NARO




# ANNUAL REPORT

## 2022-2023

National Agricultural Research Organisation (NARO)

**Recommended citation**
National Agricultural Research Organization 2023, Annual Report 2022-2023.
Entebbe, Uganda.

**Fair use policy**
Reproduction of the text from this Annual Performance report for educational or non-commercial use is authorized without prior permission from National Agricultural Research Organization provided proper citation is made and the material is used accurately and not in a misleading context.

**Author:** National Agricultural Research Organisation

**Content Review:** Dr. Yona Baguma, Dr. Sadik Kassim and Dr. Damalie Akwango Aliau.

**Lead Editor and Compilers:** Joshua Guina, Dr. George Lukwago, Victoria Mbigidde, Christine Elong M, Jane Kugonza, Abbey Sseguya and Eliza Nahayo

**National Agricultural Research Organisation (NARO) Secretariat**
Plot 11-13, Lugard Avenue, Entebbe
P. O. Box 295, Entebbe, Uganda
**Tel:** +256 41 320 512, +256 41 3203 41/2
**Fax:** +256 41 321 070
**Email:** dgnaro@naro.go.ug

**Website:** www.naro.go.ug







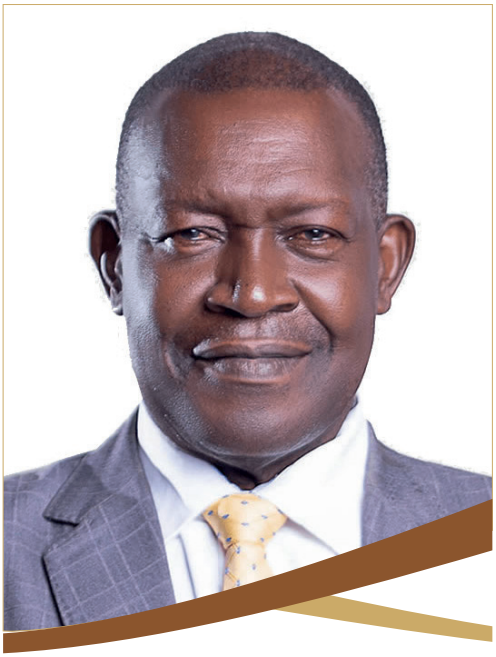
# TABLE OF CONTENTS


| | |
|---|---|
| MESSAGE FROM CHAIRMAN NARO GOVERNING COUNCIL | 2 |
| MESSAGE FROM DIRECTOR GENERAL NARO | 3 |
| **SUMMARY OF NARO PERFORMANCE FY 2022/23** | 9 |
| **CHAPTER 1: INTRODUCTION** | 13 |
| **CHAPTER 2: TECHNOLOGY GENERATION** | 17 |
| **CHAPTER 3: TECHNOLOGY PROMOTION** | 29 |
| **CHAPTER 4: AGRICULTURAL RESEARCH STRENGTHENING** | 35 |
| **CHAPTER 5: GOVERNANCE AND MANAGEMENT** | 41 |
| **CHAPTER 6: PROFILES OF SELECTED PROJECTS** | 45 |
| PICTORIAL: EVENTS | 60 |
| LIST OF PUBLICATIONS | 66 |




# Message from Chairman NARO Governing Council

**I welcome you all to NARO's annual report for FY 2022/23. This was a year of transition at various levels especially the top leadership. The year ushered in the 5th NARO Governing Council that I chair and a new Director General, Dr. Yona Baguma. It is important to note that "A leader's job is not to do the work for others, it's to help others figure out how to do it themselves, to get things done, and to succeed beyond what they thought possible," – Simon Sinex.**



In light of this, the new leadership continued to create an enabling environment to foster the much-needed growth. In particular Council passed a number of policies and provided guidance to enable staff effectively contribute to achieving NARO's overall goal. I therefore thank NARO top management and the entire staff for their efforts to support the process.

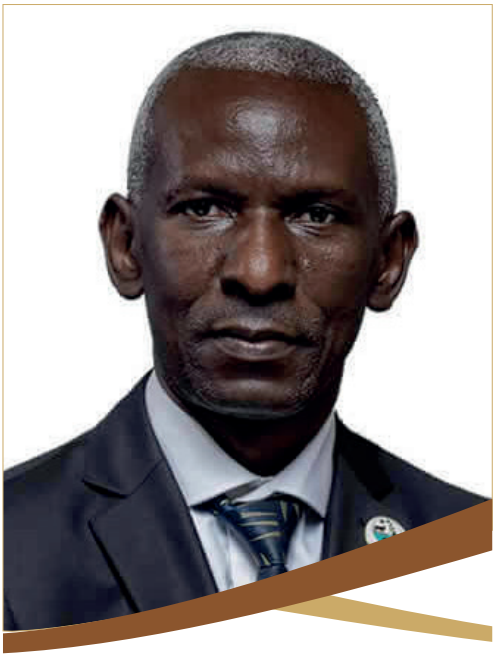
This report highlights a number of breakthroughs achieved including infrastructure for agriculture research (laboratories, offices, technology demonstration and training centers), capacity built, innovations commercialized, demand driven technologies developed, and partnerships established. It further presents technology demonstration and multiplication centers established, scientific publications, to mention but a few.

These achievements provide the momentum for NARO to innovate further and contribute to the promising future of agricultural research. Finally, I thank the government of Uganda, development partners and our stakeholders for their unwavering support which enabled us to make these achievements.

**Dr. William Olaho Mukani**
**Chairman NARO Governing Council**

# Message from Director General NARO

**The FY 2022/23 was considered a landmark for NARO, during which it was retained as an entity following the government decision to rationalize agencies and positively restructured with help of the Ministry of Public Service. NARO also continued to strengthen her product pipelines in crops, livestock, fisheries, and forestry which technologies and innovations contribute to total factor productivity, hence making agriculture more attractive as a business.**



During this period, top leadership also evolved. I thus, take this opportunity to thank the previous members of the 4th NARO Governing Council, led by Prof. Joseph Obua, for steering NARO forward in the right direction at the frontiers of agricultural research. To the new team of the 5th NARO Governing Council, under the able leadership of Dr. William Olaho Mukani, we welcome you, thank you for the good work you have done thus far, and wish you success in developing enabling policies towards improving NARO's performance at all levels.

I thank my predecessor, Dr. Ambrose Agona for leading the organization for the last nine years and as well express my gratitude to him for his leadership, wisdom, and direction in bringing NARO to this point as a potent research brand on a national and international level.

Reflecting on NARO's performance during this financial year, we have made significant breakthroughs at the frontiers of agricultural research for development. The launch of anti-tick vaccine on-farm trials in five different agro-ecologies; the isolation and identification of atoxigenic (non-poisonous) ***Aspergillus flaus*** strains of Ugandan origin to manage aflatoxin in cereals and nuts; the development of over 40 different products suited for food and nutrition security, and industry for commercialization, are a clear manifestation of the sheer determination and continued commitment of the NARO team.

A total of 23 crop varieties were submitted to the National Variety Release Committee of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

> **I thank my predecessor, Dr. Ambrose Agona for leading the organization for the last nine years and as well express my gratitude to him for his leadership, wisdom, and direction in bringing NARO to this point as a potent research brand on a national and international level.**



While these varieties are still undergoing vetting, upon release, the crop varieties will reduce workloads and costs of production, increased food and nutritional security, increased seed access, favorable market access and incomes for women and youth. They will further contribute to agro-industralization since they are suitable for industrial use in the manufacturing of products such as beer, confectionery, starch and ethanol.

To make NARO more responsive towards mitigation against food and feed insecurity that hit the country, NARO actively participated in the production of seeds (maize, beans, soybean, and sorghum), under the leadership of MAAIF.

Remarkable milestones were also achieved in the areas of commercialization, agro-mechanization, and forestry.

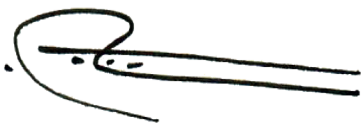
I applaud all NARO scientists who contributed to the global body of knowledge. During this period, NARO published more than 100 peer reviewed scientific papers in reputable journals. The Biennial NARO-MAK Scientific Conference was also held and aided dissemination of research results, and agricultural knowledge to over 300 participants from across the globe.

It's worth to note that NARO doesn't operate in isolation, we hence broadened our boundaries by establishing strategic partnerships through formal MoUs. On this note, let me appreciate all our partners (new and old) in development.

Since each of us is as strong as our weakest link, I beg of you to join forces with me as NARO creates a national sustainable food system that is accessible to all population demographics.

We appreciate the financial support from GOU, donors and development partners.

Lastly, I urge everyone to read the annual report as a key reference to the contribution of NARO to Uganda's social and economic transformation.



**Dr. Yona Baguma**
**Director General**

# Sector Political Leadership



**Hon. Frank K. Tumwebaze**
Minister of Agriculture, Animal Industry and Fisheries



**Hon. Bwino Fred Kyakulaga**
Minister of State for Agriculture



**Hon. Bright Rwamirama**
Minister of State for Animal Industry



**Hon. Hellen Adoa**
Minister of State for Fisheries

# The 5th NARO Governing Council



**Dr. William Olaho Mukani**
Chairperson NARO Governing Council



**Rev. Dr. Susan Awino**
Chairperson, Users Committee



**Ms. Nankunda Olivia Mpuuga**
Chairperson, Audit and Risk Committee



**Mr. Katungisa Kenneth**
Chairperson, Finance and Human Resources Committee



**Dr. John Wasige**
Chairperson, Science Committee



**Ms. Masika Kateeba Jolly**
Member, UC



**Prof. James M. Kajete**
Member, UC/SC



**Ms. Nanvuma Rehema Wandera**
Member, FHRC



**Dr. Martin Patrick Ongol**
ED, UNCST Member, SC



**Ms. Akullo Sharon Atoo**
Member, UC/SC



**Dr. Sylvester Dickson Baguma**
Member, SC



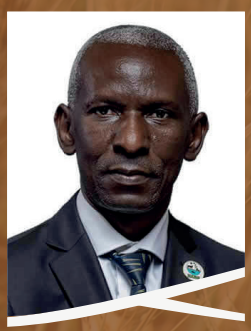
**Dr. Ramathan Goobi**
PSST, MoFPED
Member, FHRC



**Maj. Gen. David Kasura-Kyomukama**
PS, MAAIF
Member, FHRC



**Dr. Samuel Mugasi**
Executive Director, NAADS
Member, FHRC & UC

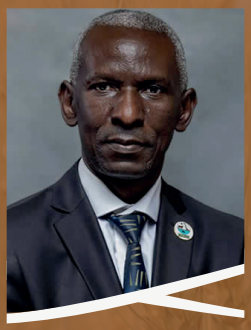


**Dr. Yona Baguma**
Director General, NARO
Member, FHRC & SC

# NARO Management



**Dr. Ambrose Agona**
Director General – NARO
(out-going)



**Dr. Yona Baguma**
Deputy Director General, Research coordination (Incoming Director General)



**Dr. Sadik Kassim**
Deputy Director General, Technology Promotion



**Mrs. M. T. Kiggundu**
Director, Finance



**Mr. Robert Bagonza**
Director, HR



**Mr. Denis Owor**
Director, Audit



**Dr. Justus Rutaisire**
Director, Corporate

# Directors of Public Agricultural Research Institutes



**Dr. Godfrey Asea**
National Crop Resources Research Institute (NACRRI)



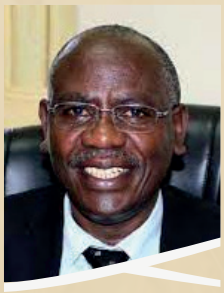
**Dr. Geoffrey Arinaitwe**
National Coffee Research Institute (NaCORI)



**Dr. Winnie Nkalubo**
National Fisheries Resources Research institute (NaFIRRI)



**Dr. Hillary Agaba**
National Forestry Resources Research Institute (NaFORRI)



**Dr. Wilberforce Tushemereirwe**
National Agricultural Research Laboratories (NARL)



**Dr. Swidiq Mugerwa**
National Livestock Resources Research Institute (NaLIRRI)



**Dr. Michael Ugen**
National Semi Arid Resources Research Institute (NaSARRI)



**Dr. Lawrence Owere**
Buginyanya ZARDI



**Dr. John Walakira**
Abi ZARDI



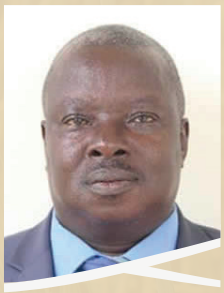
**Dr. Sylvester Dickson Baguma**
Bulindi ZARDI



**Dr. Halid Kirunda**
Mbarara ZARDI



**Dr. Barbara Zawedde**
Mukono ZARDI



**Dr. Laban Turyagyenda**
Ngetta ZARDI



**Dr. Rubooni Tumuhibise**
Rwebitaba ZARDI



**Dr. Alex Barekye**
Kachwekano ZARDI



**Dr. Paul Okullo**
Nabuin ZARDI

# SUMMARY OF NARO PERFORMANCE FY 2022/23

***NARO contributes to NDP III programs particularly the Agro-industrialization program and other government frameworks including Presidential strategic guidelines and directives. It develops and promotes appropriate technologies, innovations and management practices aimed at increasing productivity and production for improved livelihoods and economic development.***

In addition to coordination of agricultural research in the country, NARO undertakes agricultural research through her 16 PARIs in all aspects of agriculture including crops, livestock, fisheries, forestry and cross cutting areas. In the FY 2022/23, NARO registered tremendous achievements in technology generation, technology promotion, Agricultural research strengthening and, governance and management surpassing most of the physical performance targets in light of the key indicators:

## Technology Generation

| | |
|---|---|
| **6** | Varieties with various desirable attributes released |
| **23** | Crop varieties submitted to the National Variety Release Committee for release |
| **1** | Lablab pasture variety submitted for enlisting on the National Variety Register |
| **97** | Improved agricultural technologies and innovations developed and adopted. |
| **24** | Research products and services suitable for industry developed. |
| **48** | Research products and services for food and industry generated. |
| **10** | Markets created along product lines to diversify market opportunities. |
| **2** | Bio-fortified technologies developed and promoted to enhance nutrition. |
| **1100** | Crop genetic resources and 5 Animal genetic resources conserved for sustainable utilization. |
| **3** | Putative genes with potential of increasing production of bio-based oils in shea nut tree identified. |
| **1** | A digitized soil sheet for Masaka region was updated from a scale of 1:250,000 to 1: 50,000 |
| **3** | Improved Macadamia varieties KMB-3, KRG-15 and MRC-20 with high yielding and faster maturity traits adapted. |
| **8** | Soil crop suitability maps and fertilizer blends developed in effort to enhance soil Fertility. |

## Technology Promotion

| | |
|---|---|
| **5** | IPs and innovations commercialized. |
| **5** | Agricultural research platforms established. |
| **9** | Climate smart technology demonstrations established. |
| **700** | Tons of assorted seed of maize, beans, soybean and sorghum produced and distributed to seed companies, community seed producer groups and individual farmers. |
| **70,000** | High quality Hass Avocado plantlets raised from clean root stocks and scions for supporting establishment of mother gardens. |
| **1.6M** | Assorted fish seed (800,000 Tilapia, 12,500 mirror carp and 800,000 Catfish fingerlings) were produced and distributed to hatcheries and lead farmers. |
| **51** | Public-Private Partnerships established for technology development and promotion. |
| **10** | Farmer groups empowered in quality seed production under capacity development initives for community seed producers. |
| **26** | Stakeholder groups trained on new agricultural technologies and innovation. |
| **176** | Scientific publications in peer reviewed journals, 20 IEC materials and 5 high-level bulletins to update policy makers were produced. |
| **1** | issue of Uganda Journal of Agricultural Sciences (UJAS) published. |

## Agricultural Research Strengthening

### Human Resources Development

- 12 staff were trained (4 PhD, 2 Msc, 6 short courses)
- Several supported to subscribe on professional bodies
- Tremendous achievements in enhancing staff salaries and performance management

### Financial Resources Mobilization

- Budget increased to 117.926 billion compared to 110.607bn in 2021/22
- Off-budget project grants amounted to 59.713bn
- The overall fund absorption performance 100%

### Infrastructure Development

- 2 Research and administrative infrastructure constructed
- 1 Research and administrative infrastructure rehabilitated
- 2 research laboratories constructed,
- 1 research laboratory rehabilitated,
- 1 research laboratory equipped,
- 2 demonstration facilities constructed
- 1 demonstration facility equipped

### Securing Agricultural Research Land

- Tremendous achievement on land protection through boundary opening, surveying, development of deed plans, titling, fencing and mutual partnerships that promote secure land use.

## Governance and Management

- A new organisational structure and staff establishment approved.
- Two (2) guidelines for streamlining access and sharing of biological resources and submission of candidate varieties processes approved.
- Performance management and engagements for resource mobilization increased.
- NARO's performance and compliance ratings by Government MDAs and Development partners were high: Budget Monitoring and Accountability Unit (BMAU) of MoFPED at 80%; National Planning Authority (NPA) at 76.1%; Equal Opportunity Commission (EOC) at 76.6%; Auditor General expressed unqualified opinion on her annual accounts.
- Overall, NARO was compliant to national policies and frameworks.



CHAPTER 1

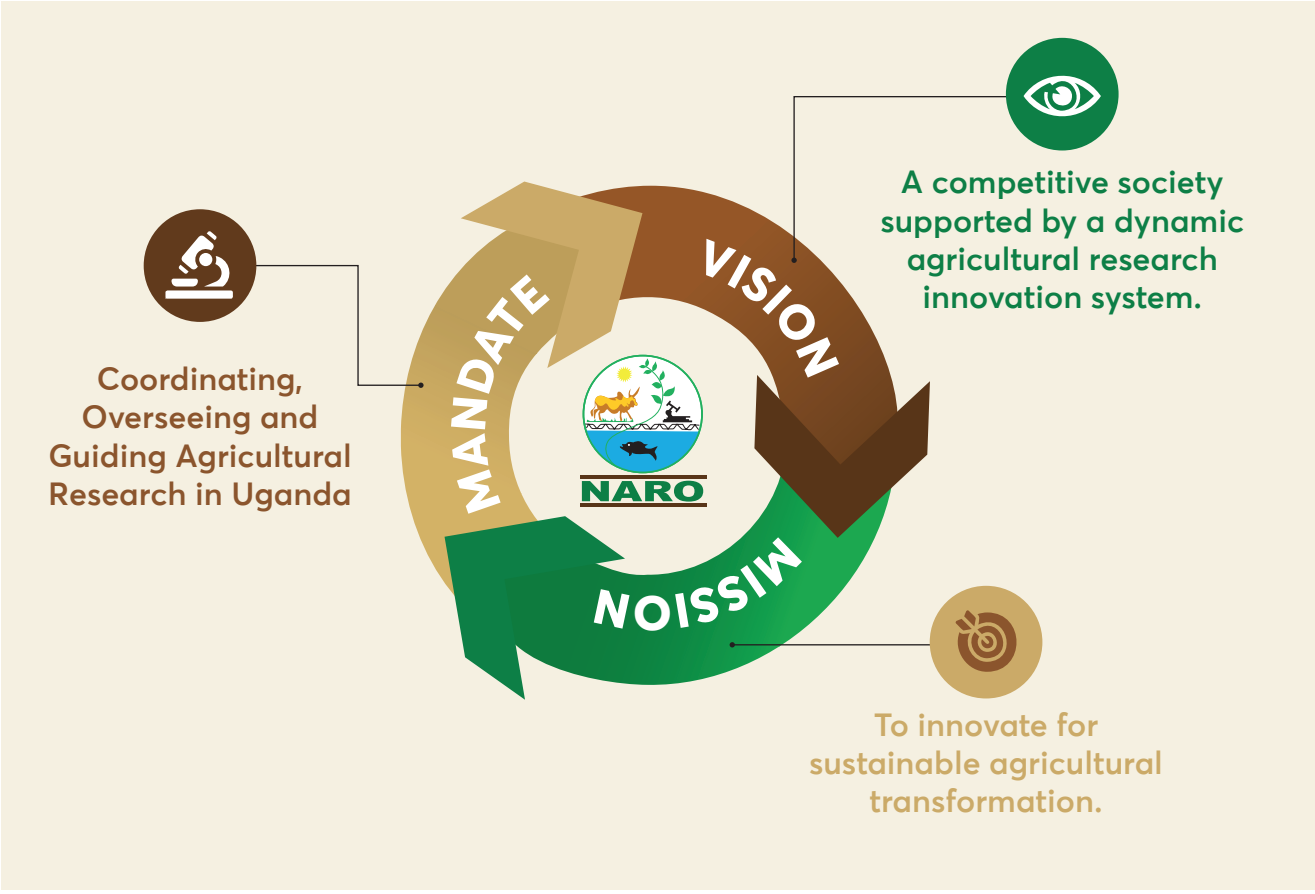
# INTRODUCTION

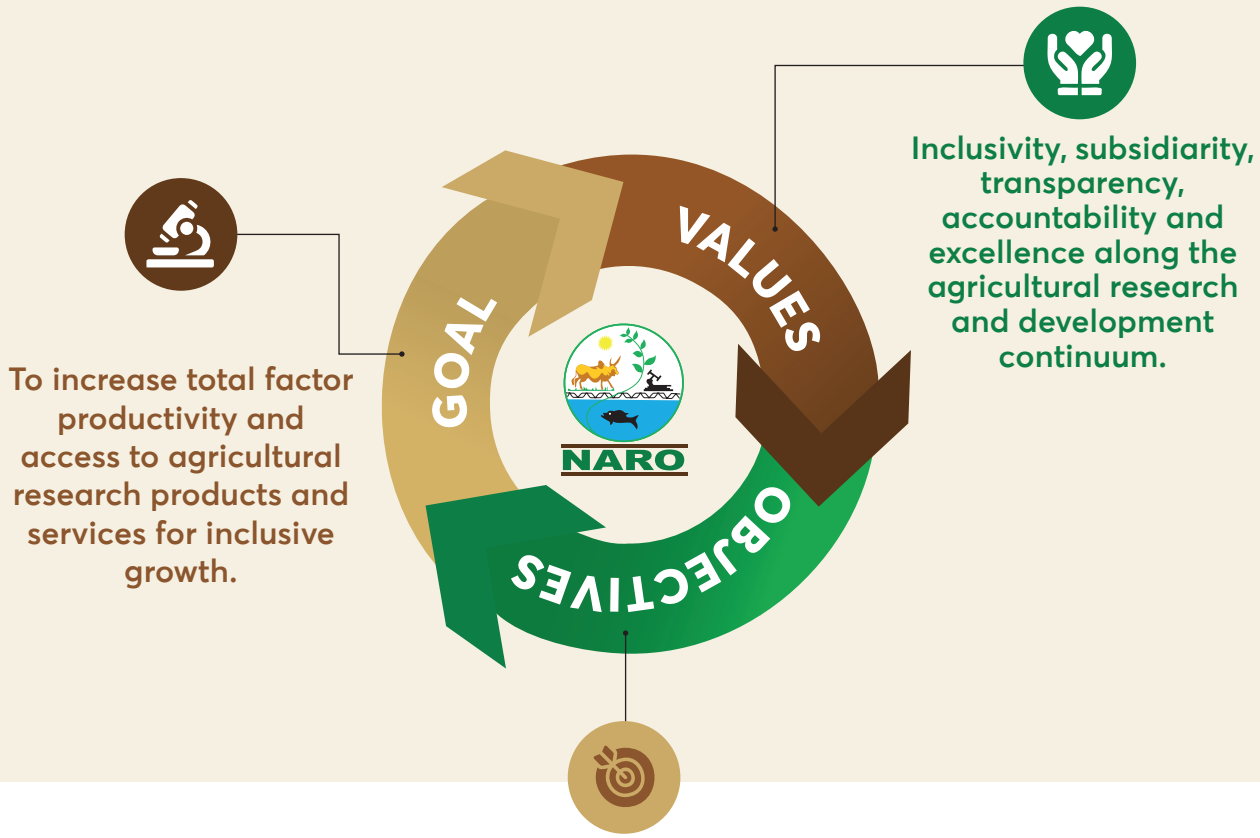
## 1.1 Background

***The National Agricultural Research Organisation (NARO), is an agency of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). NARO was first established by a Statute of Parliament in 1992 and later reformed by the National Agricultural Research (NAR) Act of 2005 as a body corporate with mandate to coordinate, oversee and guide agricultural research in Uganda. NARO comprises a Governing Council, a Secretariat and 16 Public Agricultural Research Institutes (PARIs).***

The PARIs consist of 7 National Agricultural Research Institutes (NARIs) conducting research of national and strategic importance and 9 Zonal Agricultural Research and Development Institutes (ZARDIs) serving specific research needs of our diverse agro ecological zones. NARO Conducts research in all aspects of agriculture including crops, livestock, fish, forestry and cross cutting areas.

## 1.2 Mandate, Vision, Mission, Goal and objectives






***NARO is primarily financed by government through vote 142 with the following strategic objectives:***

- **i)** Develop and promote demand-driven technologies, innovations and management practices that respond to target clientele demands
- **ii)** Increase research products and services suited for vertical integration into industries
- **iii)** Improve access and sustainable utilization of improved agricultural technologies and innovations by communities
- **iv)** Increase Total Factor Productivity to accelerate community institutional orientation to agricultural transformation.
- **v)** To improve farmers' Allocative Efficiency to ensure optimal productivity at minimal cost.

## 1.3 Alignment of the research agenda

NARO adopted a 5-year strategic planning. The current strategic plan (2020/21 – 2024/25) focuses on research and innovation towards increased development and utilization of research products and services suited for market and industry and is well aligned to the National Agriculture Policy (2015), Agriculture Sector Strategic Plan and the

National Development Plan (NDP) designed to pursue Uganda's vision 2040 on transforming the country from peasantry to industry and prosperity.

Currently NARO mainly contributes to the NDP III programme on Agro-industrialization whose objectives include: (i) increased production and productivity, (ii) improved post-harvest handling and storage of agricultural products, (iii) increased agro-processing of the priority products, (iv) increased market access and competitiveness of agricultural products in domestic and international markets, (v) increased mobilization, equitable access and utilization of agricultural finance, and (vi) strengthen institutional coordination for improved service delivery. NARO also contributes to three other NDP III programmes: (i) Regional development, (ii) Environment and Natural resources; (iii) Innovation, Technology development and Transfer.

In pursuation of the national aspirations, NARO's research agenda is equally well aligned to regional, continental and global commitments (R&D guiding policies and planning frameworks) especially the Comprehensive African Agricultural Development Programme (CAADP) and Malabo declaration on accelerated agricultural growth and transformation, African Union Agenda 2063 on inclusive and sustainable socio-economic development and Sustainable Development Goals especially SDG 1, 2, 3, 12, 13 and 14.

## 1.4 Interventions during the FY 2022/23

In the FY 2022/23, NARO developed and disseminated several technologies, innovations and management practices (TIMPs) with a goal to increase agricultural productivity and production contributing to food and nutrition security, economic growth and agro-industrialization.

The interventions forcused on developing and deploying disease and pest resistant, climate-resilient and nutrient rich crop varieties; Improving livestock productivity through sustainable solutions; Innovations towards improving the fisheries sector both capture fisheries and aquaculture; Innovations in forestry and sustainable natural resources management; and Cross cutting interventions in agro-machinery and socioeconomics.

This report presents progress recorded against those interventions under four broad sections of technology generation, technology promotion, Agricultural research strengthening and, governance and management in line with her key performance indicators. The report is organized into 6 chapters including the introductory chapter and profiles of selected projects.





CHAPTER 2

# TECHNOLOGY GENERATION

***NARO generates technologies in all aspects of agriculture including crops, livestock, fisheries, forestry, and cross cutting areas such as agricultural engineering and social economics with a goal to enhance agricultural production and productivity in the country.***

## 2.1 Development and deployment of disease and pest resistant, climate-resilient and nutrient rich crop technologies

During the FY 2022/23, NARO generated various crop technologies addressing production, productivity and food nutrition challenges. These include:

### a) Six (6) varieties with various desirable attributes released: 2 maize (NARO MAIZE 63 Vita and NARO MAIZE 64STR), 2 rice (WDR 73 and KF 20039) and 2 sweet potatoes (NARO SPOT 6 and NAROSPOT 7)

NARO MAIZE 63 Vita is high in protein with provitamin A content 12.2 µg/g. It has grain yield of 7.0 – 7.8 t/ha with milling percentage ≥60% flour. It matures in about 120 days, its tolerant to drought and foliar diseases and performs well in mid-altitude regions. NARO MAIZE 64STR is resistant to striga, high yielding (6.5 – 7.5t/ha and 3.5 – 4.0 t/ha under striga free and striga conditions, respectively. It has a high milling percentage ≥60%. It is tolerant to foliar diseases and adapted to mid-altitude regions.



*NARO MAIZE 63 Vita variety with orange colored seed.*

Rice variety WDR 73 is high yielding (9.5- 10tons / ha) with large heavy grains (32grams/1000grains). It has moderate aroma and matures in 130 days. It is tolerant to Rice Yellow Mottle Virus (RYMV), Rice blast, BLB, Narrow leaf spot and moderately resistant to bacterial leaf blight and bacterial leaf streak. Rice variety KF 20039 is moderately yielding, with large heavy grains (32grams/1000grains). It has moderate aroma and matures in 130 days. It is tolerant to RYMV, Rice blast, BLB, Narrow leaf spot and moderately resistant to bacterial leaf blight and bacterial leaf streak.



*Rice variety WDR 73 with characteristic heavy grain.*

NARO SPOT 6 is high yielding (32.49 t/ha- 36.20t/ha) and matures in 120 days. It is moderately resistant to Sweet-potato virus disease, Alternaria blight disease and Sweet potato weevils, and is widely adapted. It has high dry matter content of 32-35% and is suitable for industrial use (flour and grade starch-yield 66.1%). It also has uniform storage root shape with smooth skin suitable for processing and export.



*NARO SPOT 6 variety.*

**b) 23 crop varieties submitted to the National Variety Release Committee of MAAIF: 11 sorghum, 3 cassava, 3 wheat, 2barley and 4 groundnut varieties**

The sorghum varieties yield between 1,500 to 4,000t/ha, are tolerant to common pests and diseases and have desirable traits for wide industrial use ranging from food, beer and forage.

The cassava varieties are highly resistant to Cassava Mosaic Disease (CMD) and Cassava Brown Streak Disease (CBSD). They have a yield potential of 13t/ha and 5t/ha for fresh root yield and dry yield respectively. They have good industrial processing properties especially manufacture of products such as beer, confectionery, starch and ethanol.



*Roots of one of the candidate cassava varieties submitted to National Variety Release Committee for release.*




*Starch glue prototypes derived from cassava.*

The wheat varieties are rich in zinc and iron, yield between 2.5-4.0t/ha, are tolerant to common wheat diseases, early maturing (90-100 days) and have good industrial processing properties.

Similarly, the barley varieties yield between 3-5 t/ha, are good for brewing, resistant to net blotch and barley sculd disease. They are adapted to highland areas (>1800 masl) where they mature in 100-110 days.

The groundnut varieties are drought resistant, high yielding (2.5-3.0t/ha) and early maturing (80-110 days). They are rich in iron and zinc which are good for children and elderly, have high oil content (55-63%oleic, 8-26%linoleic which are good at reducing heart-related diseases and lowering cholesterol).

All these varieties with high industrial, nutritional and health benefits were under Distinctiveness, Uniformity and Stability trials (DUS). Upon release they will contribute to reduction in nutrient deficiencies and import substitution.

**c) Other crop technologies at various stages of development**

283 Yam genotypes were evaluated and 13 advanced for further evaluation. Farmer participatory variety selection (PVS) results indicated that at least 7 out of the

13 candidate lines were preferred by farmers. Improved yams are good for increased nutrition, food security and household incomes.

Three (3) candidate Arabica varieties code named D/11/6, D/12/12 and A/3/13 were in advanced stages of generation. These varieties are tolerant to major pests and diseases and climatic variability. They possess over 80% cup quality and out-yield variety SL14 by over 60%.

376 tea genotypes were characterized both genetically and physio-chemically to understand their genetic and physicochemical diversity which is a pre-requisite for systematic breeding. As a result, 60 tea genotypes have been functionally characterized and selected using the selection index for both high quality black or green tea.

500 cocoa trees were profiled both on-station and on-farm to identify suitable trees for multiplication, conservation and sourcing clonal seed material for on-station trials, scions for grafting and vegetative production. NARO sourced elite cocoa varieties in the form of scions from the International Cocoa Germplasm DataBase (ICGD), University of Reading (UK) for multiplication and utilization in the cocoa-breeding programme. Meanwhile, a cocoa demonstration field has been maintained on-station for training of farmers on good agronomic practices (GAPs).



*Cocoa trees being profiled for seed material and breeding purposes.*

One (1) banana variety, NARITA 17 (high yielding, resistant to black Sigatoka, weevils, and nematode damage) was identified for release while five hybrids were recommended for advancement from Performance Yield Trials (PYT) to on-farm trials. The focus in improvement of the East African Highland Bananas (matooke) is to increase yield and resistance to pests and disease while maintaining good quality and sensory attributes.



*NARITA 17 banana variety with several leaves free of black Sigatoka.*

NARO initiated research on Cannabis for pharmaceutical purpose and developed Standard Operating Procedures (SOP) for Cannabinoid extraction, analysis and propagation. Biochemical analysis of Cannabis has been done at the Biotech laboratory at Kawanda for future prospects and advancements.

## 2.2 Improvement of livestock productivity through development and deployment of sustainable technologies

Livestock technologies have been developed under thematic research areas of vaccine research and development; forage improvement, agronomy and conservation; dairy research; beef and meat research; and harnessing insects for food and feed.

### a) Development of safe and efficacious vaccines against livestock pathogens and vectors

Vaccine research was focused on the development of efficacious, safe and affordable livestock vaccines against ticks, Foot and Mouth Disease (FMD) and African swine fever (ASF) viruses.

**Anti-tick vaccine trials** - Multi-locational Anti-tick vaccine trials of 4 injectable anti tick vaccines for controlling the three economically important tick species notably the Brown ear tick(engoha), Blue tick(Entujjo), and the Bont-logged tick (Embarabara) were conducted in five sites (Kiburara, Nabuin, Isimba, MbaZARDI, and Maruzi). The results were promising in that the animals in most of the sites were not attacked by ticks nor lost to tick-borne diseases. In addition, laboratory tests of blood samples done showed that the animal body functionality was not interfered with the vaccine. The blood tests further confirmed that the animal products were safe for human consumption. Similarly, there has been a reduction in egg-laying capacity of the ticks from vaccinated animals and where egg-laying occurred, the eggs did not hatch. These positive results give hope towards finding a sustainable solution to the tick burden in the country and beyond.



*Hon. Frank K. Tumwebaze, Minister of Agriculture, Animal Industry and Fisheries administering an Anti-tick vaccine during trial launch at Mbarara ZARDI.*

**FMD vaccine development** - Some progress was made on collection of samples (>200 samples) from suspected sick animals in sites where there was disease outbreak, identification of viruses from collected samples (at least 40 positive samples) and serotyping of extracted virus strains. Four (4) FMD virus strains are prevalent in Uganda (O, A, SAT1, and SAT2). In the effort to develop candidate FMD vaccine, protocols and tools were optimized for production of cell lines, virus in-activation and production of a vaccine extender. These formative phases will enable the advancement of the research on FMD vaccine.

**ASF vaccine development** - Six (6) African swine fever virus isolates (2 from Western Uganda, 1 from Central Uganda and 3 from Eastern Uganda) have been isolated and purified. The purified isolates constitute the active ingredients for ASF vaccine and will aid in formulation of at least three ASF candidate vaccines. Meanwhile NARO developed an African swine fever rapid on-farm diagnostic kit and established a diagnostic kit production platform with capacity to produce over one million kits annually. The platform would be operationalized to enable massive production of the kit for evaluation and commercialization.

### b) Improvement of forages to enhance livestock feeding and productivity

NARO submitted one (1) Lablab pasture variety under code name T16 for enlisting on the National Variety Register. The Variety has high protein content and is expected to reduce the pressure on soybean for both animal feed and humans. The variety is also high yielding, drought resilient and highly nutritious with high levels of Digestible Protein (DP) amounting to 261g/kg. On the hand, five (5) candidate brachiaria varieties were selected for submission to the Variety Release Committee. These forage varities will enhance live stock feeding and productivity across the country given their wide adaptability.

### c) Enhancing availability of livestock seed (stock)

Over 1600 embryos for beef and dairy cattle were produced of which 100 embryos were availed to uptake pathways. In addition, a functional embryo supply

and distribution center has been established at Bulindi-ZARDI to serve livestock farmers in the Mid-western zone.

#### d) Genetic improvement of indigenous chicken to enhance growth and productivity

Currently, indigenous chicken takes upto twelve months to attain 2kg and 1.5kg for cocks and hens respectively. Efforts have been directed to improve the performance of indigenous chickens by developing elite cocks and hens with the capacity to attain 3kg and 2kg respectively in five months. Sofar, elite cocks and hens that attain 2.7kg and 1.8kg in five months respectively have been developed. This effort is expected to increase chicken production and supply in the country given the wide adaptability of local chicken.



*A section of indigenous chicken under improvement in Mukono ZARDI.*

#### e) Dairy and Beef improvement

Under the relocation project, the trust on dairy cattle has been on improving milk yields and quality (butter fat content) from the current average of 5 litres per cow (2.5 %) to 15 litres per cow (3.5 %). This has been achived through developing a Tropicalized Jersey breed, developing Ankole X Jersey cross breed, and establishing a breed suitability map for Uganda based on breed attributes, agro-climatic, ecological and economic factors. Enhancing feed productivity by developing and promoting adapted, quality and safe forage grass and legume packages; forage processing and conservation practices; and low-cost feed concentrate substitute using aeroponic systems.

While for beef cattle the target is to improve beef productivity and meat quality (meat to bone ration) from 250-300Kg (50%) in 5 years to 600 Kg (30%) in 24 months using Ankole/Zebu x Brahaman crossbreds.



*A section of dairy cattle under improvement at NALIRRI, Nakyesasa.*

### 2.3 Improvement of fish conservation and sustainable harvests and aquaculture productivity

In fisheries, research has been undertaken to improve both capture fisheries and aquaculture.

#### a) Improvement of capture fisheries conservation and sustainable harvest

To contribute to fish conservation efforts, the genetic structure and diversity of *labeo victorianus* in River Kagera and Lake Victoria were established and a policy brief developed. In addition, a predictive model for stocks of USF in Lake Albert was developed and tested. Biodiversity in the critical modified habitats from Nalubale/Kiira dams to Bujagali Dam was also evaluated and determined. The life history and trophic traits of fish stocks were established, estimates of the biomass of invertebrates and Ecopath and Ecosim models of the Lake Edward system developed.

To further sustain biodiversity conservation, 575 fish samples from rivers and streams covering Lake Victoria, Lake Kyoga and River Aswa basins were collected for DNA analysis. Additionally, a report of sources of fisheries, aquaculture, socio-economics and climate/environmental related data (research and statistics) from relevant institutions in African Union member states was developed and gaps in fisheries biostatistics and research identified.

In collaboration with regional institutions such as Regional Economic Communities (REC), Lake Victoria Basin Commission (LVBC), Lake Victoria Fisheries Organization (LVFO) and African Union - Inter African Bureau for Animal Resources (AU-IBAR) recommendations and policy reforms that will aid utilization and also boast fish and aquaculture trade were developed.

In the same vein, awareness about the threatened aquatic wildlife and habitats among all stakeholders was created and communities were trained and equipped with the necessary skills on how to patrol, manage and protect the Community Conservation Area. Further, the Lake Nyaguo Management Plan was developed and submitted to the Minister of Tourism, Wildlife and Antiquities. These efforts would improve fish conservation and sustainable harvests.

**b) Improvement of aquaculture production and productivity**

During the reporting period of FY 2022/23, research in aquaculture focused on improving fish production and productivity with emphasis on seed, feed, health and production practices amongst fish farmers.

To better the understanding of genetic composition of fish destined for culture, the genetic structure of *Labeo victorianus* populations in Lake Victoria and R. Kagera was profiled. In addition, 7000 *Labeo* fry and 25 *Barbus altinalis* broodstock (used to produce 8,334 *Barbus altinalis fry)* were acquired. Over 1,600,000 assorted fish seed (800,000 Tilapia, 12,500 mirror carp and 800,000 Catfish fingerlings were produced and distributed to hatcheries and lead farmers.



***A sample of mirror carp broodstock.***

On feed, two major outputs were achieved; 3.4 tons of quality fish feed were produced and a feed formulation and test diets for infusing omega 3 fatty acids into the fillet of Nile tilapia were developed using locally available resources.

Under Farmer Income Enhancement and Forest Conservation (FIEFOC) II project, 127 farmers were trained on Best Management Practices of integrated rice-fish farming; two (2) integrated rice fish demonstrations were established; randomized control trails on integrated fish- crop culture initiated in five (5) districts covering a total of 400 fish farmers; and 2500 fish seed were stocked in two (2) established integrated rice fish culture demonstration sites. Similarly, 40 farmers were trained on BMPs of integrated rice fish farming and in Best Aquaculture Management (BAMPs) practices of pond management, harvesting, post-harvest and value addition.

To improve value addition in fish, four bio-based

packaging material were produced and characterized. Sensory and shelf-life profiles for smoked, salted, sun-dried and fermented farmed fish products were established.

In collaboration with the Food-land/food systems Africa, a fish business hub was established in Masaka. The hub is composed of a smocking kiln, one storage room, and 15 assorted equipment/items for primary and secondary processing of fish products. All these will facilitate and increase trade of farmed fish.

## 2.4 Innovations in Forestry and Natural Resource management

In an effort to justify conservation of woody plants, their pharmaceutical potential and ultimate contribution to healthy livelihoods was explored. Overall, 50 woody medicinal plants were documented and their attributes in diabetes treatment highlighted. These include Antidiabetic, Anticancer, Anti-inflammatory, Antioxidant, Antiproliferative, Antimicrobial, Anti-ulcerative and Antigenotoxic, anti-fungal and anti-microbial. As a result, an antidiabetic drug under the trademark KAV 400 was issued, published and the registration process with National Drug Authority initiated. a complimentary handbook titled ***antidiabetic woody plants of Uganda*** has been produced will the aim of informing Ugandans about the value of woody plants towards improving their health. The book also targets students, researchers and practitioners in the field of ethnobotany and ethnomedicine.

Under the model of maximum utilization of wood-based resources, commonly considered as wastes during carpentry activities (saw dust and wood shavings), a technology to convert them into useful products (fuel lighters) that contribute to safety and environmental protection was developed.

Development of the lighters was further intentioned to reduce production of dangerous gases as they replace the use of plastics and paper in lighting charcoal stoves. As part of the commercialization process for the product, a certificate for trademark was secured and now produced under "Supalight", the official trade name. The lighters are now available in most supermarkets around Mukono and Kampala.

As a way of reducing desertification and pressure on key wood species for fuel use; two common exotic bamboo species, namely *Dendrocalamus gingateus* and *Bambusa vulgaris*, have been examined and found to have high volatile matter, high proportion of carbonaceous materials, low ash content, i.e., non-combustible minerals and high calorific value. These species have been found to be potential sources of renewable energy, and their usage as fuel source will ultimately reduce pressure on woody sources hence decreasing deforestation that currently stands at 100,000 ha per annum. Other bamboo products that are undergoing exploration include charcoal, biochar, vinegar and tar. Consquently, a pyrolysis prototype for carbonizing bamboo is under development, while cyclone and condenser have been fabricated.

In order to further sustain the raw-material source for bamboo, 4 acres of new bamboo species (*Bambusa polymorpha, Bambusa Bamboo* and *Oxythenanthera abyssinica)* were established at Kifu forest reserve. Maintenance of the old plantation continued and efforts to explore its ecotourism potential underway.



*On-station bamboo plantation targeting ecotourism.*

In a bid to improve Macadamia production, three improved Macadamia varieties KMB-3, KRG-15 and MRC-20 with high yielding and faster maturity traits (mature in 3 years compared to 8 years exhibited in the locally available varieties) were adapted. Two mother gardens each of 4 acres were established in two agro-ecological zones of Lake Victoria crescent (Kifu Mukono) and the western highlands (Kyegegwa). These will serve as sustainable sources of elite macadamia germplasm for multiplication to enable adequate access by farmers.

As a way of simplifying the exercise of identifying the right tree species for the right sites; a Site-Species-Matching Tool (SSMT) for decision-making on right trees for the right sites was developed and launched in partnership with Gatsby Africa and Geospatial Forestry Platform. The tool is hosted on the Geospatial Forestry Platform (GFP) and can be accessed via the Geospatial Forestry Platform *www.forestryplatform.com.* Through this platform, users can access both free and paid SSMT modules. Three putative genes (Vitpa08g23800, Vitpa09g05750 and Vitpa09g14250) with potential of increasing production of bio-based oils in Shea nut tree were identified. The discovery is expected to direct the breeding of shea trees in Uganda for high oil yield, thus maximizing the commercial potential of the tree.

In an effort to harness the economic potential of Jack fruit and Hass avocado, NARO has profiled the existing jackfruit ethno-varieties for pulp proximate composition. This will guide the selection from the four known ethno-varieties i.e. Kananansi (Yellow/Orange), Namata (White), Namusayi (Red) and Serebera (Soft) for value addition and industrialization. All the jackfruit varieties have moderate Vitamin C, low Vitamin A, low lipid content and low ash content.

With the growing interest in Hass avocado, NARO has contributed 70,000 high quality Hass Avocado plantlets (about 437 acres) raised from clean root stocks and scions. A germplasm mother garden is also maintained as well as screen houses to support production of avocado and other tree planting material.



***Hass avocado plantlets raised from clean root stocks and scions at NAFORRI.***



***Hass avocado grating using clean root stocks and scions at NAFORRI.***



***Typical appearance of Hass avocado fruits.***

NARO has initiated the development of context specific assorted low horsepower weeding implements with the ultimate goal of encouraging

youth to engage in farming and also improve labor productivity of women. To that effect, three (3) weeding implement prototypes including 1st prototype of hand-held low horsepower motorized weeder, 2nd prototype of single axle tractor weeder and 2nd prototype of ox-drawn weeder for legumes are under development.

Cognizant of NPD III aspirations for conservation and sustainable utilization of bio-diversity, NARO continued with her routine efforts of conserving Uganda's bio-diversity at Plant Genetic Resources Centre in Entebbe.

Efforts towards Biodiversty conservation saw 30 genetic resources including Beans 15, Millet 5, Gnuts 4, sorghum 2, Maize 2, and Amaranth 2, being conserved in Hoima community genebank located in Kibaire. Other conservation efforts included mass propagation of *Dendrocalamus asper* species of bamboo and *Mondia whitei* (Mulondo), which are beneficial for both environmental conservation and medicinal product development, respectively. 300 groundnuts lines were generated for conservation and diversity for Africa and global groundnut communities. A digitized soil sheet (Masaka sheet covering nearly five districts) was updated from a scale of 1:250,000 to 1: 50,000) to guide agricultural investment and resource use planning. As a result, sixty-six (66) soil types were identified as compared to only ten (10) under the 1:250,000 scale.

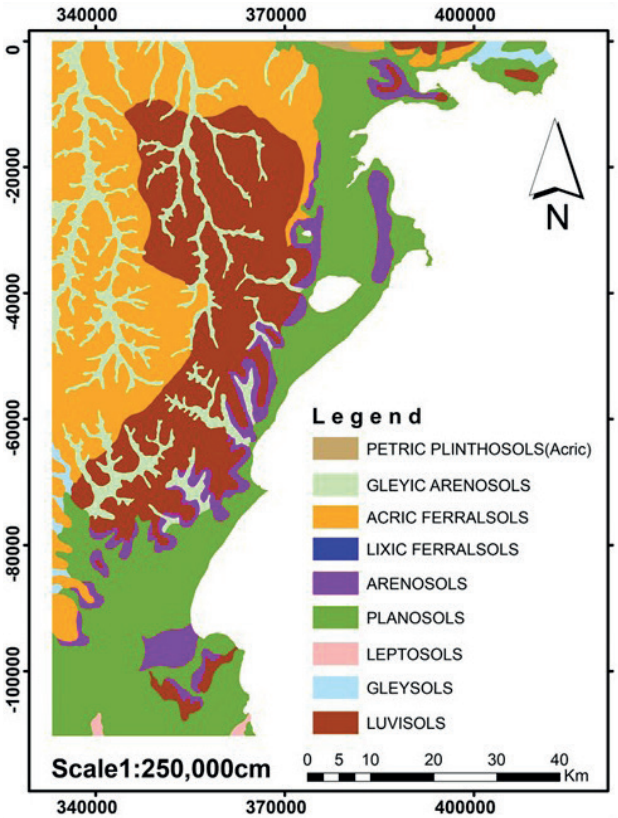


*A section of the various soil type samples studied.*

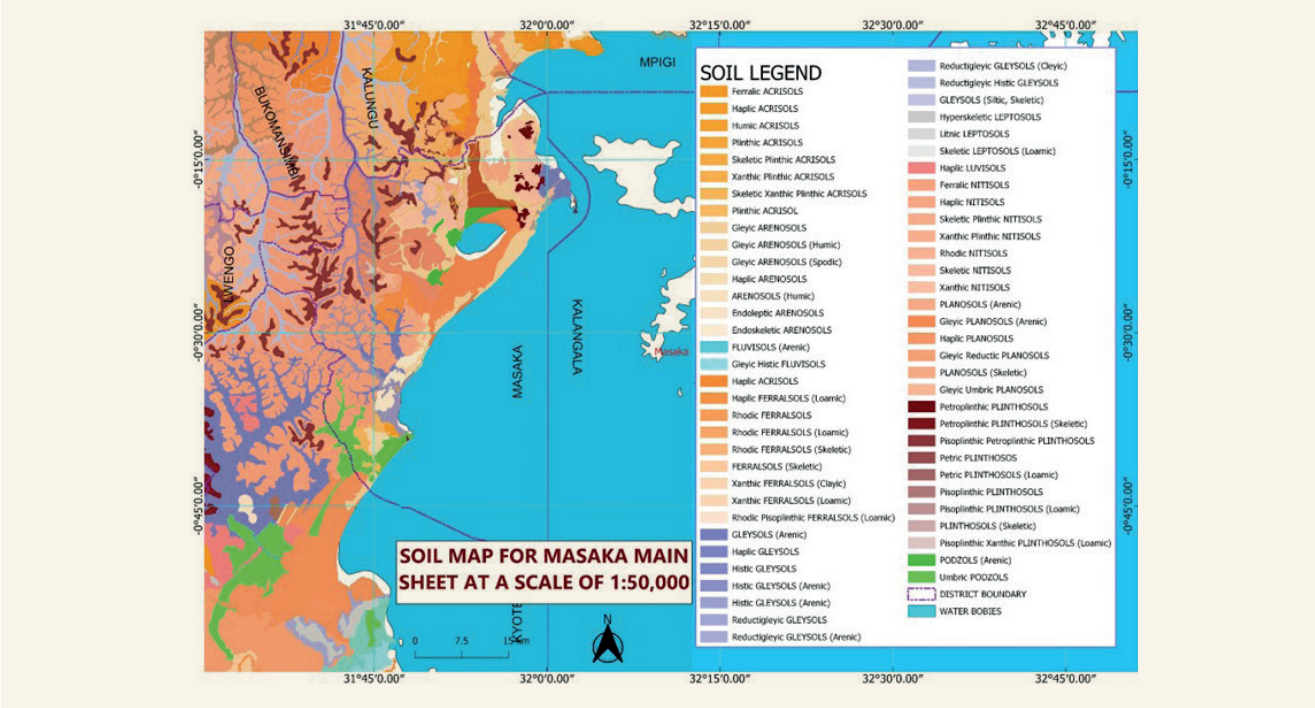
This study found that 64% of soils on the Masaka sheet (fig.5) have severe limitations that either reduce the choice of plants, or require special conservation practices, or both.

Soil suitability for oil palm production in Buwunga, Kyanamukaaka, and Bukakata sub-counties of Masaka district (*Annex 1.3*) was determined guided by the updated soil sheet (1:50,000). 50% of the soils are marginally suitable, 46% are moderately suitable, 0.8% are suitable while 2.4% are not suitable for oil palm production hence the need for sustainable oil palm production through frequent application of organic and inorganic fertilizers.

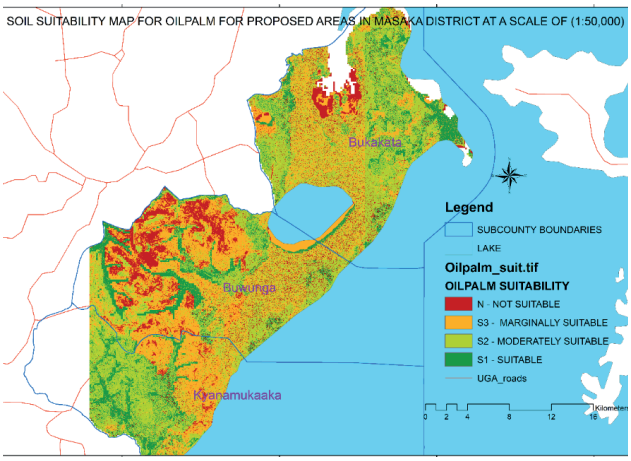
The marginal and moderate classification for the majority of soil types is due to their sandy texture, poor drainage, low nutrient holding capacity, location in low-lying areas, and low organic matter and nutrient (P, Ca, Mg, K) contents.




*The old soil map of the Masaka sheet at 1:250,000.*




*The updated Masaka sheet at 1:50,000.*




*Soil suitability and ratings for oil palm and their spatial variation within selected sub-counties of Masaka district.*

## 2.5 Innovations in cross cutting areas

This section highlights progress and achievements in areas such as post-harvest handling, development of agro-machinery solutions, development of value-added prototypes, food bio-sciences, gender and equity considerations and social economics among others.

### a) Innovations and technologies for Post-harvest handling, Quality and Safety enhancement

During the FY 2022/23, NARO developed several innovations that focus on improving quality and safety, especially the management of Ochra-Toxin A in coffee, soybean and bean quality, and aflatoxin management in maize.

NARO together with its partners developed and tested two biological control products using natural-occurring non-aflatoxin producing strains (cousins) isolated from major grain producing areas in the country. Two products code named UG01 and KE01 were formulated and tested in farmers' fields for four seasons. Test results show that both products are effective and efficacious in control of Aflatoxin for use in management and mitigation of Aflatoxin contamination.

Application dossier for product registration and commercialization strategy have been developed. Investor's forum for commercialization of Aflasafe was scheduled for October 2023 to interest them to

market the Aflasafe product expected from the mass production facility which was at advanced stages of development and equipment.




*Aflasafe product ready for mass production and commercialization.*

**b) Value added prototypes**

Three (3) prototypes for wet processing technologies including a low horsepower coffee pulper, briquette carbonizer and hybrid biomass based solar dryer have been developed.

High energy content raw briquette blends (A, B, and C) have been formulated and evaluated. The preliminary results showed heating values of 16.595 to 17.368 MJ/kg, which are above that of pure tree species such as eucalyptus with low heat values of around 14MJ/kg. The raw briquette targets the agro-industries, large institutions and for use in hybrid solar dryer as alternative energy source.

A biochemistry platform for profiling biochemical compounds in tea, coffee, cocoa and other high-value aromatic plants was established to identify ingredients required in the development of product prototypes with dietary and industrial applications.

A Coffee Facial Scrub (patent application: UG/2023/000001) was as advertised in the New Vision newspaper of March 06, 2023 for interested private sector players to commercialize. In addition, a Trademark (UG/T/2022/75655) was registered for NaCOFE coffee powder and related products. A number of other NARO industrial designs were under publication by the Uganda Registration Services Bureau (URSB).




*NARO developed coffee facial scrub ready for commercialization.*

**c) Gender and Equity consideration (Hidden hunger, nutrition and drudgery)**

NARO has focused immensely for inclusivity on gender aspects identified in agricultural technology generation. These include easy use and application of these technologies in labour use reduction, reduced energy use, efficient use, enhanced productivity, food security and hidden hunger, household incomes and household harmony. For instance, during the development of the above 7 released varieties; 2 maize (NARO MAIZE 63 Vita and NARO MAIZE 64STR), 2 rice (WDR 73 and KF 20039) and 2 sweet potatoes (NARO SPOT 6 and NAROSPOT), NARO ensured gender inclusivity.

These varieties have superior attributes that support the needs of women and youth over the existing varieties with respect to yield advantage, pest and disease resistance, adaptation to drought-prone environment, culinary attributes and market and consumer preferences. The sweet potato varieties are good for fighting hidden hunger and increasing household food and nutrition among women and children.


NARO
CROP WILD RELATIVES

CHAPTER 3

# TECHNOLOGY PROMOTION

***NARO has adopted a number of approaches for delivering the generated technologies to uptake pathways. These approaches include Adaptive Trials and Demonstrations for enhanced technology uptake, Seed production for increased access to improved varieties, Multi stakeholder Innovation Platforms for enhanced value chain development, Joint Technology up scaling demonstrations for increased Technology uptake, Field days and technology fairs, Technology exhibition and showcasing at different events, Farm Clinics and knowledge, information and communication management.***

The interventions during the FY 2022/23 were focused on seed production, commercialization and incubation, adaptive trials and demonstrations, technology exhibitions and farm clinics, strengthening partnerships and knowledge, information and communication management.

### a) Early generation seed multiplication

NARO produces early generation seed (EGS) through her PARIs and NARO Holdings Limited (NHL) to be availed to both commercial seed companies and community seed producer groups. Under the strategic intervention to boost Food and Animal Feed Security in the Country, over 700 tons and 360 tons of assorted seed of maize, beans, soybean and sorghum were produced in season 2022B and 2023A respectively. In addition to seed companies and community seed producer groups, other farmer benefited directly from the seed. This addressed the anticipated seed shortage in the subsequent seasons.

Other seed multiplication and delivery efforts included:

- Over 220 acres of community-based seed multiplication fields were established for production and delivery of clean seed of NAROCass 1 and candidate variety UG120192 in Dokolo, Nakasongola, Luwero, Nakaseke, Katakwi and Kaberamaido at NACRRI.
- 0.5 tons of NARO wheat 1, 2 and 3 were bulked and availed to uptake pathways at Buginyanya ZARDI.
- 249,726 Robusta coffee seedlings that are resistant to the Coffee Wilt Disease (CWD) and other diseases, and with a good cup quality, were availed to farmers and other stakeholders at NACORI.




*Robusta coffee seedlings raised from coffee wilt disease resistant KR varieties at NACORI, Kituza.*

NARO produced assorted pasture seed including over 2 tons of Chloris gayana seed sufficient to establish over 400 acres of feed, 3000 bags of elite Napier grass sufficient to establish 428 acres of Napier fields and 200kg of elite lablab seed. These were delivered to uptake pathways at NaLIRRI.

**b) Technology Commercialization and Incubation**

NARO streamlined access and licensing of the plant varieties to foster quality assurance, product stewardship and timely delivery of early generation seed to seed producers. In this period, one (1) additional seed company (Growmore seed and Chemicals Ltd) was licensed bring the number of licensed seed companies to 13 and the licensed varieties to 78. To appreciate the breeders who bred these varieties, a Breeders' recognition ceremony was organized where the outstanding seed company, NASECO was also acknowledged.

To increase commercialization of NARO value added technologies, efforts were directed to refinement of banana starch, banana fibre for hair, shea nut and, coffee skin care and beverage products.

NARO in partnership with brewery companies tested various cassava and sorghum varieties for brewing properties. As a result, NAROSORG 1 and SESO 1 showed suitable brewing properties. These varieties promise a better market for the farmers growing them.

Seven (7) products were certified by UNBS for marketing. These products have been under incubation by six (6) Small and Medium Enterprises (SMEs). They (products) include Plantain Flour by Kalida Foods; Pumpkin Soy Porridge Composite Flour by MUTOSCAN Investments Ltd; Jack fruit Seed Powder by EKLEKTOS Enterprises; Avocado Seed Tea by CRISGROW (U) Ltd; Tomato Powder by Dani Agro (U) Ltd; and Composite Flour that consists of Pumpkin, Corn, and Soya by Equator Commercial (U) Ltd.

In addition, NARO obtained three Trade Marks for her products: "NACOFE" for Coffee Powder; Container design for coffee beauty cream; and Supalight for fuel lighters. Similarly, NARO registered five (5) Microbial Isolates with National Centre of Biotechnology Information (NCBI).

A total of eight (8) crop related value-added prototypes were developed from coffee, cocoa and banana. They include: (i) six coffee products (coffee energy drink, anti-ulcer coffee yoghurt for management of ulcers, coffee oil for skin care, coffee turmeric cream for skin brightening and coffee confectionery products); (ii) two (2) cocoa products (cocoa wine and cocoa chocolate); and (iii) three banana products (banana resistant starch, hair extensions and sanitary towels). The Banana Resistant starch met UNBS and ISO standards as a multi-fiber prebiotic under brand name 'PureBan+'.

NARO continued with its efforts on commercializing proven agro-engineering and value-added products. To that effect, a total of 17 cottage food SMEs were supported and these include: (i) 10 SMEs processing quality smoked fish using NARO PAH Safe Fish Smoking Kiln (NAROFIK-3). These enterprises are expected to create over 300 direct and indirect jobs for women and youth; (ii) one SME, Movit processing Coffee Facial Scrub from coffee; and (iii) six SMEs processing plantain flour, pumpkin soy porridge composite flour, jackfruit seed powder, avocado seed tea, tomato powder and composite flour that consists of pumpkin, corn, and soya.

Furthermore, NARO promoted (i) 10 units of Animal Draft Power (ADP) planters for Conservation Agriculture (CA), 24 ox-carts and 4 sets of power tiller technology in northern Uganda. A set of power tiller technology promoted consisted of power tiller, NARO-PMB-Plough, planter, NARO COM-Sheller, and trailer. Additionally, NARO enhanced knowledge and skills of 45 farmers, 135 ox-drivers, 45 yoke makers and 30 extension staff from Acholi sub-region in planting, weeding and transporting using oxen.

NARO continues to make efforts towards identifying NARO generated technologies with IP and commercial potential. The NARO IP portfolio is steadily growing with more IP applications being filed with the National IP office. Some of the IPs include patent, trademarks and industrial designs. Eight (8) trademark applications

(Naleng, Nature's Heritage, ApiQure, KAV 400, SuperLight, Bliss, NACOFE) have been developed and registered and two (2) patents for the banana starch, coffee scrub formulation developed and filed for protection and four industrial designs of containers for skin care products were designed and filed for protection.

**c) Outreach and extension**

These included establishment of adaptive trials and demonstrations, participation in exhibitions, organization of farm clinics, conferences and hosting high profile visitors

**i)** Nine (9) adaptive trials and demonstrations were maintained on station and partner farms focusing on key commodities. Different stakeholders including farmers, extension workers, etc got exposed to candidate lines, released technologies and best practices. This will accelerate release and uptake of farmer preferred varieties suitable for specific agro-ecological zones.

**ii)** Over 135 technologies (mainly varieties, breeds, species, production technologies and value-added products of crops, livestock, agroforestry trees and fish) were exhibited during the World Food Day celebrations of 2022 (celebrated at NACRRI-Namulonge) and a number of technologies and value-added products were exhibited to both the public and end-users during the National World Science Day celebrations of 2022 held at Kololo. The exhibitions were streamed live on selected TV stations and disseminated on various social media channels and thus reached many technology users.

**iii)** NARO in collaboration with Monitor Publications (u) LTD organized eight farm clinics focusing on national and zonal priority commodities. Several technologies on various aspects including good husbandry practices, improved varieties, agro machinery and value-added products were exhibited. The farm clinics attracted over 8,000 technology end users including farmers, private sector, extension workers, researchers and other stakeholders across the country as they were widely publicized in the media and other social media platforms. The farm clinics increase awareness and facilitate linkages between technology end users and the commodity value chain actors in addition to providing opportunity for instant feedback and consequently uptake of improved technologies.

**iv)** **NARO-MAK Conference** - The 3rd NARO-MAK Joint Scientific Conference was conducted from 14th - 16th March 2023 at Speke Resort and Conference Centre Munyonyo, Kampala, Uganda. The theme of the conference was "Innovations for Enhancing Productivity and Agro- industrialization". The presentations and discussions focused on seven agricultural production and marketing sub-thems: Challenges and opportunities in mechanization and agro-industrialization; Modernizing post-harvest management and food safety systems; Intensifying crop productivity and seed systems; Accelerating development of the animal resources-based Industry; Managing interactions among agriculture, fragile ecosystems, and changing environment; Embracing ICT based innovations for agricultural transformation; and mainstreaming cross cutting and emerging aspects: COVID-19, Future Proofing the Youth and Gender into national strategic plans. The conference attracted a total of 294 physical and over 800 virtual participants including Uganda government and partner organisations officials that dignified the official opening and closing of the conference. They included the Prime Minister of the Republic of Uganda, the Minister of State for Agriculture, the representative of USAID in charge of agriculture, and of aBi Development, to mention but a few. The online livestreaming and Youtube pages of NARO enabled many more persons within and out of Uganda to attend the conference and gain knowledge. This increased the visibility of NARO, Makerere University,

other organising institutions sponsors. Twenty-seven recommendations were made, but the most critical include on: productivity enhancement - Government, through ministries responsible for finance and economic development, should heighten investments in research and development (R&D) as well as extension in the national agricultural research and extension systems (NARES) in order to achieve enhanced and timely appropriate technology development, dissemination and transfer to intended end-users; enhancement of agricultural value chains -MAAIF and the Ministry of Trade, Industry and Cooperatives (MTIC) should collaboratively establish post-harvest centres in various agro-ecological zones. The centres should at least have facilities for handling produce (including perishables), training actors in all aspects of trade, and creating market awareness for key commodity value chains.

On enabling environment, MAAIF, Ministry of Water and Environment and Uganda National Bureau of Standards should strengthen capacity for enforcement of regulations and standards (including boosting the private sector self-regulatory function) for use of chemical pesticides (both in plants and animals), and disposal of industrial waste in order to minimise trade of products that do not conform to existing standards. In addition, they should invest in effective sensitisation of the public about the dangers of mishandling chemicals pesticides and industrial waste. Also, NITA-U and Ministry of ICT and National Guidance and MAAIF should facilitate and fast-track integration of ICT applications along agriculture value chains. On minimising climate change effects, MAAIF and MWE should promote access and use of alternative energy sources and strengthen enforcement of measures for protection of fragile ecosystems against climate change effects, among others.




*The Prime Minister Right Hon. Robinah Nabbanja ushered in by the NARO Director General, Dr. Ambrose Agona, to officially open the conference*

**d) Partnerships**

NARO leveraged on partnerships to strengthen technology development and promotion. During the FY 2022/23, NARO signed MOUs with over 13 new partners to support research and technology dissemination this includes;

**i)** Korea Program for International Cooperation in Agricultural Technology (KOPIA) for strengthening vegetable seed systems.

**ii)** KOICA for enhancing seed value chain for key vegetable crops in Uganda.

**iii)** USAID under FTF for research and commercialization of several commodities (Banana, coffee, maize, beans, cassava, sweet potato and indigenous chicken).

**iv)** USTA for enhancing seed production and supply in the country.

**v)** Breweries Companies on identifying varieties suitable for brewing.

**vi)** Bio-diversity International on up-scaling Banana Biotechnologies and genetic diversity and evolutionary plant breeding.

**vii)** Movit product limited

**viii)** University of Greenwich on cassava and sweet potato post-harvest loss assessment in Uganda.

**ix)** Cultural and Religious institutions

x) Coca-Cola to identify suitable varieties and prototypes for processing into beverage products (millet, sorghum, mango purées and concentrates).

xi) Makerere and Kyambogo Universities on development of affordable easy to use aflatoxin testing kit.

xii) Doctors Choice on Marketing nutraceutical starch extracted from the green banana.

xiii) NYUZI International Uganda Limited and Nature Fusions Limited (AFROS &MO) on Banana fibre value addition, to improve efficiency in the production of high-quality banana fibre for hair extension.

### e) Knowledge, Information and Communication Management

**Publications -** 176 Scientific publications in peer reviewed journals, 20 IEC materials and 5 high-level bulletins to update policy makers were produced as summarized in table 1 and detailed in appendix 2.

**Table 1: Summary of Scientific Publications in Journals in the FY 2022/23**

| ID | Institute | Number |
|---|---|---|
| 1. | NaCRRI | 47 |
| 2. | NaCORI | 10 |
| 3. | NaFIRRI | 16 |
| 4. | NaFORRI | 14 |
| 5. | NaRL | 32 |
| 6. | NaLIRRI | 15 |
| 7. | NaSARRI | 5 |
| 8. | Abi ZARDI | 9 |
| 9. | Bulindi ZARDI | 2 |
| 10. | Buginyanya ZARDI | 8 |
| 11. | Kachwekano ZARDI | 4 |
| 12. | Mbarara ZARDI | 7 |
| 13. | Mukono ZARDI | 5 |
| 14. | Nabuin ZARDI | 0 |
| 15. | Ngetta ZARDI | 0 |
| 16. | Rwebitaba ZARDI | 0 |
| | **Total** | **176** |

**Policies** – Two (2) policy documents were developed including NARO Knowledge Management Policy to enhance knowledge management and NARO Partnership policy to improve NARO engagements with stakeholders.

**Uganda Journal of Agricultural Sciences** - In addition to publishing widely in international journals, NARO manages the Uganda Journal of Agricultural Sciences (UJAS).

The journal, which can be accessed, on *https://bit.ly/3EfuabN* has attracted worldwide publicity for NARO and Uganda at large. During the FY 2022/23, UJAS Volume 19 issue No.1 was published on line accessible via *https://www.ajol.info/index. php/ujas*.

**Harnessing ICT** - NARO increased application of ICT in facilitating exchange of information and experiences amongst farmers, policy makers, agriculture development experts and international organizations. This was achieved through enhancing NARO's digital platforms including the corporate information hub, NARO Website, quarterly digital newsletters, newspaper supplements, electronic agricultural journals and various mobile applications.

NARO developed a freshwater biodiversity portal for Uganda, an atlas for the fishes of the Lake Edward system, and a policy brief on the status of fish stocks on lakes Edward and George.

**Other Achievements** - An online web-based CABI resources platform was made available for access by NARO scientists. A collaboration with the Forum for Agricultural Research in Africa (FARA) and ASARECA on knowledge management especially in capacity building also benefited a number of staff in the related field.


KR-3

CHAPTER 4

# AGRICULTURAL RESEARCH STRENGTHENING

***The focus in agricultural research institutional strengthening has been on human resource development, financial resource mobilization, infrastructure development and securing land for Agricultural research.***

## 4.1 Human Resources Development

Following the cabinet resolution to retain NARO as an entity and guidance to internally restructure for efficiency, the Directorate of Human Resource (DHR) worked with the Ministry of Public Service (MoPS) to undertake the restructuring. Extensive consultations were undertaken with NARO stakeholders including staff, Top Policy Management and the Governing Council. A new structure was subsequently developed for approval by the MoPS. The new structure proposed increasing NARO's staff ceiling from 995 to 1,180. However, only 809 positions were filled as detailed in Table 2.

**Table 2: NARO staffing establishment by Institute as at 30th June, 2023**

| | Institute | Male | Female | Total |
|---|---|---|---|---|
| 1. | NAROSEC | 42 | 35 | 77 |
| 2. | NaCRRI | 55 | 29 | 84 |
| 3. | NARL | 51 | 27 | 78 |
| 4. | NaFIRRI | 40 | 24 | 64 |
| 5. | NaLIRRI | 53 | 18 | 71 |
| 6. | NaFORRI | 33 | 25 | 58 |
| 7. | NaSAARI | 48 | 10 | 58 |
| 8. | NaCORI | 21 | 13 | 34 |
| 9. | Nabuin | 29 | 3 | 32 |
| 10. | Abi ZARDI | 26 | 5 | 31 |
| 11. | Bulindi ZARDI | 21 | 10 | 31 |
| 12. | Buginyanya | 23 | 7 | 30 |
| 13. | Mbarara ZARDI | 20 | 10 | 30 |
| 14. | Mukono ZARDI | 14 | 18 | 32 |
| 15. | Kachwekano ZARDI | 21 | 13 | 34 |
| 16. | Ngetta ZARDI | 26 | 8 | 34 |
| 17. | Rwebitaba ZARDI | 26 | 5 | 31 |
| | **TOTAL** | **549** | **260** | **809** |

**Table 3: NARO staffing by category and gender as at 30th June 2023**

| S/N | Staff category | Male | Female | Total |
|---|---|---|---|---|
| 1. | Directors | 19 | 3 | 22 |
| 2. | Scientist | 183 | 70 | 253 |
| 3. | Technicians | 127 | 54 | 181 |
| 4. | Support Staff | 220 | 133 | 353 |
| | **Total** | **549** | **260** | **809** |

### 4.1.1 Salary Enhancement

NARO is committed towards improving the welfare of staff through negotiating for staff salary enhancement. During the FY 2022/23, salaries for 259 scientists and 177 technicians was enhanced resulting in an average increment of 150% over the years. However, the salaries for NARO scientists and technicians remained below the approved pay structure by MoPS.

### 4.1.2 Staff registered to professional bodies

NARO supported several staff to subscribe to their professional bodies including, Association of Chartered Certified Accountants (3), East African Law Society (1), Engineers Registration Board (2), Human Resource Managers' Association of Uganda (16), Institute of Certified Public Accountants of Uganda (10), Institute of Chartered Secretaries and Administrators (1), Institute of Procurement Professions of Uganda (19), Uganda Law Society (1) and Federation of Uganda Employers (All staff).

### 4.1.3 Staff Performance management

To ensure efficient and effective staff, NARO keenly manages staff performance through performance planning, mid-tern performance reviews and annual appraisal. Most of the staff performed above average in FY 2022/23, 39% rated out standing, 36.1% rated very good while the rest had satisfactory performance.

### 4.1.4 Recruitment and training

During the financial year 2022/23, NARO did not conduct many recruitments. NARO filled the position of Director General with Dr. Yona Baguma when the contract of Dr. Ambrose Agona ended in April 2023.

A total of thirteen (13) staff who enrolled for PhD graduated in various disciplines including agriculture, livestock, aquatic sciences, and animal breeding. This increased the cumulative number of PhDs in NARO to 131 (Male - 99, Female - 32). Two (2) staff graduated with Masters while four (4) successfully completed Certified Public Accountants (CPA) course. Under short-term trainings, 6 staff undertook administrative courses, 3 in human resource and career transformation and 21 in professional training for procurement officers.

In FY 2022/23, NARO experienced a staff turnover of 29 staff. Of these 13 were scientists, 4 technicians and 12 support staff. The main reasons for staff separation (in the last ten years) are retirement, resignation mostly occasioned by low salaries paid to NARO staff compared to similar institutions like universities.

## 4.2 Financial Resource Mobilisation and Management

The 3 major sources of funds for NARO are Government of Uganda through budget allocation to her vote 142, Non-Tax revenue and off-budget projects. In FY 2022/23, NARO with support from Council secured increase in allocation compared to previous years. The budget under vote 142 increased to 117.926 billion (bn) including Non-Tax Revenue of 2.273bn compared to 110.607bn in 2021/22 while the Off-budget project grants amounted to 59.713bn. These and other sources were utilized efficiently and enabled NARO to record the numerous achievements contained in this report.

### 4.2.1 Budget Performance

**Table 4: Summary of the Income and Expenditure against budget FY 2022/23**

| S/N | Income and Expenditure | FY 2021/22 UGX(Bn) | FY 2022/23 UGX(Bn) |
|---|---|---|---|
| 1. | GoU Recurrent (Wage) | 34.233 | 39.811 |
| 2. | GoU Recurrent (Non-Wage) | 24.603 | 29.396 |
| 3. | GoU Development –1619 | 46.473 | 42.714 |
| 4. | GoU Development -1560 | 5.000 | 5.861 |
| 5. | Domestic Arrears | 0.298 | 0.144 |
| | **Total Budget, Vote 142** | **110.607** | **117.926** |

## 4.3 Securing Agricultural Research Land

NARO focused on protection of land through opening boundaries, surveying, development of deed plans, titling, fencing and mutual partnerships that promote secure land use. During the year, 1,442 hectares were surveyed and titled in Nabuin, Nyamigogo (1.7ha), Maziba (1.7ha), Kalenjere, Amuria (12.5ha), Kumi and Pallisa (8.7ha). Land measuring up to 30 hectares was surveyed, titled and fenced in Aduku-kwania (23.49) and Katakwi (4.98). At Serere, 690.2 ha were surveyed, Kaberamaido (18.6ha), and Bukedea (5.3ha) surveyed and titled. Nyabwishenya- Kisoro (157.2ha), and Kibibimbiri- Kisoro (33.8ha) surveyed.

## 4.4 Infrastructure Development

The research infrastructure improvement for the FY 2022/23 focused mainly on construction and rehabilitation of facilities, acquisition of equipment and development of ICT infrastructure and systems at selected institutes including NaLIRRI-Nakyesasa, NaLIRRI-Maruzi, NAFIRRI, NaFIRRI-Kajjansi, NARL-Namalere and Kigumba. The physical infrastructure developed projects included new constructions and renovations. The key infrastructure development achievements during the year were:

**a)** NaLIRRI-Nakyesasa – Contruction of calf-barn with a capacity of holding 327 animals, Vaccine research and production facility with a capacity of producing six million doses of each vaccine (Anti-tick vaccine, ASF and FMD vaccine), Aflatoxin mitigant research and production facility with a capacity of producing 10 tons per hour, milk quality and processing platform with holding capacity of 5000 liters of raw milk, hay barn, water supply and reticulation, cattle dip, fencing of grazing field, and diversion of the access road from NaCCRI to NaLIRRI .

**b)** With a capacity of holding 136 tons was completed, fencing and paddocking of 300 acres, construction of start-up structures (toilets, residential units, stores, kitchen), water supply and reticulation with a capacity of supplying 120,000 litres per day, a 3-phase electricity power line extension and reticulation with a step-down transformer for home voltage installed. Others include construction of 8 km farm road.

**c)** NaFIRRI - A ship for research work was acquired and located on Lake Albert to support monitoring of the ecosystem.

**d)** NAFIRRI-Kajjansi - Renovation of a feed mill and electrical works.

**e)** NARL - Construction of new administration block as part of improving agricultural engineering research facilities at Namalere.

**f)** Kigumba - Construction of 19,000 m3 water reservoir.



*Completed Administration Block at NARL – Namalere (AEATREC).*

**g)** ICT Infrastructure - NARO in partnership with NITA-U, increased connectivity of NARO Institutes to the National Backbone Infrastructure. The NARO wide area network (WAN) was enhanced and extended to NARL (Kawanda and Namalere) and Abi, Mbarara, Mukono and Ngetta ZARDIs. Assorted ICT equipments including, laptops, multifunctional scanner, projector, intercom IP Phones, digital camera, and printers were acquired and deployed in the different institutes. Migration of institutes to the Upgraded Local Area Networks was initiated starting with Kajansi.

**h)** Web-based system development - A number of software systems and applications were acquired and installed. These included NARO Website, NARO Information Hub and SESTO Based Software for managing plant genetic information at PGRC. Other systems developed were NARO Wide Fleet Management and Human Resource management systems. NITAU has provided server space to host the developed systems. Some the systems can be accessed on: community seed bank, *www.csb.naro.go.ug,* Fleet Management Information System, *www.fleet.naro.go.ug,* Uganda journal of Agri Sciences, *www.journal.naro.go.ug,* NARO Information Hub, *www.naroinfohub.naro.go.ug*.

**i)** Following enactment of the Sugar Act, 2020, NARO has been directed to establish a National Sugar Research Institute (NSRI). During FY 2022/23, NARO constituted a task team to among others conduct situation analysis to understand the sugar industry, identify critical Research and Development areas including varieties grown, value addition, mechanization, pests and diseases, and other production constraints. A draft structure for the National Sugar Research Institute was developed including human resources requirements.






*A modern fisheries research vessel (RV Angara) on Lake Albert to be used for undertaking fishery independent stock assessment studies to inform management decisions for increased and sustainable fisheries production.*


NATIONAL AGRICULTURE
POLICY

CHAPTER 5

# GOVERNANCE AND MANAGEMENT

***NARO is governed by a Council while her PARIs are directly guided by Advisory Committees. Regarding management, NARO is managed by TPM comprising mainly the Directors at secretariat and Programme Leaders and other Senior staff at the PARI level. Both Council and Management made enormous achievements during the FY 2022/23.***

## 5.1 Council Achievements

During the first half of FY 2022/23, a new NARO Governing Council (5th NARO Council) was inaugurated and inducted. In execution of its role in providing oversight of implementation of the organizational mandate and strategic plan, the Council registered a number of achievements:

**a)** Approved NARO plan for strategic interventions to boost food and animal feed security in the country and conducted supervisory monitoring visits to establish progress made in implementing the plan at the various PARIs of this special intervention to respond to the prevailing food and animal feed shortages in the country.

**b)** Approved the Budget Framework Paper for FY 2023/24, increment of staff salaries and the revised salary structure as part of the staff retention strategy (the salaries were increased to reach an average of 64 % of the target pay for scientists).

**c)** Recommended for appointment the new Director General, Dr. Yona Baguma.

**d)** Approved a new organisational structure and staff establishment and guided recruitment and promotion of qualified and talented staff for critical positions in NARO.

**e)** Reviewed and approved operational framework (the NARO Work Plan and Budget for FY 2023/24).

**f)** Approved guidelines to streamline processes and improve management of research including Guidelines for access and sharing biological resources, Guidelines for submission of candidate varieties for release to the National Variety Release Committee.

**g)** Supported NARO Management in high level stakeholder engagements and advocating for additional resources for agricultural research. This resulted in increase of the wage budget



*Hon. Bwino Fred Kyakulaga, Minister of State for Agriculture (front raw center) with the members of 5th NARO Council. To his right are, Rev. Dr. Susan Awino, Dr. Samuel Mugasi, Dr. William Olaho Mukani (Chairperson) and to his left are; Mr. George Edward Onya, Ms. Akullo Sharon Atoo and Ms. Masika Kateeba Jolly. Behind raw (left-right): Mr. Katungisa Kenneth, Ms. Nanuuma Rehema Wandera, Ms. Nankunda Olivia Mpuuga, Dr. Sylvester Dickson Baguma, Dr. Ambrose Agona (Out-going Director General – NARO), Dr. Martin Patrick Ongol, Dr. John Wasige and Prof. James M. Kajete.*

by UGX. 4.577 billion and allocation of UGX 60 billion for rolling out the anti-tick vaccine.

**h)** Reviewed audit reports and provided advice on internal controls and measures to mitigate identified risks.

**i)** Identified areas for improvement of research management at PARIs.

## 5.2 Advisory committees Achievements

PARI Advisory Committees are mandated to provide technical guidance in the technology generation and promotion process. They were able to register a number of achievements:

**a)** Provided independent expert advice to their institutes in identifying and prioritizing research issues and, contributed to the quality of the research process and the research findings, regularly reviewed work plans and progress reports and made recommendations on technologies that would enhance productivity in the zone.

**b)** Advised PARIs on emerging research ideas and opportunities and the research implications of a range of strategic research management and policy issues (e.g., collaborations with farmers; creation of synergies with extension; scaling out partnerships with more farmers to produce certified seed and build their capacity through training; strengthen partnerships with NGOs, Universities and other organizations involved in Agriculture.

## 5.3 Management Achievements

In execution of the management role with support of the Council and cooperation/participation of the PARIs,

**a)** Management developed and implemented the operational plans and steered the organisation to achieve its objectives.

**b)** It coordinated and implemented the programmes and activities of the organisation.

**c)** Management negotiated for additional resources for agricultural research through engagement with key stakeholders including development partners.

**d)** Continued to maintain a high standing for NARO in terms of performance and compliance in the face of Government and Development partners.

**e)** In compliance with the Public Finance Management (PFM) Act 2015, Section 48, the Directorate of Internal Audit ensured that sound controls, risk management and governance processes were effective and efficient.

NARO is regularly assessed by Government of Uganda ministries and agencies including the Office of the Prime Minister (OPM), Ministry of Finance Planning and Economic Development (MoFPED), National Planning Authority (NPA), Equal opportunities commission (EOC), Office of the Auditor General and the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF).

**i)** **Budget Monitoring and Accountability Unit (BMAU) of MoFPED -** NARO contributes to the sub-programme of Agricultural production and productivity. In FY 2022/23, BMAU rated this sub-programme at 79.5% and NARO's contribution as an entity at 80%.

**ii)** **National Planning Authority (NPA) -** NPA issues a Certificate of Compliance (CoC) each FY to ensure that the National Budget comprising the programme, MDA and Local Government (LG) budgets focus on implementation of the National Development Plans (NDPs) that are aimed at achieving Vision 2040 and the programme/MDA specific interventions are aligned with the NDP targets and results. NPA rated NARO's alignment with National Development Agenda at 76. 1% for the strategic plan and 73.1% for annual workplan and budget which were well above the compliance thresh holds.

**iii)** **Equal Opportunities Commission (EOC) -** EOC assesses compliance of Sectoral Budget Framework Papers (BFPs) to gender and equity provision. They further specify measures to be taken to equalize opportunities for all, including men, women, persons with disabilities and other marginalized groups in the country. In the FY 2022/23, the EOC rated the responsiveness of NARO's plan and budget in regard to

gender and equity at 76.6% and issued her the compliance certificate which is a requirement for the submission of the Ministrial Policy Statement (MPS) to MoFPD for approval.

iv) **Assessment by MAAIF -** MAAIF assesses NARO's research progress through participation in weekly top management meetings, supervisory visits and the annual Joint Sector Reviews (JSR). The JSR is a multi-stakeholder forum for performance assessment, budget and policy guidance. During the FY 2022/23 JSR, NARO's performance was rated highly.

v) **Office of the of Auditor General –** NARO's annual accounts received unqualified opinion from the Office of Auditor General.

**An excerpt of the opinion of Auditor General of Uganda, on the National Agricultural Research Organisation, FY 2022-2023**

**REPORT OF THE AUDITOR GENERAL**
**ON THE NATIONAL AGRICULTURAL RESEARCH ORGANISATION**
**FOR THE YEAR ENDED 30th JUNE, 2023**

**THE RT. HON SPEAKER OF PARLIAMENT**

**Opinion**

I have audited the financial statements of the National Agrictultural Research Organisation (NARO), which comprise the statement of financial position as at 30th June 2023, the statement of financial performance, statement of changes in Equity and statement of cash flows, together with other accompanying statements, including summary of significant accounting policies.

In my opinion, the accompanying financial statements of the National Agricultural Research Organisation for the financial year ended 30th June 2023 are prepared, in all material respects, in accordance with section 51 of the public Finance Management Act, 2015 (PFMA) and the financial Reporting Guide, 2018 (as ammended).

**Basis for Opinion**

I conducted my audit in accordance with International Standards of Supreme Audit Institutions (ISSAIs). My responsibilities under those standards are further described in the Auditors responsibilities for the Audit of the Financial Statements Section of my report. I am independent of the Organisation in accordance with the constitution of the Republic of Uganda 1995 (as amended), the National Audit Act, 2008, the International Organisation Supreme Audit Institutions (INTOSAI) code of Ethics, The International Ethics Standard Board for independence requirements applicable to performing audits of Financial Statements in Uganda. I have fulfilled my other ethical responsibilities in accordance with the IESBA code, and in accordance with other ethical requirements applicable to performing Audits in Uganda. I believe that the audit evidence i have obtained in sufficient and appropriate to provide a basis for my.

## 5.4 Management challenges

Key challenges experienced during the FY 2022/23 included i) Limited budget for research and expansion of infrastructure, ii) Uncompetitive remuneration for scientists, iii) Inadequate facilities and policy environment for scientific advancements, and iv) pressure on the land for agricultural research.

## 5.5 Focus areas moving forward

a) Securing sustainable funding for Agricultural Research and Development.

b) Continue lobbying for salary enhancement, retention and motivation of human resources to sustain the various product pipe lines and continue responding to emerging challenges.

c) Securing accreditation of research facilities, enhancing application of ICT in agricultural research and lobbying for passage of the Biosafety law.

d) Intensifying efforts on securing the agricultural research land.


PRIDE

CHAPTER 6

# PROFILES OF SELECTED PROJECTS

***NARO has worked in close collaboration with several projects. In this report, we highlight some profile and activities of the USAID-funded Feed the Future Agricultural Research Activity, the Japanese-funded Promotion of Rice Development (PRiDe) Project Phase II, the Republic of South Korea funded KOPIA Project and CABI International.***

## 6.1 Feed the Future Agricultural Research Activity

The Feed the Future (FtF) Agricultural Research Activity (ARA) is funded by USAID and implemented by NARO. During the reporting period, the activity made significant progress towards achievement of its desired results where it continued to focus on supporting technology development and incubation, stakeholder engagements, staff capacity building, infrastructural development and systems development and strengthening to enhance commercialization of NARO technologies and other research outputs.

### a) Technology development and promotion

The Activity focused on improvement of prototypes (resistant starch, fiber, natural food colorants, composite flours, coffee-infused yoghurt, skin protection products and the banana fiber extractor); orientation of the new National Variety Release Committee to ensure that candidate varieties submitted for release are promptly handled.

### b) Industry engagement for technology development

To increase private sector involvement in joint incubation and market testing of NARO's value-added prototypes, the Activity engaged CEDO, Movit, Jesa Farm Dairy, Kazire Health Products Limited, SAWA, Uganda Breweries Limited (UBL), Nile Breweries Limited, Doctor's Choice, Nature Fusions Limited and TEXFAD Limited) to jointly develop and market-test selected technologies in preparation for commercialization.

### c) Capacity building

The Activity continued to support 21 students (6 PhD, 15 MSc) of which one (1) MSc student completed and graduated. To enhance the institutional capacity of NARO to commercialize her research outputs, it facilitated training of 332 staff on communication skills, gender integration and intellectual property to build their capacity for development of market demanded technologies. To strengthen systems for commercialization of NARO's technologies, the Activity built the capacity of NARO staff to be IP conscious, supported follow up on production of early generation seed and development of frameworks for materials access and transfer.

### d) Infrastructure development

To strengthen NARO's product incubation capacity, the Activity acquired equipment for three (3) NARO incubation centers (FBA-NARL, NaCRRI and NaCORI) to support the generation of sufficient quantities of novel value-added products for commercialization. Installation is still ongoing.

### e) Systems strengthening

In a bid to build and strengthen systems for commercialization of NARO's technologies, the Activity supported MAAIF to develop variety release guidelines, orient the new NVRC members on the variety release procedures and drafting of the NARO plant variety replacement strategy.

It acquired 3 virtual conferencing facilities which were installed at KaZARDI, NaSARRI and NARO secretariat to enhance virtual activity implementation at reduced operation costs.

### f) Technologies, products and practices made available for uptake

The Activity facilitated organoleptic testing of the dehydrated precooked bean among a total of 20 potential individual users and roadside business consumers in Rakai (10), Kyotera (8) and Masaka (2) Districts to enhance its commercialisation.

Additionally, the Activity conducted shelf-life studies of the precooked bean product and recommended further improvements and standardization to meet UNBS requirements in preparation for certification. ARA supported formulation of two coffee byproducts (Lotion and facial scrub) ready for commercialization. Different production batches of the facial and body scrub were subjected to accelerated shelf-life studies and all passed UNBS regulatory requirements. It supported NARO to undertake branding and trademarking her products and NARO-NaSARRI to sign an MOU with SOSPPA to develop nutrient-dense value-added products for commercialization. The ARA supported NARO to commercialize a number of technologies.




*Some of the NARO Coffee lotion products ready for commercialization.*

### g) Increased private sector participation in commercialization of research products

The Activity facilitated development of partnership guidelines to operationalize the NARO Partnership Policy 2021 and private sector participation in joint R&D, market testing and scaling out of improved technologies. The Activity promoted nine (9) CWD-r Robusta coffee varieties (KR 1, 3-10) with private nursery operators licensed by UCDA and NAROCASS 1 cassava variety.




*Seedlings of Coffee wilt disease resistant KR varieties raised by private nursery operators.*

### h) Enhanced NARO capacity for research and commercialization of released technologies

To align current breeding processes with market needs, the Activity conducted a profiling exercise targeting seed companies, out-growers, agro-input dealers, grain farmers, farmer groups, aggregators and millers/processors to linking breeding efforts with market needs.

### i) Developed support infrastructure for commercialization

The Activity acquired a coffee oil extractor to support research on coffee oil for commercialization and installed an incubator with a capacity of 4000 eggs to enhance indigenous chicken breeding.

### j) Commercialized technologies developed under previous and ongoing research efforts

The Activity facilitated market studies on flavourants and colorants, aflatoxin prevalence/incidence and socio-economic effects.

These were aimed to validate technologies for incubation, quantify demand, identify key private sector interested in collaborating with NARO to jointly incubate these technologies and assess regulatory and policy challenges for commercialization.

**k) Mechanization Needs and Feasibility Assessment study**

The study revealed low levels of mechanization (estimated at less than 10%), and numerous missing potentially beneficial low-cost technologies to smallholder farmers of which 50% can be reverse-engineered. The capacity and capability of the local fabrication industry are however limited hence the need for support. The study further revealed the need to promote the ready agro-machinery developed by research and other private sector actors for uptake and multiplication by the private sector since government efforts to promote the technologies have largely been less effective.

**l) Market Analysis of Agro-input Dealers' Preferences for NARO seed varieties**

In order to monitor performance of NARO's commercialized varieties, a study that targeted agro-input dealers was conducted in 28 Districts. This study captured gaps and issues to be addressed by research and seed companies including reduction of counterfeit seed and timely delivery of quality Early Generation Seed to meet the demand. The study revealed that NARO crop varieties, UH 5354 (Bazooka), Longe10H and Longe 5 are the most traded varieties across all regions. However, these varieties face stiff competition from imported hybrids from Kenya such as DK series. The study further revealed that some licensed varieties such as Longe 11H, NAROBEAN 7, NAMCHE 1 and 2, and Red beauty were not available on the market probably because they have not been promoted by the companies licensed to commercialize them. These finding will help NARO to refocus its breeding pipelines.

**m) Strengthened systems and processes for commercialization of newly developed and existing products**

The Activity worked with partners on strengthening of systems to enable effective commercialization of NARO technologies including operationalization of the MAAIF online seed tracking and traceability system. Together with IAM, it engaged Uganda Fruits and Vegetable Exporters and Producers (UFVEP) to interest them to participate in incubation of the Nanofilms for preservation of fresh peeled bananas prior to market testing. To establish, foster and promote research and development collaboration for purposes of advancing agricultural productivity under UBL's local sourcing programme, the Activity engaged UBL to provide USD 23,116 to NARO to support evaluation and registration of two (2) barley varieties (Aliciana and Grace). The ARA continued to facility development of key frameworks to support commercialization.

## 6.2 PRiDe Project, Phase 2

NARO has collaborated with Japan International Cooperation Agency (JICA) to implement the Promotion of Rice Development Project Phase 2 (PRiDe II) from April 2019 to March 2024 which was initiated in response to Uganda's high demand for rice due to changing food preferences, young population and increasing urbanization. The Project aimed to enhance rice productivity and quality by focusing on four key outputs: improving technology capacities at research institutions, strengthening training and planning capacities, enhancing seed production, and disseminating technologies through the "Musomesa" Field Schools. In 2019, rice production in Uganda amounted to 166,000 tons, marking a decline compared to the previous three years. The average rice production volume from 2016 to 2019 stood at 192,213 tons. However, there was a significant surge in rice production in 2020 and 2021, with an average production volume of 338,142 tons during these two years.

**Table 5: Annual National Rice Production Volume (tons)**

| Item | Unit | Data Source | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| **Production** | Tons | FAOSTAT | 214,910 | 188,674 | 199,266 | 166,000 | 373,000 | 727,120 | 730,000 |
| **Production** | Tons | UBOS | 214,910 | 188,674 | 199,266 | 166,000 | 373,000 | 727,120 | 730,000 |

*Access to FAOSTAT in June 2023. UBOS: Uganda Bureau of Statistics*

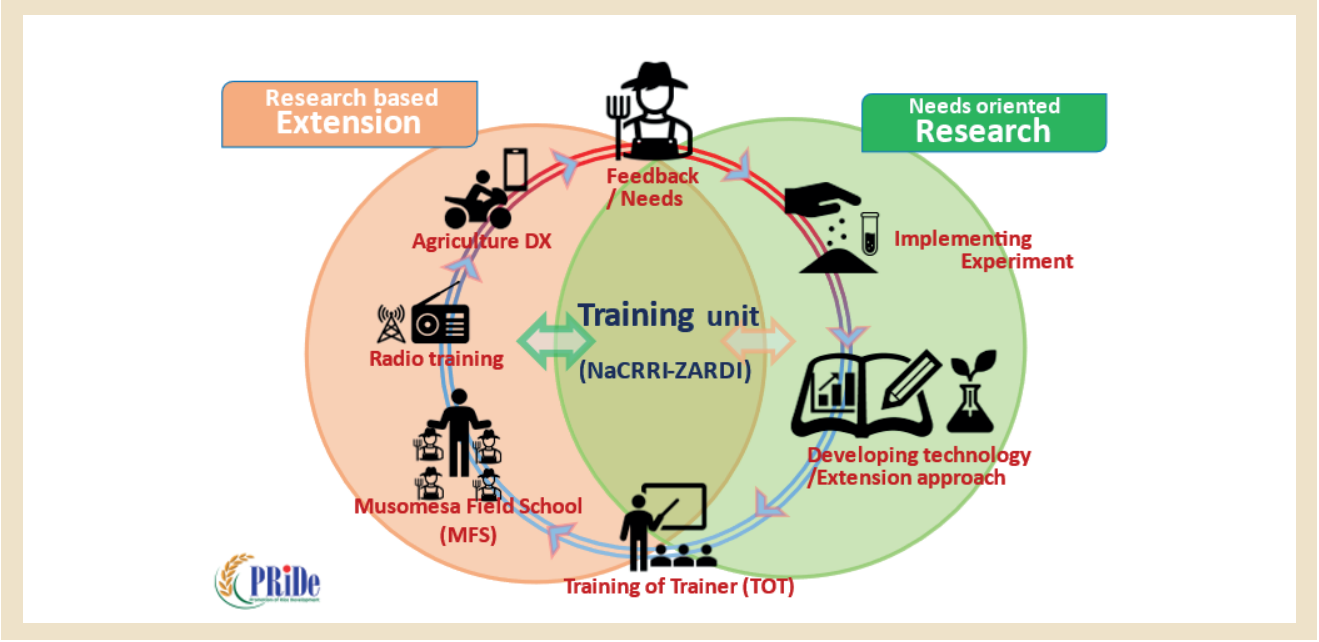
### 6.2.1 Rice Research Development

#### a) Enhancing High-Quality Seed Production

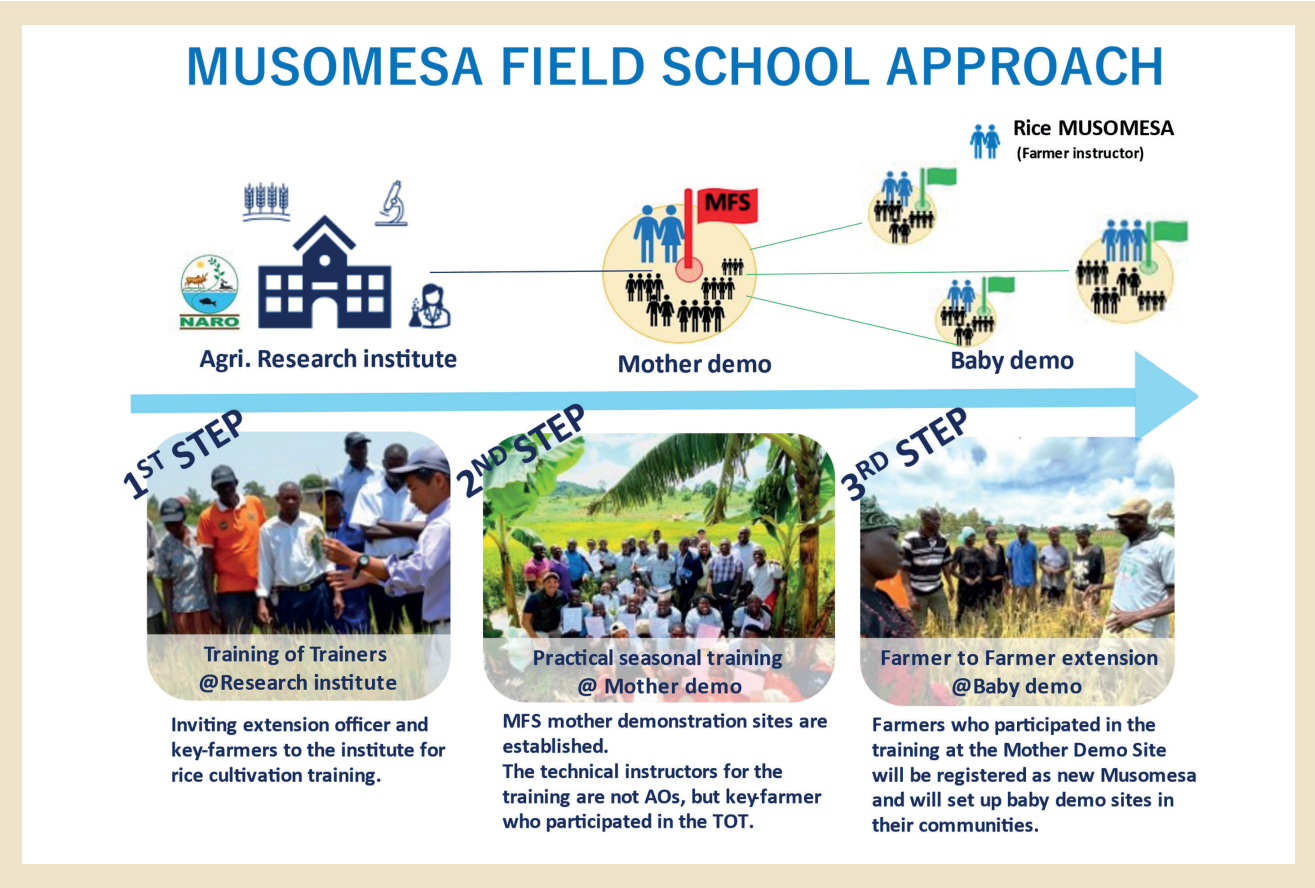
The importance of high-quality seeds in ensuring optimal crop productivity cannot be overstated. The project has been key in conserving and managing the genetic resources of registered and purified local rice varieties at NaCRRI. These resources have been systematically multiplied to produce high-quality seeds, whereby **over 70 tons of Pre-basic and Basic rice seeds have been produced**, marking a significant achievement. The establishment of a sustainable, high-quality rice seed multiplication system at NaCRRI and targeted Zonal Agricultural Research and Development Institutes (ZARDIs) serves as a pivotal step in supplying premium rice seeds to various stakeholders. This is operational at NaCRRI by using the Income Generation System (IGS) in partnership with NARO Holdings Limited (NHL). In Uganda, the accessibility of quality rice seeds remains limited, driving a widespread demand for the establishment of a robust seed supply system. Moving forward, the Project's focus will be on supporting initiatives that expand the reach of high-quality rice seeds to a broader base of farmers. This entails exploring mechanisms such as Quality Declared Seed (QDS) sales by farmer groups, facilitated by simple field inspections.

#### b) Empowering Farmers Through Innovative Outreach

Significant strides have been made in supporting farmers through innovative outreach initiatives, such as Training of Trainers (TOT), Training of Farmers (TOF), and the promotion of the Musomesa Field School (MFS) - a farmer-to-farmer extension approach. The transformative impact of the Musomesa Field School (MFS) in revitalizing farmer-to-farmer




*Approach to Research - Extension- Farmer linkage*




extension through fostering research-extension linkages was captured at the end of the project evaluation report. In close collaboration with NARO Institutes, the project has successfully established 75 Musomesa Field Schools (MFS) across the country in its efforts to disseminate improved rice cultivation technologies within local communities. Through intensive seasonal technical workshops, a total of 2,431 Musomesa have been certified, empowering them to serve as ambassadors for innovation and knowledge dissemination. This approach equips farmers with practical skills and fosters a culture of knowledge-sharing and collaboration whereby they become agents of change within their communities.

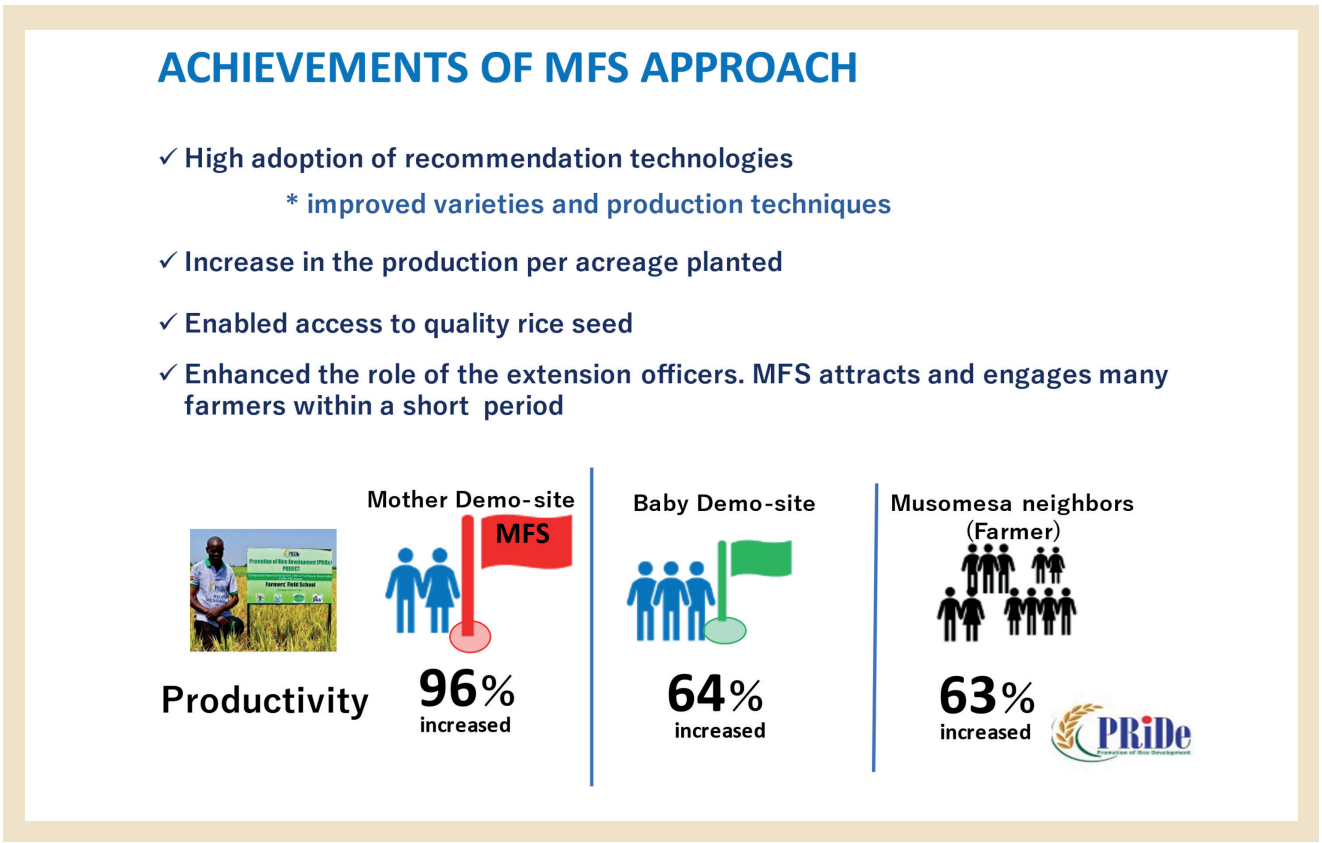
### 6.2.2 General research activities

#### a) Improving capacities for rice production and technology development for NaCRRI and priority ZARDIs

The project has prepared 11 field research reports for experiments conducted at NaCRRI and the final report preparation has been completed. Currently, Abi ZARDI, Buginyanya ZARDI (Ikulwe Station), and Rwebitaba ZARDI are preparing a report for each institute. Bulindi ZARDI completed a report and is preparing one more report. The title of the research topics included breeding, agronomy, soil health, pathology, expected report completion period, and research target area or zone are shown in the project completion report.

#### b) Maintenance of breeder seeds of 15 rice varieties at NaCRRI

At NaCRRI, the project maintains the following 22 rice varieties as breeder seed:1) WITA9, 2) NERICA6, 3) NARORICE1, 4) NARORICE2, 5) K85, 6) K34,7) K38, 8) K98, 9) Supa (Soroti), 10) Sup (unknown), 11) NERICA1, 12) NERICA4, 13) NERICA10, 14) NARIC1, 15) NARIC2, 16) Suparica1, 17) NamChe3, 18) NamChe5, 19) Yumenohatamochi, 20) Buyu, 21) Benenego, and 22) TXD.




**c) Development of 3 promising lines for new variety registration and releases**

**i) Fixation of progeny lines of PRIDE1 (cross combination line of NERICA4 and WITA9) at generation:** PRIDE1 was developed from a cross between NERICA4 and WITA9. These parental varieties are both moderately resistant to RYMV, and a few $F_2$ plants showed higher resistance to RYMV. Three seasons of National performance trials of 'PRIDE1' have been conducted at 7 locations across the country: NaCRRI-Namulonge, Ikulwe Station (Buginyanya ZARDI), Kamenyamigo Station (Mukono ZARDI), Ngetta ZARDI and Irrigation Schemes (Olweny, Tochi, and Doho).

The yield potential of 'PRIDE1' is as good as other varieties and therefore can be an effective variety in areas where RYMV is frequent. Preparations are currently underway for variety registration under the National Varietal Release Council in 2024.

**ii) Selection of Basmati 370/GIGANTE Backcross lines (B4F9) for agronomic traits and field performance**

Basmati 370 has very good eating and cooking characteristics with long grain and aroma, it is highly evaluated in the international market but it is susceptible to Rice Yellow Mottle Virus (RYMV). To introduce the RYMV resistance gene to Basmati 370, it was crossed with Gigante, a highly resistant variety to the disease.

Four lines have been selected from 85 lines and five individuals have been selected from each selected line. Of the four selection lines, two had slender-shaped grains (lines 7 and 17), one had medium-shaped grains (line 48) and the other had large-shaped grains (line 70). The line number has reduced tremendously from 85 to 25 lines for the next season.

**iii) Selection of SUPA/GIGANTE Backcross lines ($B_4F^9$ and $B^1F^6$) for agronomic trait and field performance:** Supa is a large grain and aromatic rice variety with very good cooking and eating characteristics that is highly

evaluated in the market in Uganda but susceptible to Rice Yellow Mottle Virus (RYMV). This variety was improved by crossing it with Gigante a highly resistant variety to the disease. Observation of individual lines of $B_4F_9$ and $B_1F_6$ for uniformity in terms of height and maturity have been made twice. Some $B_4F_9$ lines have shown potential and have been selected although not yet matured. On the other hand, since $B_1F_6$ lines are the early maturing lines, four lines (Line 76, 80, 81 and 82) have been selected due to earliness and harvesting.

The project also developed DNA markers for the *rymv1-2* gene using a molecular biological approach. As a result, a new *rymv1-2* DNA marker has been successfully developed. Subsequently, backcross lines were generated for several other varieties besides the Supa and Basmati backcross lines, confirming the validity of this DNA marker. The combination of the use of DNA markers and accurate virus inoculation screening established by the project will open up the possibility of introducing the *rymv1-2* resistance gene into a variety of superior varieties. In addition, by using backcrossed strains of Spa and Basmati instead of Gigante as the gene source, it is expected that not only the RYMV resistance gene but also the good taste factor will have a positive influence on the progeny. It is hoped that this will lead to the development of RYMV resistance breeding in Uganda in the future.

**d) Improvement of zonal training curricula and materials to incorporate field research/experiment outputs.**

NaCRRI and target ZARDIs collected data from research experiments including monthly trials and on-farm trials at MFS demo sites for revising training curricula and materials. The training curricula and materials have been revised after the implementation of the training reflecting the research results. In addition, the compilation of the training syllabus for Training of Trainers courses is underway with the initiative of the Training Unit of NaCRRI.

**e) Counterpart Personnel Training Overseas**

Collaborative efforts with JICA have enabled young researchers from NARO to pursue advanced studies in Japan, including Master's and PhD programs, alongside short training courses under the JICA scholarship program. Two NARO scientists have completed studies in Japan while several personnel have participated in short training courses. By nurturing talent, facilitating knowledge exchange, and fostering collaboration, JICA is playing a significant role in driving Uganda's rice industry.

**Table 6: Counterpart Personnel Trained in Japan**

| No. | Name | NARO Institute | Course Category |
|---|---|---|---|
| 1. | Emmanuel Odama | Abi ZARDI | PhD |
| 2. | Peter Ssenyonga | Rwebitaba ZARDI | Masters |
| 3. | Jonah Ssemwogerere | NaCRRI | Rainfed Rice Cultivation, Seed Production and Variety Selection Techniques |
| 4. | Solome Nakigaya | NaCRRI | Development of core Agricultural Research for the Promotion of Rice Production in Sub-Saharan Africa |
| 4. | Samason Ojok | NaCRRI | Development of core Agricultural Research for the Promotion of Rice Production in Sub-Saharan Africa |
| 5. | Morish Obura | NaCRRI | Development of core Agricultural Research for the Promotion of Rice Production in Sub-Saharan Africa |
| 6. | Zainah Kampi | NaCRRI | Rainfed Rice Cultivation, Seed Production and Variety Selection Techniques |

## 6.3 Kopia Uganda achievements

### 6.3.1 Citrus Model Village Project

#### Project Title

Establishment of Citrus Management Technology Demonstration Sites, Market Development and Model Village Delivery Pathway in Teso, Uganda

#### Project location

Teso (Soroti, Kumi and Ngora districts)

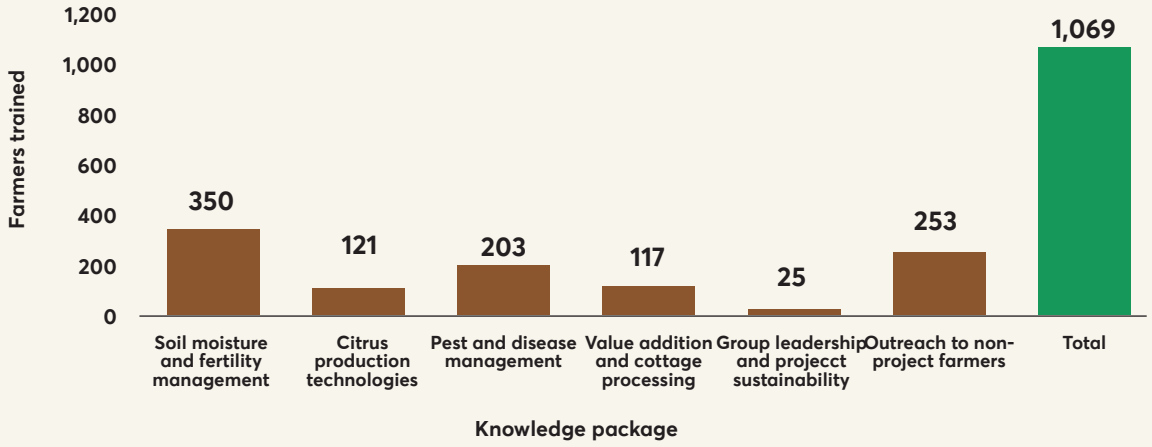
**Project objectives:**

- To promote and increase adoption of citrus pest and disease management practices and techniques by 160 farmers in Soroti, Kumi, Ngora and Kalaki districts
- Increased adoption of integrated soil fertility and water management practices by 300 citrus farmers, and
- To increase marketing volumes of citrus fruits from Teso as a result of improved citrus fruit quality, safety and a developed market system including pack house, storage and value addition through cottage processing

#### Project Achievements

**a) Adoption of citrus pest and disease, and soil moisture and fertility management technologies by the citrus farmers**

Over 1000 farmers were trained on adopted pest and disease, and soil moisture and fertility management technologies.




*Number of farmers trained in 2023.*

**b) Increase in farmers' yield, income and livelihoods**

**i) Citrus yield**

Farmers annual yield increased greatly by 210% in the first year (2021) and continued to increase by 194% in the second year of the project. In 2023, in first season alone, the citrus yield in first season (April-June) alone was 32tons, two times more than the baseline yield. After compilation of the second harvest season (August to February data, the annual yield is expected to increase much more than the annual yield for 2022.

**ii) Farmers' income**

On the other hand, the citrus farmers' annual income

increased by 208% between 2020 and 2021, and 32.7% between 2021 and 2022. In 2023, in first season alone, the average income earned in the first season hectare (April-June) alone was USD 2846, more than thrice the baseline yield. This income is expected to be even higher after obtaining the annual average income earned by the citrus farmers participating in the project.

**c) Technology development**

Fertilizer quantities for citrus production in Teso were established.

**d) Citrus value addition**

Farmers were taught how to add value to citrus fruits through products such as Juices and Marmalades.





*Farmers display their value-added citrus fruit products (Juices and Marmalades).*

**e) Support to farmers**

Farmers were supported with fertilizers, pesticides, ladders and street light, solar and other farm tools.



*Farmers receiving fertilizers, pesticides, ladders, street light solar and other farm tools.*

### 6.3.2 Rice Demonstration Project

**Project Title**

Farmhouse demonstration and distribution of high-yielding aromatic rice and cultivation technology in Uganda

**Project Location**

Olweny-Lira and Doho-Butaleja district

**Project objectives**

The project aims to promote improved aromatic/ high-yielding rice and cultivation technologies to enhance on-farm productivity and enhance the household income of smallholder farmers in Uganda. The specific project objectives are to:

**i)** Increase in the number of demonstrations of improved high-yielding rice varieties in Olweny and Doho from 70 to 100, with an associated area expansion from 80 to 110 hectares in 2023 and 2024, respectively.

**ii)** Expanding the number of farms transplanted with the Korean transplant line from 60 in 2023 to 100 in 2024 and a corresponding increase in area by 75 in 2023 and 100 in 2024.

**iii)** Train 700 rice farmers in Butaleja (Doho) and Lira (Olweny) in improved rice varieties and advanced rice farming techniques (train 200 farmers in 2023 and 500 in 2024).

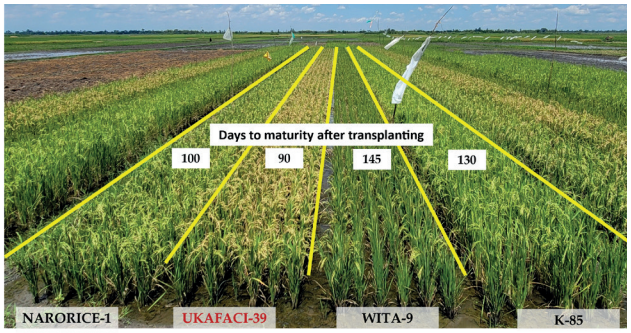
**iv)** Increase aromatic rice production in eastern and northern Uganda, where most rice is produced by more than 30%.

v) Increase the household income of target rice farmers in eastern and northern Uganda by at least 20%.

## Project Achievements

### a) Release of a new aromatic rice variety, KAFACI-39

KAFACI-39, a flagship rice variety for this project, was released and registered for cultivation by farmers in Uganda on July 12, 2023 as UKAFACI-39. UKAFACI-39 is high yielding (see image below) and matures earliest of all rice varieties currently being grown.




### b) Aromatic rice seed production and distribution to farmers

A total of 15 tons of aromatic rice seed including NARO-Rice 1 and KAFACI 39 were produced. Of these, 7.2 tons of seed was distributed to rice farmers in Doho and Butaleja districts.



*Seed Distribution exercise in Doho presided by KOPIA Uganda Director, Dr. Park Taeseon*

### c) Donation of rice production equipment and agro-inputs to farmers

Rice farmers have been faced with a huge problem of performing all rice production activities manually, which has been inefficient and labour intensive. Therefore, some equipment was donated to the rice farmers to ease the rice production process. Four male youth were also trained to operate and maintain the equipment.

In addition, fertilizers were also donated to the farmers to improve the yield of rice seed produced.

**Table 7. Donations given to farmers between January and June 2023**

| No. | Item | Quantity |
|---|---|---|
| 1. | Hydro-tiller | 1 piece |
| 2. | Threshing machines | 6 pieces |
| 3. | Tricycle (Tuk tuk) | 1 piece |
| 3. | NPK fertilizer (50kg bags) | 276 pieces |
| 4. | DAP fertilizer (50kg bags) | 13 pieces |



*KOPIA Uganda donated threshing machines to a farmer group in Doho. The projects also donated hydro-tillers and fertilizers.*

### d) Improvement of farmers' knowledge on rice cultivation technologies

200 farmers were trained on good agronomic practices for rice cultivation including pest and disease management, water management through proper bunding and irrigation, soil nutrient management,

weed management, nursery set up and production of high quality seed and care and maintenance of the rice cultivation equipment



*Farmers in the Olweny irrigation scheme were trained on how best to set up and manage rice nurseries.*

**e) Promotion of the rice project at the International Symposium on Seeds in Senegal and the 2023 Global Agricultural ODA Forum in Accra Ghana**

The rice project team leaders participated in the International Symposium on Rice Seeds for Africa from February 17th to 18th in Dakar, Senegal. The aim of the meeting was to exchange opinions on the rice production situation in Africa and Korea and to develop a plan to improve rice production in selected African countries.

The meeting decided that the seed production plan would be piloted in 7 African countries in Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Senegal, and Uganda. The teams were tasked with assessing their national capacities (land availability, human and infrastructure capacities) for the success of the initiative ahead of a follow-up meeting in June 2023.

We also participated in the 2023 Global Agricultural ODA Forum Organized by the Ministry of Agriculture, Food and Rural Affairs, Republic of Korea in Acrra,




*Presenters at the Global Agricultual ODA Forum in Acrra Ghana, including Dr. Park Taeseon, Director KOPIA Uganda.*

### 6.3.3 Potato Demonstration Project

#### Project Title

Enhancing household income through supplying and cultivation technology of high quality and yielding potato in Uganda.

#### Project location

Kigezi and Rwenzori sub regions.

#### Project objectives

The main goal of the project was to Increase the yield and income of farmers by supplying high quality and yielding NAROPOT1 potato.

To achieve this, the project specifically targeted to;

**i)** Increase access to quality seed potato through supporting the NARO institutes to improve their capacity for production of quality seed.

**ii)** Enhancing seed availability of high yielding varieties.

**iii)** Conducting demonstrations regarding the use improved varieties such as "NAROPOT 1" for improved productivity and household income.

#### Project Achievements

**i)** Increase in quality potato tissue culture plantlets from 30,000 in 2022 to 36,000

**ii)** Increase in supply of quality seed from to over 500MT

iii) Increase in potato farmers' average annual household income from USD 3,435 to USD 5,573



*Harvesting of quality seed from high yielding NAROPOT 1 potato variety for scaling.*

iv) Introduction of the polyvinyl Mulching technology

v) Construction of 2 screen houses



*One of the newly constructed screen houses under the Potato Demonstration Project.*

## 6.4 CABI (Centre for Agriculture and Bioscience International)



*The Right Hon. Robinah Nabbanja intently listening to the contribution of CABI Africa to Uganda, as presented by Ms. Christine Alokit.*

### PlantwisePlus – Uganda

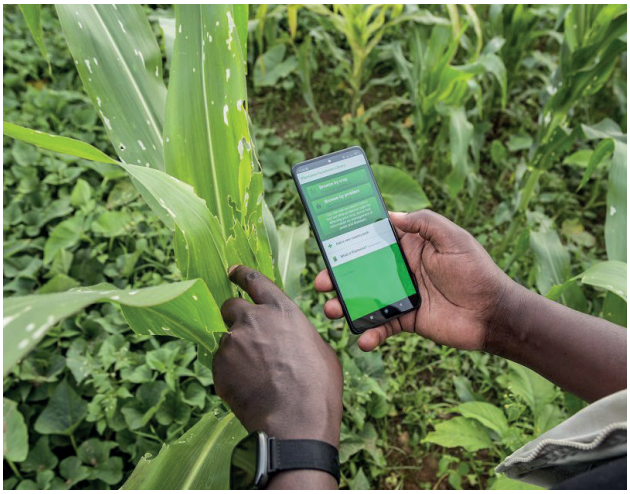
Uganda was one of the six focus countries for CABI's PlantwisePlus programme, which aimed to empower farmers to produce more food using safer and sustainable crop production practices, thereby improving food security and rural livelihoods. Work began in Uganda during the three-year (2021-2023) proof-of-concept phase of the programme, and will continue during the scaleout phase from 2024 to 2030. The following activities have been undertaken in Uganda under the three program pathways:

i) **Pest preparedness:** In Uganda, work was done to identify the status of the papaya mealybug and deploy potential early response solutions to control this invasive species, including biological control options. Under the programme, CABI also developed an evidence note for wheat stem rust to guide investment in managing the disease. Finally, PlantwisePlus delivered training to the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) National Plant Protection Office staff on horizon scanning and pest risk analysis.

ii) **Pesticide risk reduction:** Upon government approval for a biological control solution to papaya mealybug PlantwisePlus delivered training and guidance to build capacity on rearing and releasing a specific parasitoid. The parasitoid initial release in farmers' fields was done in the districts of Mukono and Kayunga. The performance of the biological control solution will be assessed in 2024. PlantwisePlus also built the capacity of agro-input dealers to provide advice to farmers based on integrated pest management principles, and lower-risk plant protection products to improve their knowledge in serving farmers.

The capacity building follows various engagements with the NPPO to address existing agro-input dealers' knowledge gaps. This led to the co-development of a training manual on IPM and lower-risk plant protection products with the MAAIF, and Makerere University (certification body). The training manual was used by CABI to train the NPPO staff/Inspectors as trainers, who then delivered pilot training for agro-dealers for improvement. In collaboration with NPPO, a consumer survey was conducted to assess consumer perceptions and knowledge of food safety risks. PlantwisePlus will use this information to inform future stakeholder and policy engagements, and when developing future strategic communication activities on pesticide risk reduction.

iii) **Farmer advisory:** Under this pathway, PlantwisePlus continued to enable access to digital decision support tools to stakeholders in Uganda and train young people as Agri service providers. The programme also continued to support plant clinics in the country with fact sheets.



### 6.4.1 Pest preparedness pathway

#### Investigating the impact of papaya mealybug and the potential for non-chemical solutions

The papaya mealybug *(Paracoccus marginatus)* is an invasive species in Uganda and several other African countries. This sucking pest causes economic damage to papaya fruits, vegetables, and ornamental plants. Farmers started observing this pest between 2017 and 2019 with more than 80% perceiving it as a serious pest. Field assessments undertaken in 2022 in central, eastern and northern Uganda confirmed that several crops were affected by papaya mealybug, which can cause crop losses of 70 to 100%.

The economic impact is severe. Before the pest invaded, farmers obtained UGX 6-8 million/acre

each season (£1,800), compared to UGX 1 million/ acre or less each season (£230) each season since the invasion. Pesticide sprays were the most common management practices though farmers reported that they were ineffective, an issue which is in part due to the mealybug's waxy covering. This contributed to the government's decision to deploy biological control methods including using parasitoids and sanitation practices.

Another contributing factor was the positive results obtained in the classical biological control of the papaya mealybug in Kenya. There, where parasitism rates were up to 73%, and a significant decline in mealybug populations and damage was observed less than 2 years after the first releases, with 78% of farmers reducing the use of their chemical pesticides on papaya as a result.

Uganda, therefore, requested that PlantwisePlus apply the same biological control method in the country. PlantwisePlus supported the submission of importation and release permits for the parasitoid Acerophagus papayae in Uganda, which were obtained in 2023.

### Evidence note on wheat stem rust

PlantwisePlus produced an evidence note on the Ug99 strain of wheat stem rust fungus in Uganda. The evidence note study showed that wheat has become an important crop in Sub- Saharan Africa, with urbanisation and increasing population as the driving factors.

However, there is a growing gap between production and demand. Stem rust re-emerged with its strain Ug99 in 1998, known to attack over 90% of the then-released varieties of wheat worldwide. Ug99 is multifaceted and requires multidisciplinary and multipronged approaches to controlling it. Key to its sustainable management in the long term is the breeding and promotion of utilisation of high-yielding Ug99-resistant varieties. The evidence suggests that supporting farmers to adopt Ug99-resistant varieties concurrently with training on appropriate agronomic technologies will be necessary to control the fungus. PlantwisePlus is exploring how to support farmers to achieve sustainable management of this disease.



*Symptoms of wheat stem rust.*

### Horizon Scanning and Pest Risk Analysis

As part of a broad-based initiative to address the plant protection needs of the Eastern African countries, PlantwisePlus delivered a practical training programme on Pest Risk Analysis (PRA) to experts drawn from the region's National Plant Protection Organizations (NPPO), including Uganda.

The training is part of a bid to establish a regional approach to pest risks and focused on early warning, preparedness, and response systems for regional plant pest risk reduction and mitigation. Practical sessions on the PRA process, the CABI Crop Protection Compendium, which gathers pest information, and the Horizon Scanning Tool, which assists countries to identify priority pest candidates for regulation are being scaled out in Uganda.

A total of 16 NARO scientists received training in 2022 comprising three females and 13 males selected from the different NARO institutes across the country. The participants included entomologists, breeders, agroforestry scientists, and plant pathologists. Although some participants were familiar with the PRA process and associated ISPM, CABI CPC PRA tools, others were not familiar with the PRA process and the support tools.

### 6.4.2 Pesticide risk reduction pathway Biological control of the invasive papaya mealybug

PlantwisePlus supported the establishment of a rearing facility in the quarantine facility of the National Agricultural Research Laboratories, (NARL) in Kawanda, using parasitoids from the main culture at the CABI quarantine facility in Nairobi. Scientists from NARL visited Muguga in Kenya for CABI training in the production of *A. papayae* and a follow-up training course was held in Uganda in November 2023.

The first two small-scale field releases were made in late 2023 with more than 10,000 mummies released. Largescale releases are planned for 2024, along with the first assessment of establishment, parasitism rates, impact on the papaya mealybug, papaya production and whether pesticide use has been reduced.



*Papaya on a farm infected with papaya mealybug.*

**Enhanced capacity among agro-input dealers on integrated pest management and pesticide risk reduction**

In Uganda, there is a clear gap in existing mandatory training for agro-input dealers regarding knowledge of and use of lower-risk plant protection products, especially those that were regarded as bioprotection or biological-based products based on a large PlantwisePlus-led survey in 2021 examining the regulatory frameworks that govern operating environments for agro-input dealers found significant differences between countries in the mandatory requirements for the licensing or certification (hereafter referred to simply as certification) of agor-input dealers. It also revealed that voluntary certification schemes for agro-input dealers are extremely rare. In general, agro-input dealers receive minimal training and post-certification support. This raises a risk about the quality of the service they are providing to farmers who, in many cases, see the agro-input dealers as one of the only sources of advice.

PlantwisePlus facilitated several workshops in Kampala with partners including MAAIF, Makerere University (certification body), and NARO co-developed a training manual and training curricula. NARO scientists participated in the workshop to review the draft manual. Following a successful Training of Trainers (ToT) workshop, the programme team carried out a pilot phase training for 30 prospective agro-input dealers. The training component around lower-risk plant protection products was well received by both trainees and trainers. There is a clear interest in further content development from MAAIF.

### 6.4.3 Farmer Advisory Pathway

Twenty-five (25) (6 female, 19 male) NARO scientists received training in 2022 in plant pests and diseases diagnosis, operation of plant clinics, and giving a good recommendation. These join the pool of plant doctor trainers that include staff from MAAIF and selected academic institutions to offer extension staff plant doctor training in the country.

# PICTORIAL: EVENTS



USAID Mission Team led by Richard Nelson appreciates results from USAID's investments in agricultural research.




Rt. Hon. Robinah Nabbanja tours the NARO stall during Public Service day held at Kololo Independence Grounds.



Japanese International Cooperation Agency (JICA) ARD Special Advisor, Dr. Shuichi Asanuma visit to NARO.



NARO signing an MoU with Farm Radio International to enhancing dissemination of research technologies.



MoU signing between NARO and Family TV for dissemination of information and public engagement.




MOU signing between NARO and COFIA Uganda on agricultural knowledge and technology transfer.



Uganda Breweries's Managing Director, Mr. Andrew Kilozo courtesy call to NARO.



Seeds of Gold Farm Clinics held at KaZARDI, NgettaZARDI, Mbarara ZARDI and Kajjansi ARDC.



Hon. Frank Tumwebaze administers the first anti-tick vaccine during the launch of the final field trials.




NARO exhibition at the Agriculture Ministers Conference in Munyonyo organized by ASARECA.



Farewell dinner for the outgoing DG, Dr. Ambrose Agona at the Speke Resort Munyonyo.



Dr. Ambrose Agona hands over to the incoming Director General, Dr. Yona Baguma.



Chocolate tasting by experts from Belgium and Uganda to enhance information sharing on cocoa research and innovations.



Namirembe Diocese's Bishop Kityo Luwalira and his team having a guided study tour of livestock technologies.



NACORI Scientist sharing with US mission team technologies being upscaled for economic growth.



NARO breeders and eminent scientists were recognized for their outstanding contribution towards food security.



Minister of Finance, Hon. Matia Kasaija, gets firsthand experience of the work being done by NARO.




Delegates during the launch of the One CGIAR Centre.



Farmers being exposed to urban agriculture technologies during the Harvest Money Expo.



Launch of the Eyok Maret campaign to intensify promotion of Iron-Rich beans consumption and production in Karamoja with support from USAID.



Swedish Ambassador to Uganda, H.E. Maria Hànkasson, familiarisation visit to NARO.



MoU signing between NARO and Church of Uganda on enhancing promotion and adoption of agricultural technologies.




Members of Parliament from Northern Uganda on a learning visit to NARO.



Rt. Hon. Robinah Nabbanja touring NARO stalls during the National World Fisheries Day celebrations.



Launch of Feed the Future initiative to move research products off the shelf to the market by commercializing 8 commodities along the value chain.



Hon Grace Kwiyucwiny commissioning Agro-hub Supermarket and Farmer Learning Centre in Gulu.



PS/ST, Ramathan Ggoobi durina a guided tour of the livestock vaccine facility at NaLIRRI - Nakyesasa.




Sneak peek into the 3rd NAROMAK biennial conference at Speke Resort, Munyonyo.



Committee of Parliament on Agriculture, Animal Industry and Fisheries during their oversight visit to Ngetta ZARDI.



Members of the 5th NARO Governing Council monitoring maize and soybean seed multiplication fields.




NARO staff participating in a capacity building activity on Communication, Knowledge Management, M&E for impact.




Dr Kassim Sadik took part in the UBL Farmers' Symposium on the role and impact of agriculture.



Members of top management receiving Hon. Frank Tumwebaze during his maiden visit to NARO.



Launching the Uganda Value Chain Capacity for Key Crops (VegeSeed Project). The project is funded by the Korean Embassy.



NARO volleyball teams participate in the Entebbe Corporate Sports Gala.



Hon. Fred Bwino presiding over the handover ceremony of Outgoing Chairperson Governing Council, Prof. Joseph Obua to Dr. William Olaho Mukami.

# LIST OF PUBLICATIONS

## Scientific Journal publications

### National Crops Resources Research Institute (NaCRRI)


1. Adjei, Emmanuel Amponsah, Williams Esuma, Titus Alicai, Emmanuel Boache Chamba, Richard Edema, Isaac Onziga Dramadri, Alfred Adebo Ozimati, Rolland Agaba, and Thomas Lapaka Odong. 2022. "Genotype-by-Environment Interaction of Yam (Dioscorea species) for Yam Mosaic Virus Resistance, Dry Matter Content and Yield in Uganda". Agronomy 12, no. 9: 1984. *https://doi.org/10.3390/agronomy12091984*

2. Alibu S, Obura M, Ekebu J, Nampamya D, Lamo J, Asea G, Park T-S. 2022.Modest Ag-Extension and Access to Seeds of Aromatic Rice Can Boost Returns of Smallholder Farmers in Uganda, A Case Study. Agriculture.; 12(8):1172. *https://doi.org/10.3390/agriculture12081172*

3. Amagloh, Flora C., Archileo N. Kaaya, Gaston A. Tumuhimbise, Arnold Katungisa, Francis K. Amagloh, and Benard Yada. 2022. "Household Processing Methods and Their Impact on Bioactive Compounds and Antioxidant Activities of Sweetpotato Genotypes of Varying Storage Root Flesh Colours" Antioxidants 11, no. 10: 1867. *https://doi.org/10.3390/antiox11101867.*

4. Amongi W, Nkalubo ST, Ochwo-Ssemakula M, Badji A, Dramadri IO, Odongo TL, Nuwamanya E, Tukamuhabwe P, Izquierdo P, Cichy K, Kelly J. Genetic clustering, and diversity of African panel of released common bean genotypes and breeding lines. Genetic Resources and Crop Evolution. 2023 Mar 8:1-4.

5. Amponsah Adjei E, Esuma W, Alicai T, Bhattacharjee R, Dramadri IO, Edema R, et al. (2023) Genetic diversity and population structure of Uganda's yam (Dioscorea spp.) genetic resource based on DArTseq. PLoS ONE 18(2): e0277537. *https://doi.org/10.1371/journal.pone.0277537.*

6. Apunyo, C. P., Businge, M., Otim, M., Isubikalu, P. &T. L., O. Diversity of Sorghum in Farmers ' Fields in Northern and Eastern Uganda. Int. J. Bioversity Conserv. 2022, 14, 181–189, doi:10.5897/IJBC2022.1564.

7. Arnaud, E., Menda, N., Tran, T., Asiimwe, A., Kanaabi, M., Meghar, K., Forsythe, L., Kawuki, R., Ellebrock, B., Kayondo, I.S., Agbona, A., Zhang, X., Mendes, T., Laporte, M.-A., Nakitto, M., Ssali, R.T., Asfaw, A., Uwimana, B., Ogbete, C.E., Makunde, G., Maraval, I., Mueller, L.A., Bouniol, A., Fauvelle, E. and Dufour, D. (2023), Connecting data for consumer preferences, food quality, and breeding in support of market-oriented breeding of root, tuber, and banana crops. J Sci Food Agric. *https://doi.org/10.1002/jsfa.12710.*

8. Arthur K. Tugume, Deusdedith R. Mbanzibwa, Titus Alicai, Christopher A. Omongo, and M. N. Maruthi, 2023. Endemism and Reemergence Potential of the Ipomovirus Sweet Potato Mild Mottle Virus (Family Potyviridae) in Eastern Africa: Half a Century of Mystery. Phytobiomes Journal 0 0:0 *https://apsjournals.apsnet.org/doi/abs/10.1094/PBIOMES-05-22-0031-RVW.*

9. B. M. Prasanna, J. Burgueño, Y. Beyene, D. Makumbi, G. Asea, V. Woyengo, A. Tarekegne, C. Magorokosho, D. Wegary, T. Ndhlela, M. Zaman-Allah, P.M. Matova, K. Mwansa, K. Mashingaidze, P. Fato, A. Teklewold, B.S. Vivek, P.H. Zaidi, M.T. Vinayan, N. Patne, R. Kumar, K.B. Koirala, P. H. Kuchanur, S. Ahmed, F. S. Vicente, T. Dhliwayo, J. E. Cairns. 2022. Genetic Trends in CIMMYT's Tropical Maize Breeding Pipelines. Nature Scientific Reports, 12 (1), 20110.

10. Baguma, J.K., Mukasa, S.B., Nuwamanya, E., Alicai, T., Omongo, C., Hyde, P.T., Setter, T.L., Ochwo-Ssemakula, M., Esuma, W., Kanaabi, M. and Iragaba, P., 2023. Flowering and Fruit-set in Cassava under Extended Red-Light Photoperiod Supplemented with Plant-Growth Regulators and Pruning. BMC Plant Biology 23(1). DOI: 10.1186/s12870-023-04349-x.

11. Bayiyana, Irene and Bua, Anton and Ozimati, Alfred and Mugisha, Johnny and Colvin, John and Omongo, Christopher Abu. 2023. Insecticide Applications to Control Cassava Whitefly: An Economic Analysis for Small-Scale Growers in Uganda. Agriculture 13, 1043. *https://doi.org/10.3390/agriculture13051043.*

12. Beine P. Ahimbisibwe, John F. Morton, Shiferaw Feleke, Arega D. Alene, Tahirou Abdoulaye, Kate Wellard, Eric Mungatana, Anton Bua, Solomon Asfaw & Victor Manyong (2023). Assessing the crop productivity and household welfare effects of adopting certified seeds of improved cassava varieties in Uganda. Agrekon 1-14. DOI: 10.1080/03031853.2023.2220684.

13. Bisikwa, J.; Nampala, P.; Nsibo, D.L.; Kwikiriza, N.; Bukenya, C.; Otim, M.H.; Kapting, I.; Kabuye, F.M.; Felix, J. 2022. Assessment of Striga Hermonthica Infestation and Effectiveness of Current Management Strategies in Maize-Based Cropping Systems in Eastern Uganda. African Crop Sci. J. 30, 525–538, doi:10.4314/acsj.v30i4.10.

14. El Hamss H, Maruthi MN, Ally HM, Omongo CA, Wang H-L, van Brunschot S, Colvin J and Delatte H (2022) Spatiotemporal changes in endosymbiont diversity and composition in the African cassava whitefly, Bemisia tabaci SSA1. Front. Microbiol. 13:986226.

15. Ephraim Nuwamanya, Christopher Turyasingura, Isaac Magumba, Arnold Katungisa, Titus Alicai. 2022. Cyanogenic Potential Variations Within Plot, Plant and Roots of Cassava Varieties Grown in the Same Environment. Proceedings of the National Academy of Sciences, India: Biological Sciences volume 93, 365–372. doi:10.1007/s40011-022-01418-3.

16. Esther L. Nampeera., Mathew E. O'Neal, Gail R. Nonnecke, Lucy K. Murungi Mary o. Abukusta-Onyango, John M. Wesonga., 2023. Effects of seed treatment and storage duration on Myzus persicae (Hemiptera: Aphididae) and amaranth fresh leaf yield. Environmental Entomology 52 (3), 360–370.

17. Esuma W, Eyoo O, Gwandu F, Mukasa S, Alicai T, Ozimati A, Nuwamanya E, Rabbi I and Kawuki R (2022). Validation of KASP markers associated with cassava mosaic disease resistance, storage root dry matter and provitamin A carotenoid contents in Ugandan cassava germplasm. Frontiers in Plant Science. 13:1017275. doi: 10.3389/fpls.2022.1017275.

18. Flora Christine Amagloh, Archileo N. Kaaya, Benard Yada, Doreen Murenju Chelangat, Arnold Katungisa, Francis Kweku Amagloh, Gaston Ampe Tumuhimbise. 2022. Bioactive compounds and antioxidant activities in peeled and unpeeled sweetpotato roots of different varieties and clones in Uganda. Future Foods 6, 100183. *https://doi.org/10.1016/j.fufo.2022.100183*.

19. Florence Nameere-Kivunike,Elly A. Gamukama,Joyce Nakatumba-Nabende,Daniel Mutembesa, Jeremy Francis Tusubira, Solomon Nsumba,Christopher A. Omongo, Gloria Namanya, 2022. Assessing the contribution of the Adhoc crop health surveillance tool on the food security and livelihoods of smallholder farmers in Uganda. The Electronic Journal of Information Systems in Developing Countries (EJISDC) 89 (3), e12249 *https://doi.org/10.1002/isd2.12249*.

20. G. Asea, D. B. Kwemoi, C. Sneller, C. L. Kasozi, B. Das, L. Musundire, D. Makumbi, Y. Beyene, B. M. Prasanna. 2023. Genetic Trends for Maize Yield and Adaptative Traits in Pre-Commercial and Commercial Varieties Between 2008 and 2020 in Uganda. Frontiers in Plant Science 14, 795.

21. Halerimana, C.; Kyamanywa, S.; Olaboro, S.; Paparu, P.; Nkalubo, S.T.; Colvin, J.; Cheke, R.A.; Kriticos, D.J.; Otim, M.H. Bean Leaf Beetle (Ootheca Spp.) (Coleoptera: Chrysomelidae) Management via Planting Timing and Insecticides. Insects 2022, 13, 709, doi:10.3390/insects13080709.

22. Iliya Mohammed, Perpetua Ipulet, Africano Kangire.2023. Effect of Purple Blotch Farm Management Practices on Onion Production in Uganda. East African Journal of Agriculture and Biotechnology. 6 (1), ISSN: 2707-4293 | e-ISSN: 2707-430. DOI: *https://doi.org/10.37284/2707-4307*.

23. Immaculate Babirye, Florence Nakazi, Eliud Abucheli Birachi, Jackline Bonabana Wabbi, Michael Adrogu Ugen & Gabriel Elepu (2023) Exploring processed common beans market in Kenya: Implications for the business community. Cogent Food & Agriculture, 9:1, DOI: 10.1080/23311932.2023.2175538.

24. Julius K. Baguma, Settumba B Mukasa, Ephraim Nuwamanya, Titus Alicai , Christopher Omongo , Peter T. Hyde , Tim L. Setter, Mildred OchwoSsemakula , William Esuma , Michael Kanaabi, Paula Iragaba, Yona Baguma and Robert S. Kawuki. 2023. Flowering and fruit-set in cassava under extended red-light photoperiod supplemented with plant-growth regulators and pruning. BMC Plant Biol 23, 335. *https://doi.org/10.1186/s12870-023-04349-x*.

25. Kabange, N.R.; Lee, S.-M.; Shin, D.; Lee, J.-Y.; Kwon, Y.; Kang, J.-W.; Cha, J.-K.; Park, H.; Alibu, S.; Lee, J.-H. Multiple Facets of Nitrogen: From Atmospheric Gas to Indispensable Agricultural Input. Life 2022, 12, 1272. *https://doi.org/10.3390/life12081272*.

26. Kalyebi, A.; Otim, M.H.; Walsh, T.; Tay, W.T. 2023. Farmer Perception of Impacts of Fall Armyworm (Spodoptera Frugiperda J . E . Smith) and Transferability of Its Management Practices in Uganda. CABI Agric. Biosci. 1–14, doi:10.1186/s43170-023-00150-w.

27. Kanaabi, M. and Nuwamanya, E., 2023. NIRS acquisition on fresh cassava roots using FOSS DS2500 and ASD quality spec and relating the NIRS spectra to fresh HCN content by Picrate method. High-Throughput Phenotyping Protocols (HTPP), WP3.

28. Lutaakome, M., Kyamanywa, S., Paparu, P., Olaboro, S., Halerimana, C., Nkalubo, S. T., & Otim, M. H. 2022. Host and Seasonal Effects on the Abundance of Bean Leaf Beetles (Ootheca spp.) (Coleoptera: Chrysomelidae) in Northern Uganda. Insects, 13(9), 848.

29. M. H Otim, S. Alibu, G. Asea, G. Abalo, J.P. Sserumaga, S Adumo, J Alupo, S Ochen, T Tefera, A Y. Bruce, Y Beyene, B Meisel, R Tende, F Nang'ayo, Y Baguma, S Mugo, S O. Oikeh. 2022. Performance of Bt maize event MON810 in controlling maize stem borers Chilo partellus and Busseola fusca in Uganda. Crop Protection 156, 105945.

30. Mugisa I, Karungi J, Musana P, Odama R, Alajo A, Chelangat DM, Anyanga MO, Oloka BM, Gonçalves dos Santos I, Talwana H, Ochwo-Ssemakula M, Edema R, Gibson P, Ssali R, Campos H, Olukolu BA, da Silva Pereira G, Yencho C and Yada B (2022) Combining ability and heritability analysis of sweetpotato weevil resistance, root yield, and dry matter content in sweetpotato. Frontiers in Plant Science. 13:956936. doi: 10.3389/fpls.2022.956936.

31. Mugonza, J.; Egonyu, J.P.; Otim, M.H. Farmers' Knowledge, Control Methods, and Challenges of Managing Bean Leaf Beetles (Ootheca Spp.) in Uganda. Sustainability 2023, 15, 5229, doi:10.3390/su15065229.

32. Mukayiranga A., Rubaihayo P., Gibson P.T., Edema1 R., Nkalubo S.T., Chiteka Z.A. and Rutayisire A. 2022. Genetic progress achieved in bean breeding in Uganda. African Crop Science Journal, 30:4:115 – 131. DOI: *https://dx.doi.org/10.4314/acsj.v30i4.9*.

33. Nandudu L, Kawuki R, Ogbonna A, Kanaabi M and Jannink J-L (2023) Genetic dissection of cassava brown streak disease in a genomic selection population. Frontiers in Plant Science 13:1099409. doi: 10.3389/fpls.2022.1099409.

34. Nantale, N., Wasswa, P., Tusiime, R., Muhumuza, E., Dramadri, O.I. and Paparu, P. 2023. Response of Cowpea germplasm to bacterial blight in Uganda. Journal of Scientific Agriculture 7: 17-27. Doi: 10.25081/jsa.2023.v7.8061. *https://updatepublishing.com/journal/index.php/jsa*.

35. Nantale, N., Wasswa, P., Tusiime, R., Muhumuza, E., Paparu, P. and Dramadri, O.I. 2023. Combining ability of Cowpea (Vigna unguiculata (L) Walp) genotypes for resistance to Cowpea bacterial blight in Uganda. American Journal of Agricultural Science, Engineering, and Technology (AJASET). DOI: 10.54536/ajaset.v7i1.1174.

36. Nanyiti S, Kabaalu R, Alicai T, Abidrabo P, Seal SE, Bouvaine S, Bailey AM and Foster GD (2023) Detection of cassava brown streak ipomoviruses in aphids collected from cassava plants. Front. Sustain. Food Syst. 7:1027842. doi: 10.3389/fsufs.2023.1027842.

37. Nuwamanya, E., Kanaabi, M., Katungisa, A., Muhumuza, N., Lyatumi, I., Esuma, W., Kawuki, R., Baguma, Y. and Atwijukire, E., 2023. Evaluation of the industrial potential of cassava based on pasting properties of cassava flour from Ugandan elite varieties. African Crop Science Journal, 31(2), pp.201-214.

38. Ojwang SO, Okello JJ, Otieno DJ, Mutiso JM, Lindqvist-Kreuze H, Coaldrake P, Mendes T, Andrade M, Sharma N, Gruneberg W, Makunde G, Ssali R, Yada B, Mayanja S, Polar V, Oloka B, Chelangat DM, Ashby J, Hareau G and Campos H (2023) Targeting market segment needs with public-good crop breeding investments: A case study with potato and sweetpotato focused on poverty alleviation, nutrition and gender. Frontiers in Plant Science. 14:1105079. doi: 10.3389/fpls.2023.1105079.

39. Osaru, F., Karungi, J., Odama, R., Chelangat, D. M., Musana, P., Otema, M. A., Oloka, B., Gibson, P., Edema, R., Ssali, R. T., Yencho, G. C., & Yada, B. (2023). Identification of the key morphological sweetpotato weevil resistance predictors in Ugandan sweetpotato genotypes using correlation and path-coefficient analysis. Crop Science, 00, 1– 13. *https://doi.org/10.1002/csc2.20915.*

40. Ozimati A, Esuma W, Manze F, Iragaba P, Kanaabi M, Ano C, Egesi C and Kawuki RS (2022.) Utility of Ugandan genomic selection cassava breeding populations for prediction of cassava viral disease resistance and yield in West African clones. Frontiers in Plant Science 13:1018156. doi: 10.3389/fpls.2022.1018156.

41. Paul Mwebaze, Sarina Macfadyen, Paul De Barro, Anton Bua, Andrew Kalyebi, Fred Tairo, Donald Kachigamba, Christopher Omongo and John Colvin, 2022. Impacts of cassava whitefly pests on the productivity of East and Central African smallholder farmers. Journal of development and Agricultural Economics, 14(3), pp. 60-78, *https://doi.org/10.5897/JDAE2022.1330.*

42. S. Alibu, M. Obura, EJ. Kebu, D. Nampamya, J. Lamo, G. Asea, T. Park. 2022. Modest Ag-Extension and Access to Seeds of Aromatic Rice Can Boost Returns of Smallholder Farmers in Uganda, A Case Study. Agriculture (12), 1172. *https://doi.org/10.3390/ agriculture12081172.*

43. S. Alibu, M. Obura, J. Ekebu , D. Nampamya, J. Lamo, G Asea , T. Park. 2022. Agronomic Evaluation of Alternative Lowland Rice Varieties for Farmers in Uganda; A Case of Aromatic Rice. Journal of Food Security, (10), No 2, 81-88.

44. Sesay, J.V., Lebbie, A., Wadsworth, R., Nuwamanya, E., Bado, S. and Norman, P.E., 2023. Genetic Structure and Diversity Study of Cassava (Manihot esculenta) Germplasm for African Cassava Mosaic Disease and Fresh Storage Root Yield. Open Journal of Genetics, 13(1), pp.23-47.

45. Titus Alicai, Henry Wagaba, 2023. Chapter 5 - Cassava brown streak ipomoviruses. Editor(s): Rajarshi Kumar Gaur, Basavaprabhu L. Patil, Ramasamy Selvarajan. Plant RNA Viruses, Academic Press, 2023. Pages 99-116. ISBN 9780323953399. *https://doi.org/10.1016/B978-0-323-95339-9.00010-7. (https://www.sciencedirect.com/science/article/pii/B9780323953399000107.*

46. Yi-Wen Lim, Ben N. Mansfeld, Pascal Schläpfer, Kerrigan B. Gilbert, Narayanan N. Narayanan, Weihong Qi, Qi Wang, Zhenhui Zhong, Adam Boyher, Jackson Gehan, Getu Beyene, Zuh-Jyh Daniel Lin, Williams Esuma, Suhua Feng, Christelle Chanez, Nadine Eggenberger, Gerald Adiga, Titus Alicai, Steven E. Jacobsen, Nigel J. Taylor, Wilhelm Gruissem & Rebecca S. Bart, 2022. Mutations in DNA polymerase- subunit 1 co-segregate with CMD2-type resistance to Cassava Mosaic Geminiviruses. Nature Communications 13, 3933 (2022). *https://doi.org/10.1038/s41467-022-31414-0.*

47. Babirye F. N, E. Nuwamanya, M. Kanaabi, P. Gibson, E. Wembabazi, P. Iragaba, R.S. Kawuki. 2023. NIRS Predictions, Phenotypic Variability and Optimization of Cooking Time for Evaluation of the Root Softness of Boiled Cassava. Uganda Journal of Agricultural Sciences, 21 (2), 41 – 53. DOI: http://dx.doi.org/10.4314/ujas.v21i2.4

## National Coffee Research Institute (NaCORI)

48. Adage, H., Kagezi, GH., Asiimwe, J., Twesigye, V., Mulindwa, J., Nakayaga, R., Musiime, D. and Arinaitwe, G. 2023. Scaling-up NARO Technologies and Innovations: Success Stories in Coffee. Presented at the First National Agricultural Extension Week in Uganda (UG-NAEW 2023). Kabira Country Club, Bukoto, Kampala, May 23 – 26, 2023.

49. Chemutai, J.A., Nanyonga, J. and Lutaakome, S.E. 2023. Exploring the coffee species, Coffea liberica in Uganda. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

50. Kagezi G.H., Kyalo G., Twesigye V., Helerimana C., Anyijuka M., Musasizi J.K., Ssenoga G., Kobusinge J., Sseremba G., Arinaitwe G. and Niyibigira E.I. 2023. Coffee Berry Moth, Prophantis smaragdina (Butler) (Lepidoptera: Pyralidae): Another threat to Robusta coffee, Coffea canephora production in Uganda. Uganda Journal of Agricultural Sciences 21(2):1-16. http://journal.naro.go.ug/index.php/ujas/article/view/485

51. Kagezi, GH., Kobusinge, J., Olango, N., Sseremba, G., Olal, S., Kucel C., Harelimana, C., Apunyo, P., Nakitende, A., Anyijuka, M., Nanjego, W., Kyalo G. and Arinaitwe G. 2023. Agronomic and Biotic Stresses Limiting Cocoa Production in the Three Major Growing Zones of Uganda. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

52. Kagezi, GH., Nakitende, A., Anyijuka, M., Kobusinge, J., Katerega, J., Adage H., Twesigye, V., Asiimwe, A., Sseremba, G. and Arinaitwe, G. 2023. Community-based Participatory Research-Extension-Farmer Model for Managing Invasive Coffee Pests in Uganda: A Case of the Black Coffee Twig Borer. Presented at the First National Agricultural Extension Week in Uganda (UG-NAEW 2023). Kabira Country Club, Bukoto, Kampala, May 23 – 26, 2023.

53. Kobusinge, J., Gabiri, G., Kagezi, G.H., Sseremba, G., Nakitende, A., Arinaitwe, G. and Twesigye, C.K. 2023. Potential of Moisture Conservation Practices to Improve Soil Properties and Nutrient Status of Robusta Coffee Plant. Agronomy (13):1148. $^{o}$

54. Kwaka, L. Sseremba, G., Nakitende, A., Nambuya, A., Kayemba, F., Kagezi, HG. and Arinaitwe, G. 2023. Effect of Different NPK Fertilizer Blends on the Growth and Yield of Robusta Coffee in Uganda. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

55. Olal, S., Bitalo, D., Olango, N.., Akodi, D., Apunyo, P., Kagezi G. and Arinaitre G. 2023. Pilot demonstration of a satellite-based system for the detection and monitoring coffee wilt disease spread in Uganda. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

56. Olango, ND., Olal, S., Kagezi, G., Kucel, P., Ekwaru, R., Kobusinge, J.. and Arinaitwe G. 2023. Occurrence and damage/severity of coffee pests and diseases in central Uganda. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

57. Ssembajwe, R., Kafeero, CM,, Ddumba, SD., Kagezi, GK. and Arinaitwe, G. 2023. Dynamics and Associations of Selected Agrometeorological Variables in Robusta Growing Regions of Uganda. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

58. Sseremba, G., Musoli, P., Aluka, P., Kyaligonza, V., Chemutai, J., Magambo, B., Kobusinge, J., Mulindwa, J., Kagezi, GH. and Arinaitwe, G. 2023. Stakeholder-Focused Coffee Variety Product Development Approaches for Transforming Lives of Farming Communities: Achievements and Plans. Presented at the First National Agricultural Extension Week in Uganda (UG-NAEW 2023). Kabira Country Club, Bukoto, Kampala, May 23 – 26, 2023.

59. Sseremba, G., Tongoona, P.B., Musoli, P.; Eleblu, J.S.Y., Melomey, L.D., Bitalo, D.N., Atwijukire, E., Mulindwa, J., Aryatwijuka, N., Muhumuza, E., Kobusinge, J., Magambo, B., Kagezi, GH., Danquah, EY., Kizito, EB., Kyalo, G., Iyamulemye, E. and Arinaitwe, G. 2023. Viability of Deficit Irrigation Pre-Exposure in Adapting Robusta Coffee to Drought Stress. Agronomy 13:674. *https://doi.org/10.3390/agronomy13030674*

## National Fisheries Resources Research institute (NAFIRRI)


60. Andrew Whiston , Andreas W. Rost , Richard S. Mangeni , Cayleigh Bruce and Andrew S. Brierley * (2022). Drying fish (Rastrineobola argentea) on the bank of Lake Victoria in a prototype solar-heated enclosure: Using renewable energy to reduce drying-time and improve product quality and value Vol. 16(11) pp. 289-300. African Journal of Food Science

61. Angela Nankabirwa, A., Egessa, A., Naluwairo, J., Magezi, G., Kiggundu, V., Gandhi, W. P., Ocaya, H., Okello, W. (2023). Horizontal differentiation in water chemistry, phytoplankton, zooplankton and macrozoobenthic communities in Lake Kwania. Afr J Ecol. 2023; 00:1–11. wileyonlinelibrary.com/journal/aje.

62. Birungi Namuyiga Dorothy,* Till Stellmacher , Christian Borgemeister and Jeroen C. J. Groot (2022). A Typology and Preferences for Pigeon Pea in Smallholder Mixed Farming Systems in Uganda. Agriculture 12, 1186 *https://doi.org/10.3390/agriculture12081186*

63. Ce´dric Morana * Alberto V. Borges, Loris Deirmendjian, Okello William, Hugo Sarmento, Jean-Pierre Descy, Ismael A. Kimirei, and Steven Bouillon (2022). Prevalence of Autotrophy in Non-humic African Lakes. Ecosystems. *https://doi.org/10.1007/s10021-022-00783-4*

64. Esterhuyse S., Redelinghuys N., Charvet Patricia, Fearnside P., Daga V., Braga R., Okello W., Vitule J., Verheyen E. and Van Steenberge M. (2022). Effects of Hydrocarbon Extraction on Freshwaters. In: Tockner, Klement, Encyclopedia of Inland Waters 2nd edition. vol. 4, pp. 189-209. Oxford: Elsevier. dx.doi.org/10.1016/B978-0-12-819166-8.00164-X

65. Hamilton, S. E. , McGehee, D. D., Nyamweya, C. , Ongore, C. , Makori, A., Mangeni-Sande, R., Kagoya, E. , Kashindye, B. B., Elison, M., Shaban, S. S., Mlaponi, E., Mwainge, V. M., Ocaya, H., Krach, N., Ogari, Z. , Mugeni, B., Taabu-Munyaho, A., Kayanda, R., Muhumuza, E. & Natugonza, V. (2022). High-resolution bathymetries and shorelines for the Great Lakes of the White Nile basin. Sci Data 9, 642 (2022). *https://doi.org/10.1038/s41597-022-01742-3*

66. Lake Victoria: Overview of research needs and the way forward (2023). Nyamweya , C., Lawrence T. J., Ajode M. Z., Smith S., Achieng A.O., Barasa J. E., Masese, F. O. , Taabu-Munyaho A., Mahongo S., Kayanda R., Rukunya, E. , Kisaka, L. , Manyala, J. , Medard, M., Otoung, S., Mrosso, H., Sekadende, B , Walakira, J., Mbabazi, S., Kishe, M., Shoko, A. , Dadi, T.,Gemmell, A., Nkalubo W., Journal of Great Lakes Research, *https://doi.org/10.1016/j.jglr.2023.06.009*

67. Mulanda Aura C., Roegner A., Owiti, H., Birungi Dorothy, Kathryn J. Fiorella, Jessica Corman, Kayanda R., Patrick Mbullo, Chrisphine S. Nyamweya, Geofrey Mchau, Miles Daniels, Richard Oginga Abila (2022). Mind the gaps for the best practices: Enhancing the management of Lake Victoria fisheries resources. Lakes & Reservoirs. 2022;27:e12411. *https://doi.org/10.1111/lre.12411*

68. Musita A. A. , Ogello E. O. , Balirwa J. S. , Bassa S. (2022). Dietary Fishmeal Substitution by Peanut-Based Meals in Nile Tilapia (Oreochromis Niloticus L.): Effect of Pond Water Quality on Biomass Production. Uganda Journal of Agricultural Sciences ISSN: 1026-0919 (Print); 2410-6909 (Online) Volume 21 Number 1 (2022) pp. 57 – 67. DOI: http://dx.doi.org/10.4314/ujas.v21i1.5

69. NAFIRRI (2022). Aquatic Ecology Monitoring: Water quality, fish composition and abundance, fish catch, fishing effort, catch beach revenue, sanitation and disease vectors, Monitoring No. 31. Date: 9th – 14th November 2022

70. Nakiyende, H., Chapman, L., Basooma, A., Mbabazi, D., Odong, R., Nduwayesu, E., Bassa, S., Mugeni, B., Nkalubo, W., Mulowoza, A., Richard Sande Mangeni, R.S., Taabu-Munyaho, A., Efitre,J. (2023). A review of light fishing on Lake Albert, Uganda: Implications for a multi-species artisanal fishery. Fisheries Research, *https://doi.org/10.1016/j.fishres.2022.106535. Volume 258, February 2023, 106535*

71. Nduwayesu, E., Basooma, A., Sekiranda, S. K., Balirwa, J.S., Bassa, S., Muhumuza, E., Mugeni, B., Mulowoza, A. , Musobya, M., Nakiyende, H. (2023). Impacts of the Victoria Nile Bujagali hydropower dam on fisheries and livelihoods. River Res Applic. ;1–13.

72. Olokotum, M., Jean-François Humbert, Quiblier, C., Okello, W., Semyalo,R., Marc Troussellier , Marie,B., Kathrin Baumann, Rainer Kurmayer , and Cécile B. (2022). Characterization of Potential Threats from Cyanobacterial Toxins in Lake Victoria Embayments and during Water Treatment. Toxins, 14, 664. *https://doi.org/10.3390/toxins14100664*

73. Sekiranda Stephen B. K. * Pabire W. Ghandi (2022). Distributional Patterns of Gastropoda Upstream and Downstream of Bujagali Hydropower Project along the Upper Victoria Nile. Uganda Journal of Agricultural Sciences ISSN: 1026-0919 (Print); 2410-6909 (Online) Volume 21 Number 1 (2022) pp. 25 – 40. DOI: *http://dx.doi.org/10.4314/ujas.v21i1.3*

74. Simmance, F.A., Olwo, J., Mbilingi, B., Dheyongera, G., Masette, M., Ahern, M., Franz, N., Westlund, L., Kolding, J., Chimatiro, S., Nico, G., Byrd, K.A., Gee, J., Misk, R. & Ward, A. 2023. The contribution of small-scale fisheries to healthy food systems in Uganda. Rome, FAO.

75. Vianny Natugonza, Chrispine Nyamweya, Erla Sturludottir, Laban Musinguzi, Richard Ogutu-Ohwayo, Sam Bassa, Enock Mplaponi, Tumi Tomasson, Gunnar Stefansson, (2022). Spatiotemporal variation in fishing patterns and fishing pressure in Lake Victoria (East Africa) in relation to balanced harvest. Fisheries Research, Volume 252, August 2022, 106355, *https://doi.org/10.1016/j.fishres.2022.106355*.

## National Forestry Resources Research Institute (NaFORRI)


76. Agaba, H., Kalanzi, F., Kiyingi, I., Mwanja, C., Malinga, M., Theodros, G., ... & Durai, J. (2022). Bamboo Site–Species Matching Study in Uganda.

77. Buyinza J., Muthuri C. W., Denton M. D., Nuberg I. K (2023). Impact of tree pruning on water relations in tree-coffee systems on smallholder farms in Uganda. Agroforestry Systems. *https://doi.org/10.1007/s10457-023-00842-2*

78. Buyinza J., Nuberg I. K., Muthuri C. W., Denton M. D (2022). Why farmers are hesitant to adopt what appears good on the basis of science: Understanding farmers' perceptions of biophysical research. Journal of Sustainable Development, 15(3). doi: *https://doi.org/10.5539/jsd.v15n3p68*

79. Kabasindi H., Odoi J.B., Isabirye M (2022). Drought Stress and Adaptation Strategies in Kumi and Amuria Districts of Uganda. Uganda Journal of Agricultural Sciences 21(1), *https://doi.org/10.4314/ujas.v21i1.4*

80. Kalanzi, F., & Mwanja, C. K. (2023). Effect of nodal cutting position and plant growth regulator on bud sprouting of Dendrocalamus giganteus Wall. Ex Munro in Uganda. Advances in Bamboo Science, 100016.

81. Kamusiime E., Nantongo J.S., Wacal C (2023). Insect pests in apple (Malus domestca Borkh) gardens: Review. GSC Advanced Research and Reviews,15(01), *https://doi.org/10.30574/gscarr.2023.15.1.0109*

82. Kissa D.O., Ssali F., and Sheil D (2023). Sex ratios, damage and distribution of Myrianthus holstii Engl.: a dioecious afromontane forest tree. Journal of Tropical Ecology. 39(e11), 1–13. *https://doi.org/10.1017/S0266467422000499*

83. Mwanja, C. K., Ishengoma, R., Terziev, N., Banana, A., & Kalanzi, F (2023). Perception of artisans towards bamboo preservation for improved product durability in Uganda. Advances in Bamboo Science, 100020.

84. Nantongo J. S., Odoi J.B., Agaba H, Gwali S (2023). Evaluating the genetic structure in Vernonia amygdalina using genotyping-by sequencing, PLOSone. 10.1371/journal.pone.0283563

85. Nantongo J. S., Odoi J.B., Agaba H., Gwali S (2022). SilicoDArT and SNP markers for genetic diversity and population structure analysis of Trema orientalis; a fodder species, PLOSone *https://doi.org/10.1371/journal.pone.0267464*

86. Nantongo J.S., Potts B.M., Klápšt J., Graham N.J., Dungey H., Fitzgerald H., O'Reilly-Wapstra J.M (2022) Genomic selection for resistance to bark stripping and associated chemical compounds in radiata pine, G3, *https://doi.org/10.1093/g3journal/jkac245*

87. Odoi J.B., Okia C.A., Gwali S., Odong T.L., Agaba H., Okullo J.B.L (2022). Kernel Morphometric Characteristics and Oil content among Shea tree Genotypes in Uganda. African Crop Science Journal, 30 (4), *https://dx.doi.org/10.4314/acsj.v30i4.12*

88. Odoi J.B., Prasad H., Arfang B., Kitiyo R., Ozimati .E., Gibson P., Edema R., Gwali S., Odong T. L (2022). Evaluation of Genomic Prediction Algorithms for Reducing Selection and Breeding Cycles in Shea Tree (Vitellaria Paradoxa). Uganda Journal of Agricultural Sciences, 21 (1), http://dx.doi.org/10.4314/ujas.v21i1.1

89. Odoi, J. B., Adjei, E. A., Hendre, P., Nantongo, J. S., Ozimati, A. A., Badji, A., Nakabonge, G., Edema, R., Gwali, S., & Odong, T. L. (2023). Genetic diversity and population structure among Ugandan Shea tree (Vitellaria paradoxa Subsp. nilotica) accessions based on DarTSeq Markers. CropScience. *https://doi.org/10.1002/csc2.21013*

## National Livestock Resources Research Institute (NaLIRRI)

90. Bugeza, J. K., Roesel, K., Moriyón, I., Mugizi, D. R., Alinaitwe, L., Kivali, V., ... & Cook, E. A. J. Sero-prevalence, and factors associated with anti-Brucella antibodies in slaughter livestock in Uganda. Frontiers in Epidemiology, 3, 1213592. *https://doi.org/10.3389/fepid.2023.1213592*

91. Bugeza, J., Mutagubya, F., Ssekamanje, R., Mulondo, H., Asiimwe, T., Mbaziira, A., ... & Ayebazibwe, C. Reconnaissance of major challenges affecting poultry farming using participatory epidemiology methods in Jinja District, Uganda. http://repository.ruforum.org/sites/default/files/8.%20Bugeza%20James.pdf

92. Geoffrey A. Beyihayo, Eugene Rukundo, Robert Mwesigwa, Timothy Lwanga and Stephen Kabugo., 2022. Evaluating the performance and profitability of varied combinations of brewery by-products for fattening pigs. Animal Production Science 62(7) 661-667 *https://doi.org/10.1071/AN21122.*

93. Kakooza, S., Waiswa, J., Barasa, M., Nanono, L., Mugizi, D., Bugeza, J., ... & Cook, E. A. (2022). Integrated interventions towards proper food safety culture in Uganda's meat sector. *https://cgspace.cgiar.org/bitstream/handle/10568/121983/Food%20safety%20culture.pdf*

94. Kankya, C., Mugizi, D., Muleme, J., Bugeza, J., Alinaitwe, L., Okello, J., ... & Cook, E. A. (2022). Meat inspectors' refresher training in Uganda. *https://cgspace.cgiar.org/bitstream/handle/10568/122014/Meat%20inspection.pdf?sequence=1*

95. Kankya, C., Okello, J., Natweta Baguma, J., Wambi, R., Rose Ninsiima, L., Tubihemukama, M., Bugeza,J., & Muleme, J. (2023). Prevalence and factors associated with cryptosporidiosis among livestock and dogs in Kasese District, Uganda: A cross-sectional study. medRxiv, 2023-02.

96. M.H. Otim, S. Alibu, G. Asea, G. Abalo, Julius P. Sserumaga, S. Adumo, J. Alupo, S. Ochen, T. Tefera, A.Y. Bruce, Y. Beyene, B. Meisel, R. Tende, F. Nang'ayo, Y. Baguma, S. Mugo, S.O. Oikeh, 2022. Performance of Bt maize event MON810 in controlling maize stem borers Chilo partellus and Busseola fusca in Uganda, Crop Prot. 156 (6) 105945. *https://doi.org/10.1016/J.CROPRO.2022.105945.*

97. Mayanja, M. N., Morton, J., Bugeza, J., & Rubaire, A. 2022. Livelihood profiles and adaptive capacity to manage food insecurity in pastoral communities in the central cattle corridor of Uganda. Scientific African, 16, e01163. *https://doi.org/10.1016/j.sciaf.2022.e01163*

98. Mugizi, D., Cook, E. A., Roesel, K., Kivali, V., Bugeza, J., Alinaitwe, L., ... & Bett, B. K. (2022). Use of abattoirs as sentinel points for surveillance of Rift Valley fever in Uganda. *https://cgspace.cgiar.org/bitstream/handle/10568/125002/Sentinel%20surveillance.pdf*

99. Nakiganda Annuciate, Wamubirigwe Bernard, Mubiru Sarah, Bugeza James, Kigozi Abasi, Mugerwa Swidiq, Kigongo John, Stephen Kayiwa, Sserumaga Pyton, Namwanje Joan, Kivumbi Achileo, Serwadda Joseph, Kasule Hannah Talinda, Twesigye Annet. 2023. Assessment of Adoption, Market Potential and Environmental Impact of Carbonized Briquettes Among Farmers in Western Uganda's Beef-Producing Region. International Journal of Economy, Energy and Environment 2023; 8(2): 23-29, *https://doi.org/10.11648/j.ijeee.20230802.12*

100. Nviiri, G., Kigozi, A., Turyagyenda, L., and Mugerwa, S. 2022. The Role of Bentonite Clays in Aflatoxin-Decontamination, Assimilation and Metabolism in Commercial Poultry. Biomed J Sci & Tech Res 43(3)-2022. BJSTR. *https://doi.org/10.26717/BJSTR.2022.43.006913.*

101. Others can be found at *https://afjrd.org/index.php/jos/article/view/251 and https://afjrd.org/index.php/jos/article/view/293.*

102. Paul D. Kasaija, Marinela Contreras, Fredrick Kabi, Swidiq Mugerwa, Joseba M. Garrido, Christian Gortazar, Jose de la Fuente, 2022. Oral vaccine formulation combining tick Subolesin with heat inactivated mycobacteria provides control of cross-species cattle tick infestations, Vaccine, ISSN 0264-410X, *https://doi.org/10.1016/j.vaccine.2022.06.036.*

103. Sugino, Y., Bugeza, J., Bahame, D., Byaruhanga, J., Shimazaki, H., Anzai, M., ... & Makita, K. (2023). Structure and milk hygiene of dairy cooperative value chains in an intensive production area of Uganda—A bottleneck of intervention. Frontiers in Sustainable Food Systems, 7, 1110915.

104. Zziwa, E., Bugeza, J., Mubiru, S., Sserumaga, J. P., KIGGUNDU, M., & SEMWANGA, M. (2021). Common invasive weed species in the central and southwestern rangelands of Uganda. African Journal of Rural Development, 6(2), 53-61.

## National Agricultural Research Laboratories (NARL)

105. Abubakar Sadik Mustafa, Benison Tugume, Jamilu Ssenku, Paul Ssemanda, Shahasi Athman, Hannington Oryem-Origa, Jerome Kubiriba, Savithramma Dinesh-Kumar, and Arthur Tugume. Xanthomonas campestris pv. musacearum bacterial infection induces organ-specific callose and hydrogen peroxide production in banana. 2022, 01, 06, *https://apsjournals.apsnet.org/doi/abs/10.1094/PHYTOFR-11-21-0073-R*

106. Ajambo S. **Tinyiro, E.S**. and Kikulwe, E.M (2022). Gendered mapping and consumer testing of steamed matooke in urban areas of Uganda. Lima (Peru). CGIAR Research Program on Roots, Tubers and Bananas (RTB). RTB Working Paper. No. 2022-1. *https://doi.org/10.4160/23096586RTBWP20221*

107. Ali Milton, Dennis Muhanguzi, Allan Male, Ali Kajubi, Stephen Buah, Jerome Kubiriba, Robooni Tumuhimbise. Analysis of Genetic Diversity of Banana Weevils (Cosmopolites sordidus) (Coleoptera: Curculionidae) Using Transcriptome-Derived Simple Sequence Repeat Markers. 2022, 01, 11, *https://academic.oup.com/jee/article/115/2/637/6503512?login=true*

108. Aurélie Bechoff, Laurent Adinsi , Gérard Ngoh Newilah , Mariam Nakitto , Zoé Deuscher, Reuben Saali, Ugo Chijioke, Elizabeth Khakasa, Kephas Nowakunda Alexandre Bouniol , Dominique Dufour, Christophe Bugaud (2023). Combined use of sensory methods for the selection of root, tuber and banana varieties acceptable to end-users. Accepted for publication (2023). (Ref: JSFA-23-0311). Journal of the Science of Food and Agriculture.

109. Ayetigbo Oluwatoyin, Arufe Santiago, Kouassi Antonin, Adinsi Laurent, Adesokan Michael, Escobar Andres, Delgado Luis Fernando, Tanimola Abiola, Oroniran Oluyinka, Kendine Vepowo Cédric, Nakitto Mariam, Khakasa Elizabeth, Chijioke Ugo, Nowakunda Kephas, Ngoh Newilah Gérard, Otegbayo Bolanle, Akissoe Noel, Lechaudel Mathieu, Tran Thierry, Alamu Emmanuel Oladeji, Maziya-Dixon Busie, Mestres Christian, Dufour Dominique (2023). Review of instrumental texture measurements as breeding tools to assess phenotypic diversity for quality of root, tuber and banana food products. Accepted for publication (2023). (Ref: JSFA-23-0322) Journal of the Science of Food and Agriculture.

110. Bakaze Elyeza, Tinzaara William, Gold Cliff, Kubiriba Jerome. The Status of Research for the Management of the Banana Weevil, Cosmopolites sordidus (Germar) (Coleoptera: Curculionidae) in Sub-Saharan Africa. 2022, *https://nru.uncst.go.ug/handle/123456789/3643.*

111. Bechoff A, Adinsi L., Newilah G. N., Nakitto M., Deuscher Z., Ssali R., Chijioke U., **Khakasa E., Nowakunda K**., Bouniol A., Dufour D. and Bugaud C. (2023) Combined use of sensory methods for the selection of root, tuber, and banana varieties acceptable to end-users. Journal of Science of Food and Agriculture, *https://doi.org/10.1002/jsfa.12723*.

112. Buregyeya H, Oyesigye N., Amumpaire D., Namanya P. B., **Nowakunda K.,** Tushemereirwe W. K., Karamura E., and Rubaihayo P. (2023). Female Reproductive Potential and 3x by 2x Breeding Approach for Hybrid Seeds Development in Sukali Ndizi Genotype (Musa genome AAB). European Journal of Agriculture and Food Science. doi.org/10.24018/ejfood.2023.5.3.670

113. Buregyeya Henry, Steven Kashub Tumwesigye, Ephraim Nuwamanya, Moses Matovu, Priver Namanya, Kephas Nowankunda, Wilberforce K Tushemereirwe, and Patrick Rubaihayo. "A high throughput phenotyping technique for banana cultivar Sukali Ndizi based on internal fruit quality attributes." International Journal of Science and Technology Research Archive 3, no. 2 (December 30, 2022): 258–69. http://dx.doi.org/10.53771/ijstra.2022.3.2.0155.

114. Catherine Kiwuka, Jan Vos, Jacob C. Douma, Pascal Musoli, John W. Mulumba, Valerie Poncet and Niels P.R. Anten. Intraspecific variation in growth response to drought stress across geographic locations and genetic groups in Coffea canephora Pierre ex A. Froehner" Ecology and Evolution, 13(1), e9715, (2023).

115. Davis, Aaron P., Catherine Kiwuka, Aisyah Faruk, John Mulumba, and James Kalema. "A review of the indigenous coffee resources of Uganda and their potential for coffee sector sustainability and development." Frontiers in Plant Science 13 (2023): 5251

116. Davis, Aaron P., Catherine Kiwuka, Aisyah Faruk, Mweru J. Walubiri, and James Kalema. "The re-emergence of Liberica coffee as a major crop plant." Nature Plants (2022):1-7

117. Dennis Ochola, Bastiaen Boekelo, Gerrie W. J. van de Ven, Godfrey Taulya, Jerome Kubiriba, Piet J. A. van Asten, Ken E. Giller. Mapping spatial distribution and geographic shifts of East African highland banana (Musa spp.) in Uganda. 2022, 02, 17, *https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0263439.*

118. Gulkirpik E, Donnelly A, **Nowakunda K**, Liu K and Andrade Laborde JE (2023) Evaluation of a low-resource soy protein production method and its products. Front. Nutr. DOI: 10.3389/fnut.2023.1067621.

119. Fernanda Alcobé & James Lwasa (2022). How Uganda's climate reporting is delivering national value. International Institute for Environment and Development (IIED), UK. ISBN: 9781784319922, Product code: 21171IIED. Link: *https://www.iied.org/21171iied*

120. Geresemu Omuut., Happyness G. Mollel., Dalton Kanyesigye., Felicien Akohoue., Stella Adumo Aropet., Henry Wagaba., Michael H. Otim. (2023). Genetic analyses and detection of point mutations in the acetylcholinesterase-1 gene associated with organophosphate insecticide resistance in the fall armyworm (Spodotera frugiperda) populations in Uganda. BMC Genomics 24:22. *https:/doi.org/10.1186/s 12864-022-09093-4.*

121. Kabango, F. J. Byalebeka., O. Semalulu, Lenssen, A., Majaliwa, M. and Stewart, K. (2022) Effect of Applying Low Rates of Agricultural Lime and Chicken Manure on Selected Soil Properties on Ferralsols of Lake Victoria Agro-Ecological Zone, Uganda. Journal of Agricultural Chemistry and Environment, 11, 240-257. doi: 10.4236/jacen.2022.114017.

122. Kabango, F. J. Byalebeka., O. Semalulu, Lenssen, A., Majaliwa, M. and Stewart, K. (2022). Effect of applying low rates of lime and manure on bean growth and yield on Ferralsols of Lake Victoria crescent agro-ecological Zone-Central Uganda. African J. Agric. Research. 18(12):1110-1120. DOI: 10.5897/AJAR2022.16176. http://www.academicjournals.org/AJAR

123. Kephas Nowakunda, Elizabeth Khakasa, Kenneth Akankwasa, Robooni Tumuhimbise Christophe Bugaud, Moreen Asasira, Brigitte Uwimana, Alexandre Bouniol, Ephraim Nuwamanya, Lora Forsythe,

Pricilla Marimo, Dominique Dufour and Wilberforce Tushemereirwe (2023). East African highland cooking banana: towards an efficient selection of hybrids with user-preferred food quality traits. Accepted for publication (2023). (Ref: JSFA-23-0244) Journal of the Science of Food and Agriculture.

124. Khakasa E, Muyanja C, Mugabi R, Bugaud C, Forestier-Chiron N, Uwimana B, Arinaitwe IK, Nowakunda K (2023). Sensory characterization of the perceived quality of East African Highland Cooking Bananas (Matooke). Journal of the Science of Food and Agriculture. *https://doi.org/10.1002/jsfa.12606*

125. Kiconco, Stella, Suresh Chandra Babu, and Kenneth Akankwasa. 2022. "Adoption Patterns and Intensity for Multiple Banana Technologies in Uganda" Sustainability 14, no. 23: 15986. *https://doi.org/10.3390/su142315986*

126. Madalla, N.A., Massawe, C., Shimwela, M., Mbongo, D., Kindimba, G., Kubiriba, J., Arinaitwe, I., **Nowakunda, K**., Namanya, P., Tumuhimbise, R. and Okurut, A.W., 2022. TARIBAN1, TARIBAN2, TARIBAN3, and TARIBAN4 'Matooke' cooking banana cultivars for the Great Lakes Region of Africa. HortScience, 57(12), pp.1588-1592. *https://doi.org/10.21273/HORTSCI16854-22*

127. Moses Matovu, Rose Nankya, Hannington Lwandasa, Brian E. Isabirye, Paola De Santis, Devra I. Jarvis, and John Wasswa Mulumba. Heterogeneity in Nutritional and Biochemical Composition of Cassava Varieties in Uganda. 2022. J. Agric. Sust. 15. 1-36.

128. Nankya, R.; Jika, A.K.N.; De Santis, P.; Lwandasa, H.; Jarvis, D.I.; Mulumba, J.W. Community Seedbanks in Uganda: Fostering Access to Genetic Diversity and Its Conservation. Resources 2022, 11, 58. *https://doi.org/10.3390/*

**129.** **Nowakunda, K**.; Akankwasa, K.; **Khakasa, E**.; Asasira, M.; Kisakye, S.; Arnaud, E.; Mukasa, Y.; Nuwamanya, E.; Uwimana, B.; Bugaud, C.; Dahdough, L.; Bouniol, A.; Ricci, J., (2022), "Gendered Matooke product profile in Uganda", *https://doi.org/10.18167/DVN1/HQX13V, CIRAD Dataverse, V1*

130. Onesimus Semalulu, Patrick Kibaya, Stewart Kyebogola, Edson Mworozi, Nelson Sewankambo, Berhane Gebru (2022). Profitability and Farmer Acceptability of Selected Climate Smart Technologies and Practices for Maize-Beans Production in Drought-Prone Areas, Uganda. Agricultural Sciences Vol. 13 No. 11, November 2022. *https://www.scirp.org/journal/paperinformation.aspx?paperid=121516*

131. R. Mufumbo, S. Chakrabarty, M. Nyine, S. M. Windpassinger, J. W. Mulumba, Y. Baguma, L. T. Odong, M. Frisch, R. J. Snowdon. 2023. Genomicsbased assembly of a sorghum bicolor (L.) moench core collection in the Uganda national genebank as a genetic resource for sustainable sorghum breeding. Genet Resour Crop Evol. 70:1439–1454. *https://doi.org/10.1007/s10722-022-01513-4*

132. Ronner E., van de Ven G. J., Nowakunda K., Tugumisirize J., Kayiita J., Taulya G., Uckert G., and Descheemaeker K. K. E. (2023). What future for banana-based farming systems in Uganda? A participatory scenario analysis. Agricultural Systems. Volume 209, (2023, 103669) *https://doi.org/10.1016/j.agsy.2023.103669.*

133. Ssali R., Ted C., Imoro S., Low J., Dery E. K., Boakye A., Omodamiro R. M., Yusuf H. L., Etwire E., Iyilade A. O., Adekambi S., Ali A., Haliru M., Etwire P. M., Tinyiro S. E., Bouniol A. 2022. Participatory processing diagnosis of fried sweetpotato in Nigeria & Ghana. Understanding the drivers of trait preferences and the development of multi-user RTB product profiles, WP1, step 3. Kampala: RTBfoods Project-CIRAD, 15 p. *https://doi.org/10.18167/agritrop/00617.*

134. Tournebize, R., Borner, L., Manel, S., Meynard, C.N., Vigouroux, Y., Crouzillat, D., Fournier, C., Kassam, M., Descombes, P., Tranchant-Dubreuil, C. and Parrinello, H. et al., 2022. Ecological and genomic vulnerability to climate change across native populations of Robusta coffee (Coffea canephora). Global Change Biology, 28(13), pp.4124-4142.

135. Vernooy, R., Adokorach, J., Kimani, D., Marwa, A., Mayoyo, A., Nyadanu, D. 2023. Policies, laws and regulations in support of farmer-managed seed systems: still a long way to go. A review of 14 countries in Africa. ISSD Africa, Alliance of Bioversity International and CIAT, Rome, Italy. *https://hdl.handle.net/10568/128579*

136. Waniale Allan, Settumba B Mukasa, Arthur K. Tugume, Jerome Kubiriba, Wilberforce K Tushemereirwe, Rooboni Tumuhimbise. Early Withering of Enlarged Ovules in Pollinated Fruits of Bananas (Musa spp.) Suggest Abortion after Fertilization. 2022, 05, 10, *https://www.mdpi.com/2311-7524/8/5/426*

## National Semi-Arid Resources Research Institute (NaSARRI)

137. Esther Achola, Peter Wasswa, Daniel Fonceka, Josh Paul Clevenger, Prasad Bajaj, Peggy Ozias-Akins, Jean-François Rami, Carl Michael Deom, David A. Hoisington, Richard Edema, Damaris Achieng Odeny & David Kalule Okello, 2023. Genome-wide association studies reveal novel loci for resistance to Groundnut rosette disease in the African core groundnut collection. Theoretical and Applied Genetics volume 136, Article number: 35 (2023). *https://doi.org/10.1007/s00122-023-04259-4*

138. Oteng-Frimpong R, Karikari B, Sie EK, Kassim YB, Puozaa DK, Rasheed MA, Fonceka D, Okello DK, Balota M, Burow M and Ozias-Akins P (2023). Multi-locus genome-wide association studies reveal genomic regions and putative candidate genes associated with leaf spot diseases in African groundnut (Arachis hypogaea L.) germplasm. Front. Plant Sci. 13:1076744. doi: 10.3389/fpls.2022.1076744

139. Okello DK, Deom CM, Puppala N. 2022. Registration of 'Naronut 1R' Groundnut. Journal of Plant Registrations, 1–7. *https://doi.org/10.1002/plr2.20248*

140. Essandoh, D. A., Odong, T., Okello, D. K., Fonceka, D., Nguepjop, J., Sambou, A., Ballén-Taborda, C., et al. (2022). Quantitative Trait Analysis Shows the Potential for Alleles from the Wild Species Arachis batizocoi and A. duranensis to Improve Groundnut Disease Resistance and Yield in East Africa. Agronomy, 12(9), 2202. *http://dx.doi.org/10.3390/agronomy12092202*

141. Chapu I, Okello DK, Okello RCO, Odong TL, Sarkar S and Balota M (2022). Exploration of Alternative Approaches to Phenotyping of Late Leaf Spot and Groundnut Rosette Virus Disease for Groundnut Breeding. Front. Plant Sci. 13:912332. doi: 10.3389/fpls.2022.912332

## Abi ZARDI

142. Abaca, A., Odama, E., Komakech, A., Kassim, S., & Walakira, J. K. (2023). Effect of phosphorus-based fertilizer on groundnut yield and incidence of groundnut rosette disease in West Nile Region of Uganda. Uganda Journal of Agricultural Sciences, Volume 21 Number 2 (2023) pp. 1 – 14. (DOI: http://dx.doi.org/10.4314/ujas.v21i2.1)

143. Bore, E. K., Ishikawa, E., Libron, J. A. M. A., Goto, K., Odama, E., Nakao, Y., ... & Sakagami, J. I. (2023). Primed Seeds of NERICA 4 Stored for Long Periods under High Temperature and Humidity Conditions Maintain Germination Rates. Applied Sciences, 13(5), 2869. ( *https://doi.org/10.3390/app13052869)*

144. Chemura, A., Arumugum, P., Awori, E. K., and Gornott, C.: Elucidating climate change adaptation potential of improved maize (Zea mays L.) varieties with crop modelling, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-15686, *(https://doi.org/10.5194/egusphere-egu23-15686, 2023)*

145. Hinrichsen, E., Walakira, J. K., Langi, S., Ibrahim, N. A., Tarus, V., Badmus, O., & Baumüller, H. (2022). Prospects for Aquaculture Development in Africa: A review of past performance to assess future potential. *(https://hdl.handle.net/20.500.11811/9582)*

146. Nandudu, L., Kawuki, R., Ogbonna, A., Kanaabi, M., & Jannink, J. L. (2023). Genetic dissection of cassava brown streak disease in a genomic selection population. Frontiers in Plant Science, 13, 5627. *(https://doi.org/10.3389/fpls.2022.1099409).*

147. Oba, P., Dione, M., Mwiine, F. N., Wieland, B., Erume, J., & Ouma, E. (2023). Economic losses associated with respiratory and helminth infections in domestic pigs in Lira district, Northern Uganda. *Frontiers in Veterinary Science*, *10*, 1198461.

148. Oba, P., Wieland, B., Mwiine, F.N. et al. Co-infections of respiratory pathogens and gastrointestinal parasites in smallholder pig production systems in Uganda. Parasitol Res 122, 953–962 (2023). *https://doi.org/10.1007/s00436-023-07797-4*

149. Oballim, G., Obura, M., Mutio, J. M., Isubikalu, P., Opile, W., & Ochuodho, J. O. (2022). Production and utilisation of Bambaranut (Vigna subterranea (L.) Verdc.) in Northern and Eastern Uganda. *African Journal of Agricultural Research*, *18*(11), 977-990.

150. Odama, E., Tsujimoto, Y., Yabuta, S., Akagi, I., & Sakagami, J. I. (2023). P-dipping improved NERICA 4 rice seedling resilience to water and nutrient stresses under rainfed-like conditions. Rhizosphere, 26, 100688. (*https://doi.org/10.1016/j.rhisph.2023.100688*)

## Buginyanya ZARDI


151. Owoyesigire Brian Britex (2022). Climate variability extremes, pastoralists adaptation strategies and future livestock productivity in the rangelands of Uganda. PhD. Thesis, Makerere University, Kampala Uganda. *http://makir.mak.ac.ug/handle/10570/11861* .

152. Ondhoro, C.C., Kagolola, I., Osipa, G., Odong, R., Kubiriza, G.K., Owere, L. (2023). Growth and economic evaluation of different fish species for culture in Uganda□s mid altitude areas using local feeds. J. Appl. Sci., 23: 71-80. *https://doi.org/10.3923/jas.2023.71.80*

153. Tibihika, P.D., Curto, M., Aruho, C., Muganga, G., Lugumira, J.S., Namulawa, V.T., Aanyu, M., Ddungu, R., Ondhoro, C.C., Okurut, T. (2022). Exploring the morphological dynamics of Nile tilapia (Oreochromis niloticus Linn. 1758) in Victoria Nile as depicted from geometric morphometrics. Research square, 2022. *https://doi.org/10.21203/rs.3.rs-1941464/v1*

154. M. G. Kaiira, L. Owere, B. Chemayek, J. Etiang and M. Elesu, (2023). Effect of weeding regime and row direction on growth and yield of upland rice in Uganda. International Journal of Plant and Soil Science 35(9):45-57.

155. M. G. Kaiira, L. Owere, B. Chemayek and J. Etiang (2023). Effects of selected crops on germination and growth of B. pilosa and other weeds. In Press: Allelopathic Journal.

156. Omiat, E.G., Asante, M.D., Traoré, V.S.E., Oppong, A., Ifie, B.E., Ofosu, K.A., Aribi, J., Pinel-Galzi, A., Comte, A., Fargette, D., Hébrard, E., Traoré, O., Offei, S.K., Danquah, E.Y., Poulicard, N. (2023). Genetic diversity and epidemic histories of rice yellow mottle virus in Ghana. Virus Research. DOI: 10.1016/j.virusres.2023.199106.

157. Fall, A.F.; Nakabonge, G.; Ssekandi, J.; Founoune-Mboup, H.; Badji, A.; Ndiaye, A.; Ndiaye, M.; Kyakuwa, P.; Anyoni, O.G.; Kabaseke, C.; Ronoh, A.K.; Ekwangu, J.(2023).Combined Effects of Indigenous Arbuscular Mycorrhizal Fungi (AMF) and NPK Fertilizer on Growth and Yields of Maize and Soil Nutrient Availability. Sustainability, 15, 2243. *https://doi.org/10.3390/su15032243*

158. Ekwangu, J.; Tumwebaze, B.S.; Basamba, A. AT.; Tenywa, J.S.; Opie, H.; Nabirye, D.L.; Andiku, C.; Owere, L. (2023). Soil carbon sequestration in finger millet production in Sub-Saharan Africa: A review of concepts and practices. Journal of Agriculture Forestry and Fisheries ISSN print: 238-563X.


## Bulindi ZARDI


159. Ivan Abaho, Gabriel, N. Naftal, and Izaara, A.Arinaitwe (2023). Use of plant extracts to control reproduction in tilapia production systems: An emerging eco-friendly innovation. In: Gabriel, N.N., Omoregie, E., Abasubong, K.P. (eds) Emerging Sustainable Aquaculture Innovations in Africa. Sustainability Sciences in Asia and Africa(). Springer, Singapore. *https://doi.org/10.1007/978-981-19-7451-9_7.*

160. Ivan Abaho, Peter Akoll, Clifford L.W. Jones, and Charles Masembe (2022). Dietary inclusion of pine pollen alters sex ratio and promotes growth of Nile tilapia (Oreochromis niloticus, L. 1758). Aquaculture Reports, 27: 101407. *https://doi.org/10.1016/j.aqrep.2022.101407*

## Kachwekano ZARDI

161. Emmanuel Amponsah Adjei, Williams Esuma, Titus Alicai, Emmanuel Boache Chamba, Richard Edema, Isaac Onziga Dramadri, Alfred Adebo Ozimati, Rolland Agaba, Thomas Lapaka Odong. 2022. Phenotypic Diversity within Ugandan Yam (Dioscorea species) Germplasm Collection. International Journal of Agronomy. *https://doi.org/10.1155/2022/5826012*

162. Emmanuel Amponsah Adjei, Williams Esuma,Titus Alicai, Emmanuel Boache Chamba, Richard Edema, Isaac Onziga Dramadri, Alfred Adebo Ozimati, Rolland Agaba, Thomas Lapaka Odong. 2022. Genotype-by-Environment Interaction of Yam (Dioscorea species) for Yam Mosaic Virus Resistance, Dry Matter Content and Yield in Uganda. Agronomy MDPI

163. Gerald Kwikiriza, Mourine J.Yegon, Nelson Byamugisha, Apulnal Beingana, Faith Atukwatse, Alex Barekye, Juliet K. Nattabi, Harald Meimberg. 2023. Morphometric Variations of Nile Tilapia (Oreochromis niloticus) (Linnaeus, 1758) Local Strains Collected from Different Fish Farms in South Western Highland Agro-Ecological Zone (SWHAEZ), Uganda: Screening Strains for Aquaculture. Fishes MDPI. *https://doi.org/10.3390/fishes8040217 https://doi.org/10.3390/agronomy12091984*

164. Prossy Namugga, Son Aijuka, Osbert Arinda, Benon Mateeka, Alex Barekye. 2023. Early generation seed starter materials and approaches to seed production: Challenge for improving the potato seed system in Uganda. Crop Science. *https://doi.org/10.1002/csc2.20969*

## Mbarara ZARDI

165. Bugenyi, A.W.; Song, K.-D.; Lee, H.-K.; Heo, J. (2023). Bacillus and Lactobacillus-Based Dietary Synbiotics Oropharyngeal, Proximal Colonic, and Vaginal Microbiomes of Korean Native Black Pigs. Fermentation 2023, 9, 359. *https://doi.org/10.3390/fermentation9040359*

166. Dina, N., & Godfrey, K. (2022). Abundance and Population Structure of Locally Useful Indigenous Woody Plants in a Sedentary Grazing System in South-Western Uganda. Research Highlights in Agricultural Sciences Vol. 3, 42-63. DOI:10.9734/bpi/rhas/v3/3244A

167. Kabi, F.; Dhikusooka, M.; Matovu, M.; Mugerwa, S.; Kasaija, P.; Emudong, P.; Kirunda, H.; Contreras, M.; Gortazar, C.; De la Fuente, J. (2022). Monitoring the Subolesin Vaccine Field Trial for Safer Control of Cattle Ticks Amidst Increasing Acaricide Resistance in Uganda. Vaccines 2022, 10, 1594. *https://doi.org/10.3390/vaccines10101594*

168. Kasaija, P.D.; Contreras, M.; Kirunda, H.; Nanteza, A.; Kabi, F.; Mugerwa, S.; de la Fuente, J. (2022). Inspiring Anti-Tick Vaccine Research, Development and Deployment in Tropical Africa for the Control of Cattle Ticks: Review and Insights. Vaccines 2023, 11, 99. *https://doi.org/10.3390/vaccines11010099*

169. Muzira R.; Nabasumba D.; Natuha S.; Okello J. (in Press). Gender Dilemma of Small-scale Farmers in Improving Household Income through an Agro Enterprise Development: A case of Tea Growing farm households in Uganda

170. Muzira, R., Nabasumba, D., Natuha, S. and Okello, J. (2023) Understanding Gendered Tea Pro duction Characteristics and Trends under Smallholder Farming Systems in South- Western Uganda. Open Access Library Journal, 10: e9423. *https://doi.org/10.4236/oalib.1109423*

171. Nabasumba, D.; Muzira, R.; Natuha,S.; Tugume G.; Kirunda, H. (2022) Impact of tree canopies on selected soil chemical properties and pasture nutritive values in a semi-intensive grazing system in South-western Uganda; October 2022Livestock Research for Rural Development 33(3):17

## Mukono ZARDI

172. Isaac Ongu, Priscilla Olayide, Erik Alexandersson, Barbara Mugwanya Zawedde & Dennis Eriksson (2023) Biosafety regulatory frameworks in Kenya, Nigeria, Uganda and Sweden and their potential impact on international R&D collaborations GMCrops&Food Journel,14:1,117,DOI:10.1080/21645698.2023.2194221

173. Samuel Majalija1 Gabriel Tumwine1Juliet Kiguli1 Benard Owori 1Robert Alex Isabirye2 Peter Waiswa1 Assessing the knowledge and practices of smallholder pig farmers and associated risk factors for swine gastrointestinal disorders in Masindi district, Uganda. DOI: 10.21203/rs.3.rs-2868407/v1

174. Mugisa I, Karungi J, Musana P, Odama R, Alajo A, Chelangat DM, Anyanga MO, Oloka BM, Gonçalves dos Santos I, Talwana H, Ochwo-Ssemakula M, Edema R, Gibson P, Ssali R, Campos H, Olukolu BA, da Silva Pereira G, Yencho C and Yada B (2022) Combining ability and heritability analysis of sweet potato weevil resistance, root yield, and dry matter content in sweet potato. Front. Plant Sci. 13:956936. doi: 10.3389/fpls.2022.956936

175. Ivan Abaho, Ndakalimwe Naftal Gabriel & Andrew Arinaitwe Izaara "Use of Plant Extracts to Control Reproduction in Tilapia Production Systems: An Emerging Eco-Friendly Innovation" *https://doi.org/10.1007/978-981-19-7451-9_7#DOI , book chapter, pages 167-196*

176. Catherine Nazziwa, The Economics of commercial Nile Tilapia Cage Aquaculture in Uganda, Oral Presentation; Agricultural Research and Blue Economy Conference, November 28, 2022

# Policy brief

177. Musinguzi, L. (2023). The first national red list for the fishes of Uganda: Key messages and recommendations

178. Essegbemon Akpo, Hellen Opie, Christopher O. Ojiewo, Haile Desmae, Geoffrey Muricho, Soul Midingoyi, Bonny Ntare, Amsalu Ayana Aga, Jane Ininda, Mourik Tom van, Boudy van Schagen & Patrick Okori. 2022. Designing self-sustaining early generation seed supply systems: the must-dos. ISSD Africa Policy Brief: September 2022

179. Mulindwa, J., Kagezi, G., Musubire, B., Atwijukire, E., Twesigye, V., Adage, H., Nassali, G. and Arinaitwe, G. 2023. Coffee Post Harvest Handling.

180. Mulindwa, J., Musubire, B., Musasizi, J., Bitalo, DN., Wanyama, M., Nambozo, B., Nassali, G., Atwijukire E. and Arinaitwe, G. 2020. Improving cocoa post-harvest handling practices.

# CONFERENCE PROCEEDINGS

## National Coffee Resources Research Institute (NaCORI)

181. Tumuramye, K., Kagezi, GH., Fungo, B., Nassimbwa, F., Sseruwu, G., Atim J. and Wagoire WW. 2023. Effect of Training on Farmers' Awareness and Use of NARO-Promoted Packages for Managing Black Coffee Twig Borer andCoffee Wilt Disease on Robusta Coffee. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

182. Twesigye, V., Kagezi, GH., Ssekamatte, D., Alinda, F., Kisembo, JM., Kobusinge, J., Namara, E., Anyijuka, M., Amonyo, D. and Arinaitwe, G. 2023. Participatory Monitoring and Evaluation Practices Contribution to Climate Change Adaptation Measures among Coffee Farming Households: A Case of Ntungamo District, South western Uganda. In: Book of programme and abstracts, 3rd Biennial NARO-MAK Joint Scientific Conference, 14-16 March 2023, Kampala, Uganda, Munyonyo, Uganda.

## National Fisheries resources research institute (NaFIRRI)

183. Nakasolya J., Aruho C., Kahwa D., Dungu R. (2023). Effects of Purified Pituitary Extracts on Ovulation and Spawning in Clarias Gariepinus in Uganda

184. Namatovu A., Aruho C., Kahwa D., Ddungu R. (2023). The Effect of Vitamin E and C Supplementation on Viability of Cryopreserved African Catfish (Clarias Gariepinus) Sperm

185. Nduwayesu E., Basooma A., Sekiranda S.B.K, Balirwa J. S ., Bassa S., Muhumuza E., Mugeni B., Mulowoza A., Musobya M. and Nakiyende H.(2023). Impacts of the Victoria Nile Bujagali hydropower dam on fisheries and livelihoods.

186. Stephen B.K. Sekiranda,* Pabire W. Ghandi, and Vincent Kiggundu (2023). Community structure and distributional patterns of Pelecypoda upstream and downstream of Bujagali Hydropower Project along the Upper Victoria Nile.

187. Wanda Fred Masifwa * ; Nankabirwa A., Nabwire, R. ; Akoit, I. ; Adriko, J., Olokotum, M. ; Basooma, R. and Arayo, E. (2023) Spirulina: A potential resource for biodiesel production and fish feeds ingredient

## National Agricultural Research Laboratories (NARL)

188. Nankinga C. M., Nampeera E., Magala D., Sammula A., Kisingiri B., Robert S. L., Kamulegeya P., Aool W., Kirongo P., Mukasa Y., Owiny R., Ogom P., Namasa E. J., Nampeera F., Lubega V., Nasaazi S., Rware H., Makale F., Kansiime M., Rwomushana I., Byantwale T. S., Ogwang J., Okidi M., Adriko J., Mwambu P. (2023). Farmers' knowledge and impact associated with the invasive papaya mealybug in Uganda. Proceedings: NARO-MAK Conference 14-16th March 2023, Kampala, Uganda.

189. Nankinga, C., Ssamula, A., Kisingiri, B., Mutende, D., Niyitegeka, B., Owiny, R., Ekalu, S., Kasozi, G., Rukuba, D., Asimwe, R., Mukiibi, D., Nantongo, S., Muzira, F., Tugume, J., Musimenta, H., Mwambu, P. (2023). Compliance in farmers' practices to mitigate pesticide residues in Uganda Capsicum exports to the EU. Proceedings: NARO-MAK Conference 14-16th March 2023, Kampala, Uganda.

190. Nankinga, C. M, Kisingiri, J. B., Ssamula, A., Ekaru S., Owiny, R., Okwiri, R. B., Nantongo S., Mwambu, P. (2023). A Systems Approach to Exports of Quality Capsicums from Uganda into the European Union. Proceedings: NARO-MAK Conference 14-16th March 2023, Kampala, Uganda.

191. Obongo I., Kisembo L., Semalulu O., Ddamulira G., Atim B., Driciru P., Park T., and Adriko J. (2023). Farmers' Practices, Trends, and Incomes from Citrus Production in Teso Region in Eastern Uganda. Proceedings: NARO-MAK Conference 14-16th March 2023, Kampala, Uganda.

192. Obuo John Emidiaits, Okwang Dodah, Mbeyagala Emmanuel, Wandulu Joseph Andrew. Adaptation and Agronomic Performance of Horsegram, Mothbean and Mungbean Genotypes in the Semi-Arid Regions of Uganda. Presented and submitted for publication to the NARO-MAK 3rd Joint Scientific Conference Journal, 14th – 16th March, 2023.

**193.** **Tinyiro S. E.**, Bamwirire D., Parmar A. and Stathers T. 2023. Postharvest Loss Measurement along the Cassava Value Chain in Eastern Uganda. 3rd Joint NARO-MAK Scientific Conference

**194.** **Khakasa E.**, Muyanja C., Mugabi R., Arinaitwe I. K., Uwimana B., Namanya P., **Nowakunda K.** 2023. Instrumentation predicts fruit colour associated with consumer acceptance of cooking bananas (Matooke). 3rd Joint NARO-MAK Scientific Conference.

## Abi ZARDI

195. Awori Eres1,2, Sadik Kassim2, Kiryowa Moses3, Sserumaga Julius Pyton4, Thiago Lívio P. O. Souza5, Ariadna F. Vieira6, Stanley T. Nkalubo3, and Tusiime Geoffrey1 (2023). Validation of Single Nucleotide Polymorphism markers linked to the Co-2 anthracnose resistance gene in common beans (Pheseolus vulgaris). Proceedings: NARO-MAK Conference 14-16th March 2023, Kampala, Uganda.

196. Kasozi, N., Iwe D. G., Walakira, J., Langi, S. (2023). Integration of probiotics in aquaponic systems: An emerging alternative approach. Eastern African Regional Aquaculture Conference, 14th-17th March 2023, KISUMU, KENYA

197. Kasozi, N., Wilhelmi, B. Kaiser, H. (2023) Effect of adding Bacillus species to the water of a coupled aquaponic system on the gastrointestinal microbiota of Mozambique tilapia,Oreochromis mossambicus (Peters, 1852). Third NARO-MAK Joint Scientific Conference, 14-16 MARCH 2023, KAMPALA, UGANDA

198. Nandudu, L. (2022, January). Genome-Wide Association Studies for Cassava Brown Streak Disease. In Plant and Animal Genome XXIX Conference (January 8-12, 2022). PAG.

199. Sophie von Loeben, Eres Awori, Sophia Weituschat , Abel Chemura, Lisa Murken and Christoph Gornott (2022). Losing value: how climate change impacts value chains in Uganda. Proceedings in the international Conference on research on food security, Natural resource management and rural development. Hybrid conference, Prague, Czech Republic (ID382)., November, 2022.

200. Walakira J (2022). The Role of the World Aquaculture Society in Aquatic Health Management. Presented at the World Aquatic Veterinary Medical Association (WAVMA), Pretoria, South Africa. 3-7 December 2022.

201. Walakira J, E. Hinrichsen, V. Boit and H.Baumüller (2023). African Aquaculture: The Future For Small-Scale Fish Farming presented in World Aquaculture Society, Darwin , Australia

202. Walakira J, E. Hinrichsen, V. Boit and H.Baumüller (2023). Food security and wealth creation in Africa through aquaculture: case studies presented in 7th International Conference on Ecosystem Conservation and Sustainable Development, Hawassa, Ethiopia, 20-22 June 2023.

## Mukono ZARDI

203. Tumuramye, Kellet, Kagezi, H. Fungo Bernard, Nassimbwa, Florence, Sseruwu Godfrey, Atim Jackie and Wagoire W. William Effects of training on farmers' awareness and use of NARO -Promoted packages for managing black coffee twig borer and coffee wilt disease on robusta coffee, Oral presentation, 3rd Joint NARO-MAK Scientific Conference, 2023.

204. Damalie Babirye Magala, Jerry Egesa, Jackie Atim,Godfrey Sseruwu, Teopista Namirimu. Mitigation Measures for reducing Tomato Post-Harvest Losses at Farmer Level in the Lake Victoria Crescent Agro-Ecological Zone, Oral presentation, 3rd Joint NARO-MAK Scientific Conference, 2023.

205. Nankinga Caroline M, Nampeera Esther, Magala Damali, Sammula Alexander, Kisingiri Brenda, Robert Solar Lakidi, Kamulegeya Patric, Aool Winnfred, Kirongo Patric, Mukasa Yosia, Owiny Raphael, Ogam P, Namasa Emanuel John, Nampeera Florence, Lubega Victor, Nasaazi Sharron, Rware Hattison, Fernadis Makale, Monica Kansiime, Rwomushana Ivan,Byantwale.T. Stephen, Ogwang James M,OKIDI, Mwabu Paul Farmers' knowledge and impact associated with the invasive papaya mealybug in Uganda, Oral presentation, 3rd Joint NARO-MAK Scientific Conference, 2023.

206. S., Mutonyi, D. Akwango, I. Kiyingi, D. Magala, H. Luzinda, S. Adur, I. Obongo, S. Agundupu, R. Ariongo, A. Bua, & G. Lukwango. The Effect of Adoption of Improved Bean and Maize technologies on Smallholder Income & Food Security in Uganda. Oral Presentation, 3rd NARO- MAK Scientific conference.

# Technical Reports

## National Fisheries resources research institute (NaFIRRI)

207. NAFIRRI (2022). Aquatic Ecology Monitoring: Water quality, fish composition and abundance, fish catch, fishing effort, catch beach revenue, sanitation and disease vectors, Monitoring No. 31. Date: 9th – 14th November 2022.

208. NAFIRRI (2022). Environmental Monitoring of the Cage Area at the Source of the Nile (SON) Fish Farm for Quarter 4 (Oct - Dec 2022). [Contributing Authors: Ocaya Henry, Agoe Catherine, Kiggundu Vincent, Nsega Monic, Pabire W. Gandi, Maluwairo Janet, Kamya Ashraf

## National Agricultural Research Laboratories (NARL)

209. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Abim District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

210. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Amolatar District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

211. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Amudat District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

212. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Amuria District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

213. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Buyende District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

214. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Kaberamaido District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

215. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Kamuli District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

216. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Katakwi District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

217. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Kayunga District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

218. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Luwero District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

219. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Nakaseke District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

220. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Nakasongola District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

221. Drake N. Mubiru, Ramzy Magambo, Joshua Wanyama, Julius Opio, James Lwasa, Jalia Namakula, Irene Babirye, Joselyn Kashagama, Priscilla Kyosaba, Joram Bahati and Caroline Nakalyango. 2022. Assessing and mapping natural resources and Assessing and mapping the main agrarian system in Napak District. GCP/UGA/043/LDF Project. FAO, Kampala, Uganda.

222. Drake N. Mubiru, James Lwasa, Charles K. Luswata, and Deo Ssaazi. 2022. Suitability assessment of Mayuge District for oil palm production. MAAIF, Entebbe, Uganda

223. Drake N. Mubiru and Ramzy Magambo, 2023. Climate Justice and Agriculture Strategic Framework 2023-2027. Oxfam, Kampala, Uganda

224. B. Popular versions in REPORTS

225. Assessing and mapping natural resources and the main agrarian systems in Abim District – Popular Version. FAO, Kampala, Uganda.

226. Assessing and mapping natural resources and the main agrarian systems in Amolatar District – Popular Version. FAO, Kampala, Uganda.

227. Assessing and mapping natural resources and the main agrarian systems in Amudat District – Popular Version. FAO, Kampala, Uganda.

228. Assessing and mapping natural resources and the main agrarian systems in Amuria District – Popular Version. FAO, Kampala, Uganda.

229. Assessing and mapping natural resources and the main agrarian systems in Buyende District – Popular Version. FAO, Kampala, Uganda.

230. Assessing and mapping natural resources and the main agrarian systems in Kaberamaido District – Popular Version. FAO, Kampala, Uganda.

231. Assessing and mapping natural resources and the main agrarian systems in Kamuli District – Popular Version. FAO, Kampala, Uganda.

232. Assessing and mapping natural resources and the main agrarian systems in Katakwi District – Popular Version. FAO, Kampala, Uganda.

233. Assessing and mapping natural resources and the main agrarian systems in Kayunga District – Popular Version. FAO, Kampala, Uganda

234. Assessing and mapping natural resources and the main agrarian systems in Luwero District – Popular Version. FAO, Kampala, Uganda.

235. Assessing and mapping natural resources and the main agrarian systems in Nakaseke District – Popular Version. FAO, Kampala, Uganda.

236. Assessing and mapping natural resources and the main agrarian systems in Nakasongola District – Popular Version. FAO, Kampala, Uganda.

237. Assessing and mapping natural resources and the main agrarian systems in Napak District –Popular Version. FAO, Kampala, Uganda.

## National Semi-Arid Resources Research Institute (NaSARRI)

238. Magumba, D., Akullo, J., Kalule, D. O., Sebatta, C., Gidoi, R., Muyinda, R., ... & Mweetwa, A. Awareness of Aflatoxin Contamination: The Case of Farmers, Traders, and Consumers in Eastern and Northern Uganda. Traders, and Consumers in Eastern and Northern Uganda.

239. Opie, H., Akpo, E., Desmae, H., Okori, P., Ininda, J. and Ojiewo, C.O. 2022. Business models for early generation seed production and marketing. ISSD Africa Working Paper 2022-02. Wageningen, The Netherlands: Wageningen University and Research. *https://hdl.handle.net/10883/22514*

240. Hellen Opie, Essegbemon Akpo, Haile Desmae, Patrick Okori, Jane Ininda, Chris O. Ojiewo. 2022. Scoping the implementation of recommendations from previous early generation seed studies in sub-Saharan Africa. Wageningen Centre for Development Innovation

241. Carter, A., Gill, T., Ader, D. Stephens, C. A., Kaaya, A., Lwasa, S., Musoke, D., Kemigisha, D., Mirembe, R. M., & Okello, D. (2022, April 4-7). *Empowering Ugandan youth in the groundnut value chain using Photovoice*. Association of International Agricultural and Extension Education, Thessaloniki, Greece.

The National Agricultural Research Organisation (NARO) informs the general public especially the agro-input dealers, seed buyers and farmers that in a bid to ensure quality assurance and stewardship of seed to the end-users, seed companies that fulfilled requirements signed license agreements. The public is hereby informed that the following seed companies are the only ones currently authorized to produce certified seed from NARO plant varieties as of 30th August, 2023. Any procurement/ purchase of seed from unlicensed seed companies is at own risk and peril as NARO shall not guarantee quality and authenticity. Certified seed from these licensed seed companies shall have packaging consisting of a NARO Varietal Identification Number (NVIN) as indicated in the table.

Details of allocated plant varieties by respective licensed seed companies is available on the NARO website ***www.naro.go.ug.*** Any additional licensees will be published in same way.

| VARIETY NAME | NVIN | COMPANY ALLOCATED | TYPE OF LICENSE |
|---|---|---|---|
| **CROP MAIZE** | | | |
| Longe 6H | NARO/2002/MAZ/009 | Farm Input Care Centre (FICA) | Exclusive |
| Longe 8H | NARO/2002/MAZ/011 | Syova seeds | Exclusive |
| Longe 9H | NARO/2009/MAZ/012 | FICA | Exclusive |
| Longe 10H | NARO/2009/MAZ/013 | Nalweyo Seed Company (NASECO) | Exclusive |
| UH 5354 | NARO/2013/MAZ/022 | NASECO | Exclusive |
| NAROMAIZE 61 (UH5961) | NARO/2019/MAZ/041 | Advanta Seed International | Exclusive |
| UH 5053 | NARO/2012/MAZ/019 | Okeba seeds | Exclusive |
| UH5401 | NARO/2013/MAZ/023 | Green Firm Africa | Exclusive |
| Longe 11H | NARO/2009/MAZ/014 | Pearl Seeds | Semi-exclusive |
| Longe 7H | NARO/2002/MAZ/010 | Ayellape Agro, Daylight Agro, Equator Seeds and Grow More Seeds | Semi-exclusive |
| UH 5355 | NARO/2013/MAZ/023 | Miika Albertine, Gacvic Industries, Pearl Seeds | Semi-exclusive |
| UH5403 | NARO/2015/MAZ/031 | Syova seeds | semi-exclusive |
| UH 5051 | NARO/2012/MAZ/017 | Gavic Industries, Equator Seeds, Century seeds, Savana Seeds | Semi-exclusive |
| UH 5052 | NARO/2012/MAZ/018 | BAK Holdings, Pearl Seeds | Semi-exclusive |
| UH 5556 | NARO/2015/MAZ/029 | Savana Seeds | Semi-exclusive |
| NARO MAIZE 62 | NARO/2019/MAZ/042 | FICA, Equator Seeds, Pearl Seeds | Semi-exclusive |
| NAROMAIZE 731 | NARO/2017/MAZ/036 | FICA, Equator Seeds, Daylight Agro, Grow More Seeds | Semi-exclusive |
| NAROMAIZE 60IR | NARO/2017/MAZ/040 | Ayellape Agro, FICA | Semi-exclusive |
| LONGE 5 | NARO/2000/MAZ/040 | FICA, Syova seeds, BAK Holdings, Equator seeds, Ayellape Agro, Daylight Agro, Miika Albertine, NASECO, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd, Golden Bull (U) Limited, Green Firm Africa, Century Seeds, Savana Seeds, Grow More Seeds | Non-exclusive |
| Myezi Mitatu | NARO/2010/MAZ/015 | FICA, Equator seed, Daylight Agro, Miika Albertine, Syova seeds, Century Seeds, Grow More Seeds | Non-exclusive |
| Longe 5D | NARO/2012/MAZ/015 | FICA, Syova seeds, Pearl seeds, Gavic industries, Equator seeds, NASECO, Okeba Seeds, Supa Seeds Africa, Century Seeds, Savana Seeds | Non-exclusive |
| **CROP BEANS** | | | |
| NABE 4 | NARO/1999/BEN/008 | FICA, NASECO, Syova, Equator, Ayellape,Pearl | Non-exclusive |
| NABE 5 | NARO/1999/BEN/009 | Daylight Agro, Pearl Seeds, Grow More Seeds | Non-exclusive |
| NABE 12C | NARO/2005/BEN/016 | Pearl Seeds, Okeba seeds, Green Firm Africa, Grow More Seeds | Non-exclusive |
| NABE 14 | NARO/2006/BEN/018 | FICA, NASECO, Pearl Seeds, Okeba seeds, Grow More Seeds | Non-exclusive |
| NABE 15 | NARO/2010/BEN/019 | FICA, Pearl, Syova, Equator, Ayellape, Daylight, NASECO, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd, Golden Bull (U) Limited, Century Seeds, Savana Seeds, Grow More Seeds | Non-exclusive |
| NABE 16 | NARO/2010/BEN/020 | NASECO, Miika, Syova, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd, Okeba seeds, Supa Seeds Africa, Golden Bull (U) Limited, Grow More Seeds | Non-exclusive |
| NABE 17 | NARO/2012/BEN/021 | FICA, Pearl, Syova, Equator, Ayellape, Daylight, NASECO, Miika, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd, Okeba seeds, Golden Bull (U) Limited, Century Seeds, Savana Seeds, Grow More Seeds | Non-exclusive |
| NABE 19 | NARO/2012/BEN/023 | FICA, Pearl seeds, Daylight, Miika, NASECO, Supa Seeds Africa, Century Seeds, Savana Seeds, Grow More Seeds | Non-exclusive |
| NAROBEAN 1 | NARO/2016/BEN/032 | FICA, Pearl seeds, Daylight, Miika, NASECO, Syova, Equator, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd, Okeba seeds, Golden Bull (U) Limited, Savana Seeds, Grow More Seeds | Non-exclusive |
| NAROBEAN 2 | NARO/2016/BEN/033 | FICA, Pearl seeds, Syova, Equator, Ayellape, Daylight, BAK Holdings, Miika Albertine, NASECO, Okeba seeds, Golden Bull (U) Limited, Green Firm Africa | Non-exclusive |
| NAROBEAN 3 | NARO/2016/BEN/034 | Okeba seeds, Golden Bull (U) Limited, Green Firm Africa, Savana Seeds, Grow More Seeds | Non-exclusive |
| NAROBEAN 4C | NARO/2016/BEN/035 | Pearl Seeds, Syova | Non-exclusive |
| NAROBEAN 5C | NARO/2016/BEN/036 | Pearl Seeds, Syova, Savana Seeds | Non-exclusive |
| NAROBEAN 6 | NARO/2019/BEN/037 | Pearl Seeds | Non-exclusive |
| NAROBEAN 7 | NARO/2019/BEN/038 | Pearl Seeds, Syova, Savana Seeds | Non-exclusive |
| **CROP RICE** | | | |
| NAMCHE 1 | NARO/2013/RIC/011 | FICA, Equator, Ayellape, Pearl | Non-exclusive |
| NAMCHE 2 | NARO/2013/RIC/012 | Equator seeds, Ayellape, Pearl seeds | Non-exclusive |
| NAMCHE 3 | NARO/2013/RIC/013 | NASECO, Equator, Ayellape, Daylight, Pearl, Grow More Seeds | Non-exclusive |
| NAMCHE 4 | NARO/2013/RIC/014 | Equator seeds, Ayellape, Pearl seeds, Century Seeds | Non-exclusive |
| NAMCHE 5 | NARO/2013/RIC/015 | FICA, Equator, Ayellape, Pearl, Syova, Miika, Daylight, NASECO, BRAC Social Business Entreprise Ug Ltd, Savana Seeds | Non-exclusive |
| NAMCHE 6 | NARO/2013/RIC/016 | Pearl Seeds | Non-exclusive |
| WITA 9 | NARO/2014/RIC/021 | FICA, Equator, Syova, Ayellape, Daylight, Pearl, BRAC Social Business Entreprise Ug Ltd, Century Seeds, Savana Seeds | Non-exclusive |
| Komboka | NARO/2014/RIC/018 | Syova seeds, Savana Seeds | Non-exclusive |
| Arize-1 | NARO/2019/RIC/022 | FICA, Savana Seeds | Semi-exclusive |
| Chinuga 1 | NARO/2019/RIC/023 | Syova seeds, FICA, Savana Seeds, Grow More Seeds | Non-exclusive |
| Nerica 4 | NARO/2007/RIC/010 | Okeba, Century Seeds | Non-exclusive |
| **CROP SORGHUM** | | | |
| SESO 3 | NARO/2011/SGM/007 | FICA, Equator, Ayellape, Daylight, Ntungamo, Pearl, Rhino Seeds Africa, BRAC, Century Seeds, Grow More Seeds | Non-exclusive |
| NAROSORG 1 | NARO/2017/SGM/008 | FICA, Equator, Ayellape, Daylight, Ntungamo, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd, Century Seeds | Non-exclusive |
| NARO SORG 2 | NARO/2017/SGM/009 | Pearl Seeds, Ayellape, Daylight, Equator, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd | Non-exclusive |
| NAROSORG 3 | NARO/2017/SGM/010 | Ntungamo Real Foods, NASECO, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd | Semi-exclusive |
| NAROSORG 4 | NARO/2017/SGM/011 | FICA, Pearl, Equator, Ayellape, Daylight, NASECO, Century Seeds | Non exclusive |
| **CROP FINGER MILLET** | | | |
| NAROMILL 1 | NARO/2017/FMT/008 | NASECO, Ntungamo, Syova, Savana Seeds, Grow More Seeds | Non-exclusive |
| NAROMILL 2 | NARO/2017/FMT/009 | NASECO, Ntungamo, Syova | Non-exclusive |
| NAROMILL 3 | NARO/2017/FMT/010 | Syova seeds, Ayellape, Daylight, Ntungamo, Equator | Non-exclusive |
| NAROMILL 4 | NARO/2017/FMT/011 | NASECO, Syova, Century Seeds | Non-exclusive |
| NAROMILL 5 | NARO/2017/FMT/012 | Syova seeds, Ayellape, Daylight, Ntungamo, Equator, Century Seeds | Non-exclusive |
| Seremi 2 | NARO/1999/FMT/006 | BRAC Social Business Entreprise Ug Ltd, Century Seeds | Non-exclusive |
| **CROP PEARL MILLET** | | | |
| ICMV 225 | NARO/2010/PMT/003 | FICA, Grow More seeds | Semi-exclusive |
| **CROP GROUNDNUTS** | | | |
| Red Beauty | NARO/1968/GNT/003 | NASECO, Syova, Ayellape, Pearl, Rhino Seeds Africa, BRAC Social Business Entreprise Ug Ltd, Century Seeds, Grow More Seeds | Non-exclusive |
| Serenut 7T | NARO/2011/GNT/014 | NASECO, Ayellape, Equator, Savanna Seeds | Non-exclusive |
| Serenut 9T | NARO/2011/GNT/015 | NASECO, Savanna Seeds | Non-exclusive |
| Serenut 11T | NARO/2011/GNT/016 | FICA, NASECO | Non-exclusive |
| Serenut 13T | NARO/2011/GNT/017 | Syova seeds | Non-exclusive |
| Serenut 8R | NARO/2011/GNT/018 | NASECO | Non-exclusive |
| serenut 10R | NARO/2011/GNT/019 | NASECO | Non-exclusive |
| Serenut 12 R | NARO/2011/GNT/020 | NASECO, Savanna Seeds | Non-exclusive |
| Serenut 14R | NARO/2011/GNT/021 | NASECO, Equator, Ayellape, Syova | Non-exclusive |
| NARONUT 1R | NARO/2019/GNT/022 | FICA, Pearl seeds Syova seeds , NASECO, Century Seeds | Non-exclusive |
| NARONUT 2T | NARO/2019/GNT/023 | FICA, NASECO, Syova, Century Seeds | Non-exclusive |
| **CROP SESAME** | | | |
| Sesim 1 | NARO/2006/SSM/001 | Pearl seeds, FICA, Syova, Equator, Ayellape, Daylight, Pearl, Century Seeds | Non-exclusive |
| Sesim 3 | NARO/2013/SSM/003 | FICA, Syova, Equator, Ayellape, Daylight, Pearl, Century Seeds | Non-exclusive |
| Sesame 2 | NARO/2006/SSM/002 | Rhino Seeds Africa, Golden Bull (U) Limited, Century Seeds, Grow More Seeds | Non-exclusive |
| **CROP COW PEA** | | | |
| SECOW 1WT | NARO/2003/CWP/001 | Equator seeds, Ayellape, Daylight, Syova | Non-exclusive |
| SECOW 2W | NARO/2003/CWP/002 | FICA, Equator, Ayellape, Daylight, Pearl, Rhino Seeds Africa, Golden Bull (U) Limited, Savanna Seeds, Grow More Seeds | Non exclusive |
| NAROCOW 3 | NARO/2017/CWP/008 | Equator seeds, Daylight, Ayellape | Non-exclusive |
| NAROCOW 4 | NARO/2017/CWP/009 | Syova seeds, Century Seeds | Non-exclusive |
| NAROCOW 5 | NARO/2017/CWP/010 | Equator seeds, FICA, Ayellape, Century Seeds | Non-exclusive |
| **CROP GREENGRAM** | | | |
| NAROGram 1 | NARO/2016/GGM/001 | FICA, Syova, Savana seeds, Grow More Seeds | Non-exclusive |
| NAROGram 2 | NARO/2016/GGM/002 | FICA, Syova, Equator, Ayellape, Daylight, Pearl, Rhino Seeds Africa, Savana seeds, Grow More Seeds | Non-exclusive |
| **CROP Pigeon Pea** | | | |
| Sepi 2 | NARO/1999/PGP/002 | Pearl seeds, Syova, Century Seeds | Non-exclusive |
| Sepi 1 | NARO/1999/PGP/001 | Rhino Seeds Africa | Non-exclusive |
| **CROP SUNFLOWER** | | | |
| SESUN 1H | NARO/2010/SFW/003 | Ayellape Agro, Equator, Savana seeds, Century Seeds | Semi-exclusive |
| SESUN 2H | NARO/2010/SFW/004 | Equator seeds, Ayellape, Syova, Century Seeds | Semi-exclusive |

**National Agricultural Research Organisation (NARO) Secretariat**
Plot 11-13, Lugard Avenue, Entebbe
P. O. Box 295, Entebbe, Uganda
**Tel:** +256 41 320 512, +256 41 3203 41/2
**Fax:** +256 41 321 070
**Email:** dgnaro@naro.go.ug
**Website:** www.naro.go.ug

narouganda