under brand name Mothers' Pride.

"This is the only milk processing machine east of the Nile, from Jinja to Elego," says Otto, elucidating that the members are paid UGX 1,100 per litre, which is paid through their bank accounts at the end of the month. Dream Farm, which commenced in 2013 following a visit by Kabirizi and her team, operates on 6.5 hectares and comprises 30 members, who have been trained on pasture types, field establishment, management, utilization and seed production, according Jackson Kanunu the farm chairman.

In partnership with the Eastern Africa Agricultural Productivity Programme (EAAPP), Mbarara ZARDI, NAADS, and the Government of Uganda, the members in 2014 established 6.5 hectares of Chloris gayana (Rhodes grass). Premising on technical support from NaLIRRI, the group has over the years mastered the art of pasture production through the entire value chain, and their distinguished efforts in the location propelled Operation Wealth Creation (OWC) to seek their services on training, out of which OWC in 2016 supported the group to form a cooperative.

Certified to Supply Certified Pasture Seeds

Since its inception the farm has, for example, developed capacity to sell every season 1,500kg of Chloris gayana grass hay, with an average weight of 20kg per bale, each selling at UGX8,000.

> We sell each kilogram of Chloris gayana at **UGX 40,000**

Additionally, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) has certified the Dream Farm to supply certified pasture seeds for their projects and other clients.

The farm supplies pasture seeds and Chloris gayana hay to dairy farmers within Kiruhura, Kashari, Ibanda and Ntungamo districts, and to seed companies like Victoria Seed Company and Simlaw. "We sell each kilogram of Chloris gayana at UGX 40,000,"says an excited Jackson Kanunu, noting that the group has also trained 760 stakeholders, including UWAZALEWO Army officers with technical support from NARO.

Livestock Feeds' Research in NARO

NARO through NaLIRRI embarked on a promotion program for key forage and feed technologies to amplify feed availability in small holder dairy production systems in the country. Major forage species promoted were forage grasses like Pennisetum purpureum and Brachiariahybridcv. Mulato, plus forage legumes like Lablabpurpureus, Clitoriaternatae, Macroptiliumatroprupureumand Centrosemapubescen. In addition, researchers promoted planting of forage trees and shrubs such as Calliandracalothyrus, Gliricidiasepiumand Lithonia diversifolia.

Technologies recommended for improving forage and feed included formulation of protein and energy feeds, and production

of dry season feeds. The former included promotion of homemade dairy meal, Lablab and Calliandra leaf hay, sorghum stover-Tithonia rations, and multi-nutrient feed blocks; the latter included technologies such as silage production and hay making.

Researchers tested and promoted the most effective acreage for Napier grass-forage legume mixture to provide year-round dairy cow requirements, the staggering planting dates of Lablab into maize crop to avoid competition, and NSD management package. Farmers are trained to use feed processing equipment such as the manual metallic forage chopper, motorized manual forage chopper, improved heavy pressing surface hay baler and a modified pellet making machine (from Musa Body Fabricators).

The research and dissemination of the technologies from the Livestock Nutrition Research Program was achieved through the support of the World Bank, Association for Strengthening Agricultural Research in Eastern and Central Africa, Government of Uganda, the Rockefeller Foundation, Food and Agriculture Organization, International Center for Tropical Agriculture, World Agroforestry Centre, Danish International Development Agency and the International Livestock Research Institute. The program, says Kabirizi, continues to multiply seeds of various forage and the seeds can be accessed from the Dairy Business Incubation Center at the NARO institute of Nakyesasa, Namulonge.

A summary of the effect of feed resources development technologies (Dream Dairy Farm)

Parameter	Before the intervention	After the intervention
Social Impact	Children studied in village schools	Children are studying in good schools
Average milk yield/cow/day	8 litres/cow/day	16 litres/cow/day
Average daily income UGX/cow	6400	12800
Pasture seed yield (Kg)	0	200
Bales of pasture grass conserved	0	1400
Environmental Impact	Compromised soil fertility	Improved soil fertility
Employment	Less skilled casual labourers employed (herds men)	Skilled casual labourers employed (Diploma holders)

Important numbers

2,000 = Number of bales per season
30kg = weight of each bale
UGX 20,000 = cost of a single bale

Other effects of feed resources development technologies to AGDI Dairy Farm

Parameter	Before the intervention (s)	After the intervention (s)
Average milk yield/cow/day	10 litres/cow/day	20 litres/cow/day
Average income cow/day (Ushs)	8000	16000
Pasture seed yield (kg)	0	500-800 kg
Bales of pasture conserved	0	1400
Environmental impact	Compromised soil fertility	Improved soil fertility
Employment	Herdsmen employed	Four professionals employed

NARO changes the face of extension and ervice delivery in Masaka region

Located in Masaka district, Akamila eyiye farmers group was established in 1997 with total members of 10 farmers and a treasure of one head of cattle. Although the cattle was perceived a s aresource, members had limited knowledge on how to make the most of it. It was this gap that prompted NARO – NaLIRRI to engage the group with the objective of improving feed availability, increase dairy cattle performance and improve household income in 2001. With NAROs intervention, the group has since registered great strides directly and indirectly ranging from social, economic and environmental.

With current membership standing at 63 registered farmers, Akamir'eyiye group members boast of the skills on forage production and conservation (hay and silage) technologies which have improved the quality (taste) of milk hence fetching more money, and increase in the milk yield from 2-3 litres from dairy cow pellet supplements not to mention improved nutrition of family members. The group has been further exposed to learning experiences from their counterparts from Kenya, Sudan, Tanzania, Burundi and Ethiopia and shared their experiences on the impact of adopting improved feed resources on dairy farmer livelihood.

The spill over effect of adopting NAROs technologies by the group is visible and appreciated with in the surrounding communities as it has adopted dairy cattle technologies especially silage and hay production. Adoption of Napier stunt resistant varieties and Brachiaria mulato has increased fodder availability by over 20%. Some members have benefited from selling of Napier grass cuttings to other farmers. On average, a bag (100kgs) of Napier grass cuttings goes at shs 20,000. I sold 50 bags of Napier grass cuttings and 250 bags of Brachiaria splits at shs





20,000 per bags to Kamenyamiggo Zonal Agricultural Research and Development Institute (ZARDI) and farmers in Mbarara, Rakai and Rakai districts – notes Mr. Daaki, a member of Akamira eyiye farmers group.

Other achievements registered by the group as a result of NAROs intervention are :-

- Improvement in feed supply (quality and quantity) resulting in better animal body condition and body weight especially during periods of feed scarcity leading to educed incidences of animal diseases and lowered veterinary costs.
- Educated their children and bought necessary household items in addition to training 450 (270 women and 45 youth) farmers from Masaka, Mbarara, Gulu, Hoima, Wakiso, Kampala, Rakai







and Bushenyi districts.

- Mr. and Mrs. Daaki, also members of the group have been able to renovate their house using income from sale of milk, hay, vegetables, forage planting materials and silage. "We had to renovate the house because of a number of important stakeholders who visit us". He also adds that their farm is a demonstration centre on improved feed technologies".
- Improved food and feed security as a result of intercropping maize with Lablab (Lablab purpureus cv Rongai). Intercropping Lablab with maize technology maximized land utilization. This presented a solution to land shortage which is a major constraint in intensive smallholder dairy farming systems in Masaka district, as farmers are able to use the same piece of land to produce food and feed.
- A saving culture has been cultivated as individual members are able to save 3,000 per month and borrow from the group as well.

  "The groups also helped women to get recognition in the village and respect by their husbands".

- Lastly, the attitude and approach of extension staff has changed over the years. Its noted that in the past, extension staff officials concentrated on animal health, but since NaLIRRI introduced dairy cattle nutrition technologies, extension staff officials became more interested in animal feeding and breeding. Extension services especially artificial insemination is now more readily available and more reliable.



NARO LIVESTOCK TECHNOLOGIES OPEN MULTIPLE DOORS FOR INCOME GENERATION

By Chris Berdana, Owen Singura, Victoria Mbigidde, Barbara M. Zawedde, Joshua R. Muhumuza and Jolly Kabirizi*
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Although urban farming and agribusiness is still a grey area in Kampala, Dr. Diana Nambatya (PhD in Population Studies) is living large off her empowerment programme of skilling women and youth in urban agribusiness.
At 35 years of age, the founder of Kwagala Integrated farm has dymisfied the myth of 'agriculture necessitating big chunks of land.

With only 0.5 acre of land in Kulambiro, a Kampala suburb, she is operating Kwagala integrated farm a modern farm producing biogas, organic fertilizer and seeds. In addition, she conducts trainings and mentors women and youth in urban agriculture and agribusiness, a move aimed at alleviating poverty at household level by engaging in urban farming as an income generating activity.

Dr. Nambatya started Kwagala Integrated farm in 2010 to supplement family monthly salary and cut cost on food items like tomatoes, onions and vegetables. Combined with her undying love and passion for agriculture, they planted a few vegetables, tomatoes and onions to supplement family diet. Although the focus was on supplementing family diet, the good yields prompted her to sell the surplus to neighbours and people within her jurisdiction. In 2011 Dr. Nambatya decided to integrate the two cows given during her wedding into the farm. This move presented her with challenges of especially managing cow dung, prompting her to look for solutions.

With support from NARO-NaLIRRI, she was trained on dairy cattle nutrition and management and how to harness the cow dung into biogas and organic fertilizer. "With biogas for cooking and lighting we stopped using total gas hence reducing electricity bill." "In 2012 using knowledge acquired from NARO and Dr. Jolly Kabirizi in particular, I started training women and youth every Saturday and so the farm became demonstration centre." Notes a visibly happy Dr. Nambatya.

Given the limited farm space at her home and more women expressing interest in the programme , it was almost becoming impossible to carry on with the trainings. This propelled her to convert her garage as day care centre for mothers with children in addition to hiring makeshift tents whenever a training was scheduled.

With support from NARO-NaLIRRI Competitive Grants Scheme in 2017, Dr. Nambatya set up a structure which houses all training programmes conducted on the farm. In addition to the funding, she received NARO technologies including dairy pellets, silage, hay, motorized forage chopper and a calf pen from NaLIRRI.

Benefits

Dr. Nambatya's initiative was identified by the New Vision in 2014 to compete in Best urban Farmer Competition, and to her amazement, she emerged Best Urban Farmer in Kampala in 2015, an achievement she attributes to NARO - NaLIRRI after adoption technologies like hay and silage production, the nutrient feed blocks to mention a few. These technologies further improved her dairy cattle productivity and household income.

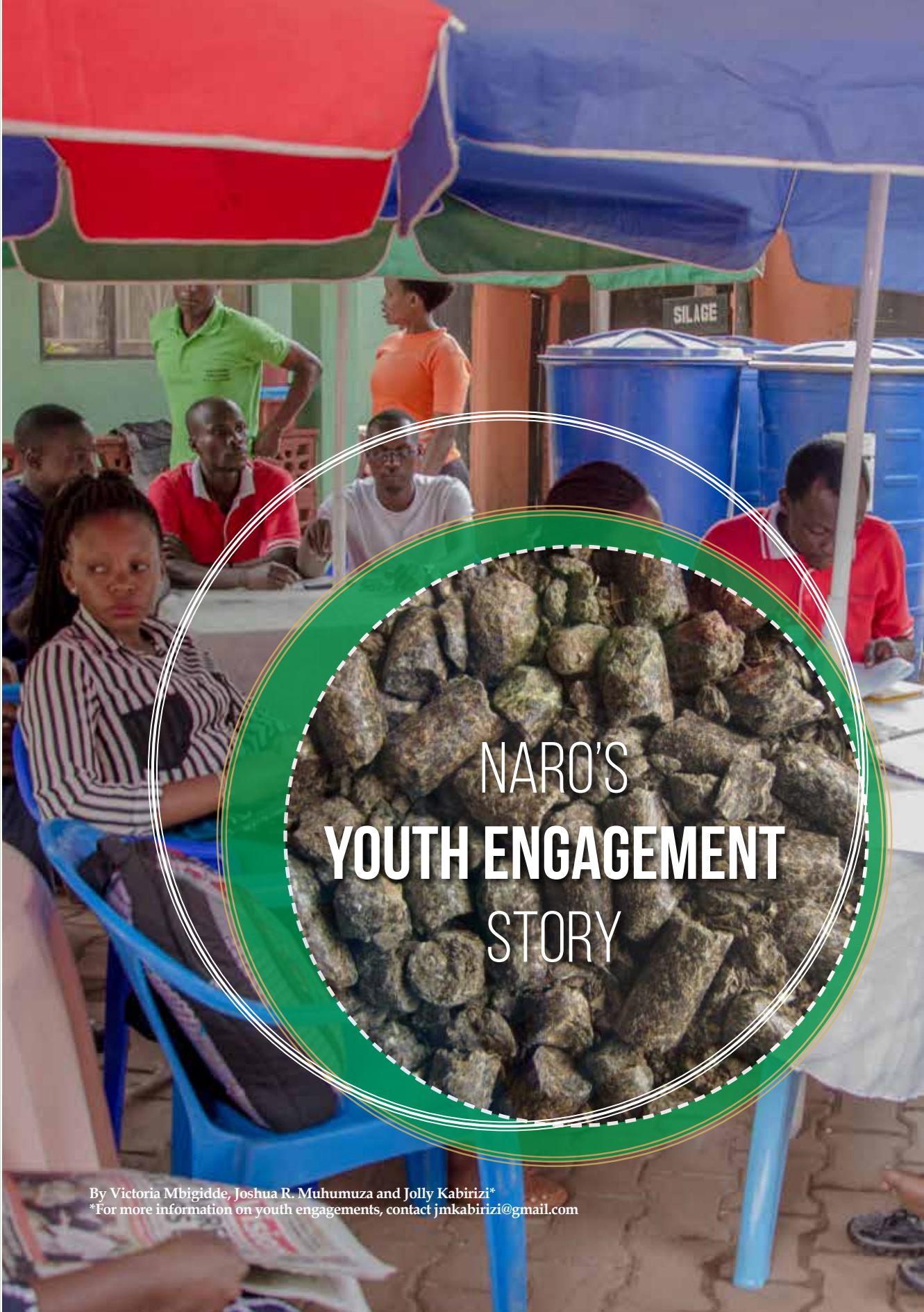
The above achievement was followed by American Express Ngen leadership award by American Express and independent sector in 2015 November. In March 2017, Dr. Nambatya received additional financial support from AVSI/SKY and National Agriculture Research Organization (NARO)- Competitive Grants Scheme funded by the Word Bank to skill women and youth in urban agribusiness. This later led to the centre to be accredited by Ministry of Education and Directorate of Industrial Training.

At the moment, Kwagala integrated farm conducts four short courses in urban agriculture and agribusiness every year, with each course duration lasting 3 months. Since its inception, the centre has trained 890 women and youth in urban farming especially in making of organic fertiliser, biofuel and mixed farming from Kiboga, Kulambilo and Kampala districts. Two hundred and fifty three (253) of which being direct beneficiaries of NARO-NaLIRRI CGS funding.

Moving forward, Dr. Nambatya plans to expand the training facility to accommodate more students including establishing a dormitory for her students including the 400 students in the waiting queue for the training programme. Dr. Nambatya is appreciative to among other NARO – NaLIRRI for developing technologies which address real challenges and the financial support which has impelled a positive change in the lives of many.

She further encourages youth and women not to despise farming but embrace urban farming to overcome family poverty and live better lives. "The idea of not having sufficient land and then resorting to looking for white colour jobs is not good enough. We need to engage in urban farming because you can generate money and supplement your family income every day" – she noted.

> **Using knowledge acquired from NARO** and Dr. Jolly Kabirizi in particular, I started training women and youth every Saturday



NARO'S **YOUTH ENGAGEMENT** STORY

By Victoria Mbigidde, Joshua R. Muhumuza and Jolly Kabirizi*
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The group has trained 2,466 stakeholders in Kampala, Wakiso, Masaka, Mityana, Soroti, Gulu, Kamuli, Luwero, Mukono and Mpigi districts.

Youth unemployment remains a serious policy challenge in Uganda with causes ranging from inadequate investment/ supply side of jobs, insufficient employable skills and high rates of labour force growth at 4.7 percent per annum.

Bavubuka Twekembe ("Youth coming together for a common cause")
Born in April 2015, Bavubuka Twekembe Group is located in Seguku village, Makindye sub-county, Wakiso district. From a membership of 2 in 2015, the group now has 29 members 15 of which are female and 14 males. The group was started with an aim of engaging in agricultural activities as a source of employment and therefore an income generating activity.

This group of likeminded youth believes that agriculture is a viable source of income and can therefore sustain livelihoods.

With both meeting and working space offered by "Kyakuwa Farm" also located in Seguku village on Kampala – Entebbe road, the group engages in a number of income generating activities resulting into products including but not limited to sweet potato silage, maize haylage, and Calliandra and Gliricidia sepium (Gliricidia) leaf hay. In addition, the team offers training to farmers in various aspects of crop and livestock production.

Commercial sweet potato vines silage production
Sweet potato is a staple root crop in Uganda that yields considerable above ground biomass in form of leaves and vines as a joint product to the roots. Sweet potato residues (vines, nonmarketable roots and peels) are some of the most widely used residues as livestock feed in smallholder systems in Uganda. One major negative



The group has since trained 1,307 farmers on silage production and utilization in Wakiso, Kamuli, Masaka, Jinja, Luwero, Gulu, Lira, Hoima and Kampala districts



attribute of sweet potato residues is that although they are a good source of energy (roots) and protein (vines), they are highly perishable. In case of urban and peri-urban areas, sweet potato residues create a disposal problem as they are dumped within the markets after sale of roots.

Conserving sweet potato residues as silage has potential to mitigate seasonal feed shortages and help cope with seasonal feed price fluctuations that many smallholder pig and dairy cattle producers experience. In addition, it provides an opportunity to reduce waste in urban markets and at household level and can open up business opportunities for youth and women.

Bavubuka Twekembe group sees sweet potato silage making as a strategy to improve food and feed security among livestock farmers and an income generating activity among members of the group. NARO through NaLIRRI has facilitated the group to train farmers on silage production and utilization. With this support, BTG group offer services to farmers by making silage and also trains farmers on silage production and utilization. The group has since trained 1,307 farmers (women, youth and men) on silage production and utilization in Wakiso, Kamuli, Masaka, Jinja, Luwero, Gulu, Lira, Hoima and Kampala districts.

Dairy cow and calf pellet production and marketing

Through Competitive Grants Scheme, NaLIRRI-NARO supported Bavubuka Twekembe Group to produce and market small quantities of dairy cow and calf pellets (Cottage industry). The group was supplied with pelleting equipment and ingredients to produce pellets which resulted in production of 5 tons of dairy pellets and 1 ton of calf pellets which were sold to farmers and retailers at UGX 1,800 per kg.

Fruit tree grafting

A technician from the National Agricultural Research Laboratories-Kawanda trained members of BTG to graft fruit trees such as mangoes and oranges. The group produced and sold 7,000 grafted fruit tree seedlings at UGX 5,000 per seedling.

Capacity building

The group continues to train youth, women and men on aspects of crop and livestock production. The group has trained 2,466 stakeholders in Kampala, Wakiso, Masaka, Mityana, Soroti, Gulu, Kamuli, Luwero, Mukono and Mpigi

districts. Since inception, BTG boasts of the following achievements (2015-2017)

- Conducted 17 farmer workshops on climate smart agriculture technologies and innovations (dairy pellet production and utilization, silage making, water harvesting, improved pig production, dairy cattle nutrition etc.) "We have trained urban and peri-urban farmers on utilisation of NARO technologies among which are the Nutrient feed blocks, silage, haylage, hay, pasture establishment and management, and dairy feed pellet production and utilisation".
- Produced and sold 200 tons of sweet potato silage mainly to urban farmers.
- Created employment opportunities for other youths through production and marketing of dairy pellets, silage and haylage production and raising Calliandra seedlings.
- Changed lives of former wrong elements in society to positive change. Mr Perezi Ssegawa appreciated the input and support from the group. "I was a member of a group which was terrorizing the community. My behaviour has changed because I am interacting with many people who have encouraged me to change to a better citizen. I have acquired skills on agribusiness and as a result, started a small poultry unit which I am very proud of. I am happy because of the contribution of BTG to my personal development"

Ms Nasuuna Stella, a group member and a specialist in dairy value addition noted, "I studied value addition (ghee, butter, yoghurt and cheese production) during my final year project at AFRISA-Makerere University but had no idea of how to tap the bigger market until I joined BTG during their training at the KCCA farm in Kyanja". According to Stella, she went with yoghurt for sale at a relatively higher price, but to her surprise it was all bought with lots of appreciation from people due to the superior quality and since then things have not been the same because sales have increased and more people are calling in to place orders as well as asking for trainings in yoghurt production.

> **My life has greatly changed** because of being a part of **Bavubuka Twekembe group**. I have been able to buy 1 acre of land

This has motivated her into self-employment, something that has changed her childhood dream of working in an office like her relatives with a driver to pick her every morning. "When I was growing up, I always saw my aunt's driver pick her every morning in a big car and dreamt to be like her but now I have a different view of life I am now inclined to self-employment rather than being employed", she narrated.

Mr. Kirumira William, a group member said "My life has greatly changed because of being a part of Bavubuka Twekembe group. I have been able to buy 1 acre of land."

Some of the challenges the group is facing include high cost of inputs, unreliable supply of inputs, adulterated inputs, inadequate funding and climate change. The group has seen more youth expressing interest to join and the number is expected to grow.

BUILDING THE NEXT CADRE OF NATION BUILDERS



By Joshua R. Muhumuza and Barbara M. Zawedde*
*For more information on youth engagements, contact ubic.nacrri@gmail.com

Youth champions are instrumental in encouraging their peers to pick interest in and practice modern agriculture

Uganda Biosciences Information Center (UBIC) was established in 2013 as communications and knowledge sharing hub for NARO. Its main objective is to facilitate informed decision making on modern agricultural technologies generated by NARO.

Youth engagements is a key part of UBIC's outreach strategy because youth constitute the largest percentage of Uganda's labor force, and they are the next cadre of nation builders.

Over 5000 students and educators have been engaged and exposed to modern agricultural research through UBIC's flagship activities—the National Biotechnology Essay Writing and National Primary Schools Poster Drawing Contests. Partnerships have been developed with over nine tertiary institutions, 58 primary and secondary schools, the National Curriculum Development Center and the Ministry of Education. Further, close to 80 youth champions—mostly in collaboration with the Miss Uganda franchise—have been engaged and supported through several initiatives.

In addition, UBIC organizes an internship for the winners of its contests at a NARO research institute. Over the course of the internship, winners receive hands-on training in modern field and laboratory practices, as well as spending quality time with renowned agricultural scientists. During field exercises, participants appreciate the outputs of laboratory work as well as see first-hand the challenges faced in farmers' fields, and the efforts by science to address.

Most of the interns have praised the contribution of this program to their careers, life choices and successes. A good number of interns have drawn inspiration from the internship to pursue careers in agricultural research.

"The entire experience was very inspiring and it motivated me to work harder so that I can join the team of scientists that work tirelessly to the livelihoods of everyday Ugandans through modern agricultural technology" said Sharon Letia who has enrolled for an MSc in Nematology at Ghent University. Omuut Geresemu was motivated to join NARO as molecular biologist and is set to pursue further studies in plant breeding at Makerere University.

"The adoption of modern climate smart agricultural technologies is critical in offsetting the growing global menace that is climate change" said Omuut.

Owen Singura, a volunteer with UBIC has through the connections got during his internship, secured admission at Tel Aviv University in Israel for further studies in plant breeding. Joshua Muhumuza picked up on the impressive work at UBIC and was enthused to join the team where he has continued to inspire fellow youths to join and advance modern agricultural research. "My experience at UBIC has

helped me get a better appreciation of the dynamics in science and the fundamental role of communication in facilitating understanding of science and adoption of its products" he reported.

Several public debates have also been organized in collaboration with various academic institutions, reaching over 2000 youths. Following up on these efforts, UBIC-NARO is involved in efforts to streamline secondary and tertiary education agricultural curricula to integrate modern biosciences. Through engagements with the Sectoral Policy Committee of the Ministry of Education and Sports, support has been garnered to integrate modern sciences during the curriculum reform, train educators in these biosciences and conduct outreach for regulatory compliance in relevant academic institutes.

All such efforts serve to further building of nation cadres with competences to innovate and utilize modern biosciences to improve agricultural productivity and to boost the country's competitiveness on the global scientific arena.



Over 5000 students and educators have been engaged and exposed to modern agricultural research

NARO COMPETITIVE GRANT SCHEME SUPPORTS PATENTABLE INNOVATIONS

Over the years, NARO through the Competitive Grant Scheme (CGS) has been carrying out research with the different public agricultural research institutes (PARIs) in collaboration with universities, private institutes and other entities with the required research capacity. The first Competitive Grant activity in NARO was under the COARD project funded by EU in eastern Uganda in the year 2004. Since then, CGS funded projects were arranged in cohorts, starting with cohort I in 2006 to cohort IV which was concluded in June 2018. Progress made over the years in implementing the scheme has been majorly guided by policy frameworks including Competitive Grants Scheme Guidelines and procedures. While Cohort I operated on a USD 6,000,000 budget under ARTPII from 2006 to 2009 and took on forty four (44) projects. The second cohort occurred between 2010 and 2013, supported thirteen (13) projects with a budget of UGX 622m which was sourced from the government of Uganda supplementary budget. The third cohort run between 2014 and 2017, supporting a total of forty one (41) projects. This lay ground for the fourth, which started in 2017 to 2018 hosting fifty (50) projects. Both cohorts III and IV were funded by the ATAAS World Bank project operating on a UGX 23 billion budget.

With focus on products ready to be commercialized, both cohort three and four presented impressive results whose profiles are describes as follows;



By Victoria Mbigidde, Dr. Barbara M. Zawedde, Dr. Victoria Tibenda *
***For more information on youth engagements, contact: researchdirectorate@naro.go.ug**

Wound healing plant

Commonly known as "plant X", the product has five active compounds responsible for wound healing. These compounds have anti-microbial, anti-tumor, tissue regenerator and anti-inflammatory abilities. Clinical observations at the MRC clinic in Wandegeya have been done to confirm the wound healing effected of this plant. For more information about the wound healing plant contact Prof. Evarist Baruga, barugaevarist@hotmail.com

Herbal medicinal products

This research targeted residual malaria vector control using extracts from lemon grass and lemon eucalyptus. The product is ideal especially for people working outdoors for long hours like fuel pump attendants and security guards. The product is a petrolatum based multi-vector repellant administered topically for management of mosquitoes and other insect bites. For more information about Herbal medicinal products, please contact Prof. Maud Kamatenesi Mugisha, mkamatenesi@gmail.com

Medicinal/aromatic plant tissue culture products

This was focused on the promotion of domestication and sustainable utilization of "Mukuzanume" (Warburgia ugandensis), "Kanzironziro" (Psorospermum febrifugum) and "Mulondo" (Mondia whitei) through promotion of tissue culture propagation system, phytochemical and molecular profiling, and generation of value added products and domestic cultivation of the plant species. *For more information about the aromatic plant tissue culture products, please contact Dr. John Adriko, adrikoj@yahoo.com

Soil test kit

Many farmers do not have access to soil testing service and other relevant support services causing a 30% yield gap due to soil fertility problem. A soil test kit was developed through a partnership between Makerere University and NARO. The kit helps to get immediate answers to what kind of fertilizer and amounts to apply. It currently costs UGX 250,000 and can be used to test about 50 soil samples, and refilling costs half price. *For more information about the Soil Testing Kit, please contact Prof. Moses Tenywa, Email: tenywamakooma@yahoo.com



Biodiesel protocols

Protocols were developed by NARO staff to generate biodiesel from used vegetable oil (UVO). In addition, the team developed local and affordable catalysts for enhancing the biodiesel production process from used vegetable oil and has mastered the efficient recycling of used vegetable oil as an environmentally and economically sustainable renewable energy resource. The product has tremendous and highly scalable for industrial potential if taken up by the private sector. *For more information about biodiesel protocols please contact Dr. Ephraim Nuwamanya, nuwamanyaephraim@gmail.com

Biodegradable plastics protocols

The highly priced global concept of circular bio-economy has attracted innovations in agricultural byproduct wastes to produce products such as goods carrier bags, grain storage bags, antimicrobial/anti-oxidant food wraps, and general sheets, whose impact will be to reduce environmental plastic pollution. For more information about the biodegradable plastics please contact Dr. Steven Tumwesigye Kashub, stvntumwesigye@gmail.com

The green protein technology

The green protein initiative was as a result of proven need to provide alternative protein sources to the conventional fishmeal and soybean meal used in livestock feed. The green protein technology reduces competition between the food and feed value chains and increase livestock productivity. For more information about the green protein, please contact Dr. Alexander Bombom, alexander.bombom@gmail.com

Bee venom processing protocols

Protocols have been developed by NARO staff to harvest and process high quality honey, propolis, making propolis tincture, ointments, lip balm, beeswax, bee venom harvesting were developed. Bee venom is an anti-Inflammatory which relives arthritis, pain and multiple sclerosis. Bee venom contains Melittin, a major component which fuses with HIV, destroying the virus's protective envelope. For more information about the Bee Venom, please contact Dr. Robert Kajobe, robertkajobe@gmail.com



Wine and jam from wild fruits

The initiative taps in the potential presented by edible wild fruit plants. Products emanating from this intervention are wines, jams, and spices. Protocols for producing granules/capsules/tablets are under development. For more information about the Wine and Jam please contact Dr. William Olupot, wolupot@gmail.com

Anti -tick vaccines

NARO scientists have developed three tick vaccines for improved control of tick and tick-borne diseases were developed. The vaccines target the most important ticks in sub-Saharan Africa including Brown ear, Blue and Bont-legged ticks. The anti-tick vaccines are able to control tick attachment, engorgement and reproduction among the vaccinated yearling calves by about 60% - 80%. For more information about the Anti -tick vaccine, please contact Dr. Fred Kabi, fred.kabi@gmail.com

Fruit fly bait

The NARO in partnership with AMOCAS Limited (Uganda) developed low cost and environmentally friendly protein food bait to manage fruit fly. Products include fruit fly monitoring traps and fruit fly suppression bait spray plus a male annihilation technique. For more information about the fruit bait, please contact Dr. Neemeye Posiano via psnemye@gmail.com

Sustainable healthy fish production and value addition

This initiative promotes low-cost sustainable technologies that will stimulate production and increased profitability of commercial aquaculture producers. Three groups namely Kati Farm, Walimi Fish Farmers Cooperative (WAFICOS) and Women Fish Network were engaged as fish producers and processors. Two value-added products: fish sausages and tilapia fish powder, and a live fish market outlet in Kampala city are supported. For more information contact Dr. John Walakira, johnwalakira2003@gmail.com

Wood waste products

During wood processing, large volumes of wood waste is generated. NARO scientists have developed two prototype machine which convert saw dust into briquettes, and one prototype machine that makes firelighters. The initiative also uses the Gluelam technology to converts short pieces of timber into commercial products such as tables, cutting boards and domestic utensils. For more information about

wood waste products, please contact Mr. Kiwuso Peter, kiwusopeter@yahoo.com



Unlocking the potential of bamboo

Bamboo resource in Uganda has not been fully exploited for product commercialization. Assorted bamboo furniture, jewelry and internal decor products were development in partnership with local artisans. Germplasm conservation and characterization are underway. For more information about Bamboo resource, please contact Dr. Hillary Agaba, hiagaba@yahoo.com

Forage chopper prototype

In order to reduce wastage of feed resources, NARO designed an effective and efficient forage chopper prototype with excellent chopping mechanisms, reliability, utility and fuel-use efficiency. The NARO motorized forage chopper prototype is efficient, reliable, has excellent fuel-saving capacity and it cheap relative to various commercial prototypes. The equipment is suitable for small and mediums dairy farmers. For more information about the calf pen, please contact Dr. Mugerwa Swidiq, mugerwaswidiq@gmail.com

The smoking Kiln

This project aimed at reducing the high level (40,000 ppb) of polycyclic aromatic hydrocarbons (PAH) in Uganda's smoked fish. The EU market demands maximum PAH level of 2ppb, but World Health Organization recommends 5ppb in any food for human consumption. The high levels of PAH found in most smoked fish are a result of local processors entirely depending on the traditional hot smoking method. In order to avert this challenge, NARO's scientists developed and released a food grade NARO PAH-Safe Fish Smoking Kiln in 2018. This kiln made a breakthrough in reducing the cancer causing compounds of PAH in smoked fish from 40,000ppb to 0.88ppb, which has opened up market gates for Uganda's smoked fish anywhere in the world. For more information about the smoking Kiln, please contact Eng. Alphonse Candia via alphonsecandia@gmail.com

Ghee processing Mrs. Kyomukama Phoebe Kiruhura district is a hub of cattle keepers and most of them engage in milk and ghee production. The rudimentary methods used traditionally for ghee making resulted in low quality product that fetched low prices. This initiative improved the livelihood of women affected by gender-based violence in Kiruhura district through production, processing, and packaging of high quality local cow ghee both to Uganda and outside markets. This initiative is called Kiruhura Women Entrepreneurs in Ghee Processing (KWEG). For more information about Ghee processing, please contact Mrs. Kyomukama Phoebe and Sylivia Baluka, sbaluka3@gmail.com



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