



NATIONAL AGRICULTURAL  
RESEARCH ORGANISATION

# ANNUAL REPORT

2019/2020



Coordinating, overseeing and guiding  
agricultural research in Uganda



National Agricultural Research Organisation (NARO)

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**Author:** National Agricultural Research Organisation

**Content Review:** Dr. Ambrose Agona, Dr. Sadik Kassim, Dr. Yona Baguma, Dr. Damalie Akwango Aliau and Mr. Joshua Guina.

**Lead Editor:** Ms. Christine M. Elong

**Contributing Directorates at NARO SECRETARIAT:** Directorate of Research Coordination, Directorate of Agricultural Technology Promotion, Directorate of Corporate Services, Directorate of Human Resources, and Directorate of Finance.

**Contributions from Public Agricultural Research Institutes:**

**Directors of Research:**

**PARI Report Writing Teams.**

**Contributing Scientists and Staff:**

**Contributing Development Communication officers:**

**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](mailto:dgnaro@naro.go.ug)

**Website:** [www.naro.go.ug](http://www.naro.go.ug)





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# ACRONYMS

<b>ARDC</b>	Aquatic Research Development Centre
<b>ASF</b>	African swine fever
<b>AYT</b>	Accelerated Yield Technology
<b>BRSU</b>	Biometrics Research Support Unit
<b>CABI</b>	Centre for Agriculture and Bioscience
<b>CBSV</b>	Cassava Brown Streak Virus
<b>CGS</b>	Competitive Grant Scheme
<b>COVID-19</b>	Corona Virus Disease of 2019
<b>DNA</b>	Deoxyribonucleic Acid
<b>ESS</b>	Environmental Social Safeguards
<b>FAW</b>	Fall Army Worm
<b>FBA</b>	Food Biosciences Analysis
<b>FMD</b>	Foot and Mouth Disease
<b>GAPs</b>	Good Agronomic Practice
<b>JASAR</b>	Joint Agricultural Sector Annual Review
<b>KPIs</b>	Key Performance Indicators
<b>LACZ</b>	Lake Albert Crescent Zone
<b>MAAIF</b>	Ministry of Agriculture, Animal Industry and Fisheries
<b>MoPS</b>	Ministry of Public Service
<b>MoSTI</b>	Ministry of Science, Technology, and Innovations
<b>MSIPS</b>	Multi-Stakeholder Innovation Platforms
<b>NARO</b>	National Agricultural Research Organization
<b>NPA</b>	National Planning Authority
<b>NPT</b>	National Performance Trials
<b>NRM</b>	National Resistance Movement
<b>NVRC</b>	National Variety Release Committee
<b>OPV</b>	Open Pollinated Varieties
<b>PARI</b>	Public Agricultural Research Institute
<b>UJAS</b>	Uganda Journal of Agricultural Sciences
<b>ZARDI</b>	Zonal Agricultural Research and Development Institute



## A WORD FROM THE CHAIRMAN, NARO GOVERNING COUNCIL

**I welcome you to the FY annual report of 2019/2020. This has been a year of great milestones and achievements.**

NARO's annual budget for FY 2019/20 was UGX 79.661 billion from the Government of Uganda. The annual budget release was UGX 57.102 billion with 100 percent funds absorption. During FY 2019/20, NARO implemented a total of 116 off-budget projects supported by development partners to a tune of UGX 41.173 billion.

During the period, the NARO Governing Council approved five policies and strategies. Besides, the structure of the organisation was expanded to create the Directorate of Internal Audit and Grants Office.

The internal Audit conducted 4 audits during the period namely the core research audit, financial and management audits, governance audits, and reviewed (12) audits to ensure that the payroll was free of ghost workers and that PAYE and NSSF computations were accurately remitted.

I would like to appreciate the continued commitment and guidance from all council members towards ensuring the smooth operations of NARO, NARO top management as well as the staff for work rendered in the financial year ending 2019/2020.

Lastly, I would like to thank the government of Uganda, donors, partners, and stakeholders for walking this year with us to ensure that NARO delivered as planned.

Prof Joseph Obua  
Chairperson, NARO Governing Council.



**During the period, the NARO Governing Council approved five policies and strategies. Besides, the structure of the organisation was expanded to create the Directorate of Internal Audit and Grants Office.**



## MEMBERS OF NARO GOVERNING COUNCIL



**Professor Joseph Bua,**  
Chairman and Eminent  
Scientist



**Mr. Pius Wakabi,**  
Permanent Secretary, Ministry  
for Agriculture, Animal Industry  
and Fisheries



**Mr. Titus Kajura,**  
Representative of the  
Permanent Secretary of the  
Ministry for Finance, Planning  
and Economic Development



**Mr. Haruna Mawanda,**  
Representative nominated  
by Uganda Local Authorities  
Association



**Capt. Tisasira Esau,**  
Vice President, Uganda  
National Farmers Federation/  
Representative of Farmers



**Mrs. Monica Kabatooro,**  
Chairperson Hoima District  
Farmers Association/  
Representative of Farmers



**Mr. Patrick Cheborion,**  
Chairperson Farmers Forum,  
Kapchorwa/ Representative of  
Farmers



**Mrs. Margaret Ebuu,**  
Uganda National Farmers  
Federation/ Representative of  
Farmers (disabilities)



**Hon. Idah Mehangye,**  
Representative of Uganda Non-  
Governmental Organizations  
Forum





**Dr. Wilberforce Tushemereirwe,**  
Representative of Public  
Agricultural Research Institutes



**Dr. Sengooba Theresa (Ph.D.),**  
Representative of private  
agricultural research providers



**Dr. Gudula Naiga,**  
Vice-Chairperson  
Private Sector Foundation  
Uganda



**Prof. John David Kabasa ,**  
College of Veterinary  
Medicine, Animal Resources  
& Biosecurity - Makerere  
University/ Representative of  
Universities



**Dr. Peter Ndemere ,**  
Executive Director, Uganda  
National Council of Science and  
Technology/ (Ex-Officio)



**Dr. Samuel Katambi Mugasi,**  
Executive Director, NAADS (Ex-  
Officio)



**Dr. Ambrose Agona,**  
Director General, NARO (Ex-  
Officio)

## WORD BY THE DIRECTOR GENERAL, NARO



**NARO's emphasis this financial year of 2019/2020 was focused on the operationalization of NARO's strategic plan (2018/19-2027/280) in line with other national, regional and international development strategies.**

Through this, NARO strives to increase the total factor productivity and access to agricultural research products and services for inclusive growth in Uganda. During this period, NARO was able to make great strides in the areas of infrastructure development, value addition, crop, fisheries, livestock, forestry, and tea research. We carried out Infrastructural Development on four of our Public Agricultural Research Institutes; Rwebitaba ZARDI, NaSARRI, NaLIRRI, and Nabuin ZARDI. These physical infrastructure development projects include renovations (5) and new constructions (6) that have either been completed or with a completion rate of 70%. NARO was also able to facilitate the relocation and operationalization of Nakyesasa and Maruzi campuses under the National Livestock Resources research institute. Livestock research also focused on vaccine development, forage seed and feed production, maintenance of elite livestock herds. We were able to submit a total of 27 varieties to the release committee of the Ministry of Agriculture, Animal Industry, and Fisheries, generate 114 technologies, undertake 40 research projects under CGS, and delivered 128 technologies along the technology uptake pathways. Tea is Uganda's third export earner and therefore a key priority commodity. NARO's Tea research and development activities focused on identifying high-quality specialty tea clones for commercialization, tea agroforestry, and climate and landscape smart tea practice. Under the forestry research, NARO directed research interventions on tree species and management options, medicinal tree database establishment, and supporting households' soil and water management.

I would like to appreciate each member of staff in their different capacities for collectively contributing to ensuring that NARO was able to deliver what we had promised to do in the financial year of 2019/2020. Your dedication and efforts cannot be overemphasized.

I would like to thank the Government of Uganda and all development partners for all the support rendered during this financial year.

We hope that this report will serve as evidence of NARO's contribution towards Uganda's agricultural productivity, economic growth, food, and nutritional security, and poverty eradication.

Dr. Ambrose Agona  
**Director General**



## NARO SECRETARIAT TOP MANAGEMENT



**Dr. Ambrose Agona,  
Director General - NARO**



**Dr. Yona Baguma,  
Deputy Director-General,  
Research coordination**



**Dr. Imelda Kashaija,  
Deputy Director-General,  
Technology Promotion**



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



**Mr. Robert Bagonza,  
Director, Human Resources**



**Mr. Denis Owor,  
Head, Internal Audit**



**Dr. Justus Rutaisire,  
Director, Corporate Services**

## **DIRECTORS OF NATIONAL AGRICULTURAL RESEARCH INSTITUTES**



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Research and Development  
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Research and Development  
Institute



**Dr. Paul Okullo,**  
Nabuin Zonal Agricultural  
Research and Development  
Institute





# ABOUT THE NATIONAL AGRICULTURAL RESEARCH ORGANIZATION (NARO)

## 1.1 Background

The National Agricultural Research Organization (NARO) is an agency under the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) mandated by the National Agricultural Research (NAR) Act 2005 to research all aspects of Agricultural activities in Uganda including crops, livestock, fisheries, forestry, agro-machinery, natural resources, and socio-economics. It is comprised of the Council as its governing body, committees of the Council as its specialized organs, and a Secretariat for its day-to-day operations.

It has sixteen (16) semi-autonomous Public Agricultural Research Institutes (PARIs). These include seven (7) National Agricultural Research Institutes (NARIs) with a national research mandate, and nine (9) Zonal Agricultural Research and Development Institutes (ZARDIs) mandated to carry out applied and adaptive research for a specific agro-ecological zone.

The vision and mission statement of NARO emphasize a *competitive society supported by a dynamic agricultural research innovation system and innovation for sustainable agricultural transformation*. The goal of the organization is *“to increase total factor productivity and access to agricultural research products and services for inclusive growth.”*

To fulfill her mandate, NARO undertakes periodic identification of research areas through demand articulation and priority setting of agricultural production and productivity constraints and opportunities.

In addition, socio-economic, gender, market potential, consumer preference, environmental and social safeguards concerns are considered.

NARO is aligned to the national agricultural research policy and receives budgetary support from the Government of Uganda and other development partners. This is in accordance with comprehensive annual work plans guided by the budget policy and procedures that are aligned to the Public Finance and Accountability Act (2015) of Uganda.

The undertakings of NARO are based on the NARO Strategic Plan, Medium Term Operational Plan, and Annual work plans that contribute to:

1. National Standards Indicators (NSI), the 2<sup>nd</sup> National Development Plan (NDP II) and agricultural sector outcomes and output targets,
2. National Resistance Movement (NRM) Manifesto commitments 2016-2021,
3. Sustainable Development Goals (SDGs) of ending poverty (SDG1), end hunger and achieve food security (SDG2), gender equality (SDG5), and taking action to combat climate change (SDG13).

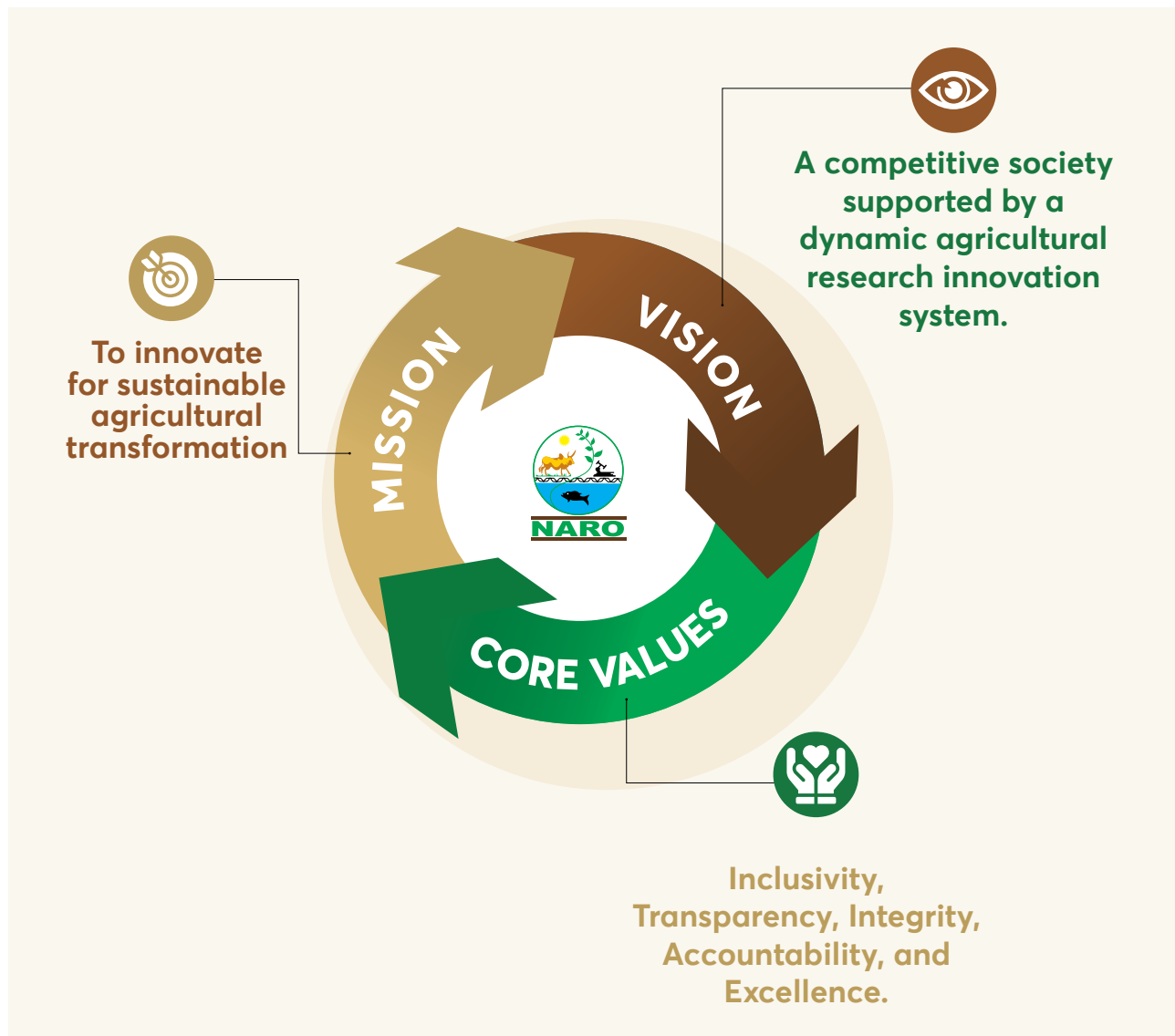
## 1.2 NARO Strategic Objectives

The principal strategic objective of NARO focuses on contributing to agricultural transformation hinged on niche markets and industry. Specifically,

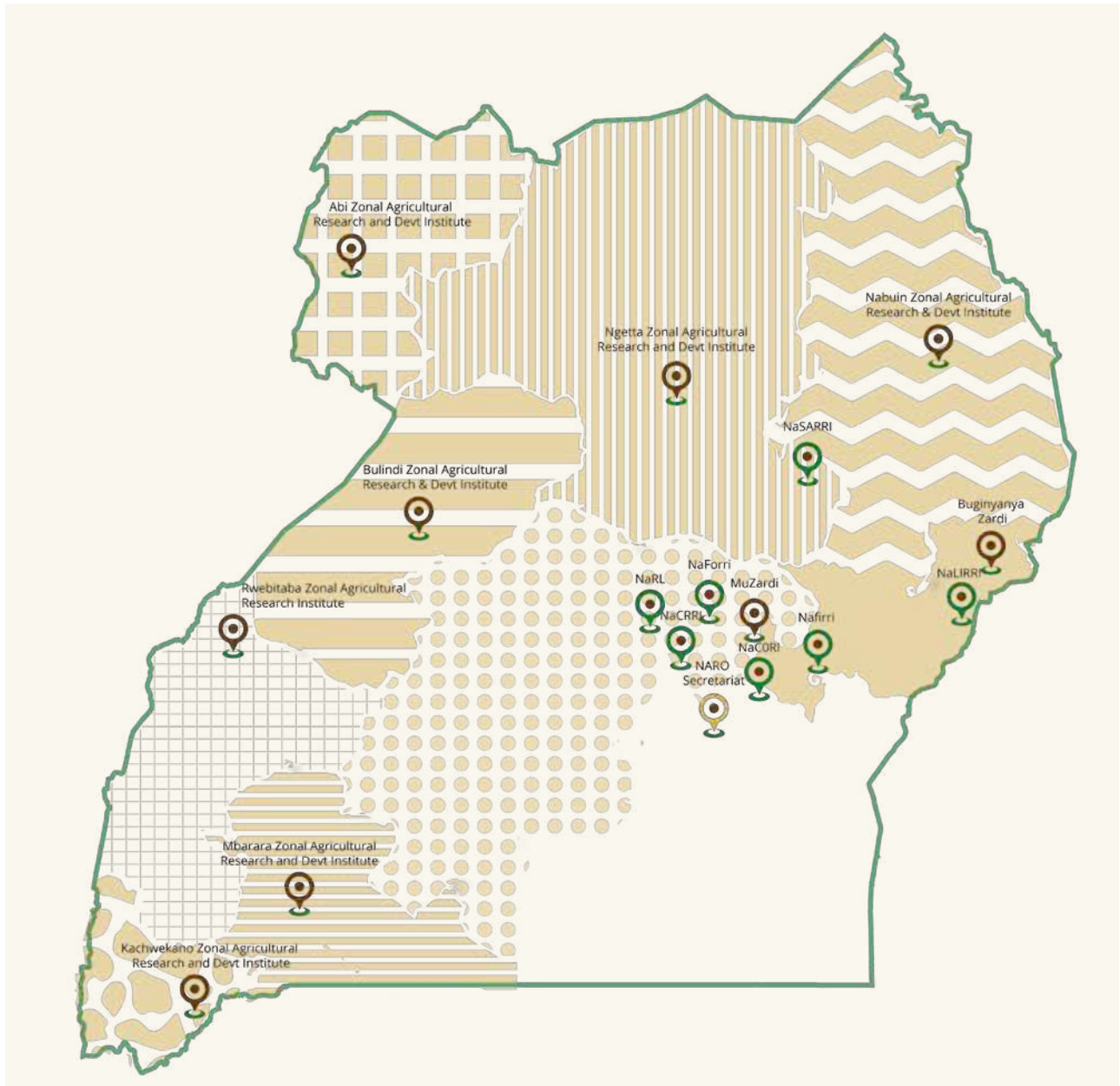
1. Develop and promote demand-driven technologies, innovations, and management practices that increase niche markets for communities in the agricultural sector,
2. Increase research products and services suited for vertical integration into industries,
3. Improve access and sustainable utilisation of improved agricultural technologies and innovations by communities,
4. Increase Total Factor Productivity to accelerate community institutional orientation to agricultural transformation.

NARO has registered significant achievements under the different targeted vote function output areas that include technology generation, and promoting partnerships between research and extension through technology dissemination, promotion, and up scaling along various pathways.

### 1.3 1.3 NARO Mandate (Mission, Vision & Core Values)



### 1.4 Map of showing locations of Public Agricultural Research Institutes (PARIs)



**KEY**

- |                          |                         |                  |
|--------------------------|-------------------------|------------------|
| West Nile farmlands      | Eastern Highlands       | NARO Secretariat |
| Northern farming system  | Lake Victoria Crescent  | NARIs            |
| Northern Moist farmlands | Western Range lands     | ZARDIs           |
| Lake Albert crescent     | South Western Highlands |                  |





# 02

## ACHIEVEMENTS AND PERFORMANCE

NARO is mandated to research all aspects of agriculture. This section presents the key progress on technology generation, agricultural research interface, and strengthening agricultural research capacity. This section elucidates the organization’s core results under the key vote function outputs, which are:

1. Generation of agricultural technologies,
2. Promoting and strengthening agricultural research extension interface and,

3. Strengthening agricultural research capacity.

### 2.1 Physical Key Performance Indicators FY 2019-2020

NARO submitted 27 varieties to the release committee, generated 114 technologies, undertook 40 research projects under CGS, and delivered 128 technologies along the technology uptake pathways (Table 1).

**Table 1: Summary of NARO Performance as per the Key Performance Indicators FY2019/20**

NARO Key Performance Indicators	Planned	Targets	Remarks
<b>Generation of agricultural technologies</b>			
Number of new varieties/ prototypes submitted to Variety Release Committee for release	20	27	Contribution of off-budget support
Number of production technologies generated	70	114	Contribution of off-budget support
Number of research studies under competitive grants scheme (CGS)	38	40	Effective planning and targeting of research needs
<b>Research extension interface promoted and strengthened</b>			
Number of technological innovation platforms established/supported	10	32	Increased interest by beneficiaries in the value chain Contribution of off-budget support
Number of technological innovations delivered to uptake pathways	40	128	Contribution of off-budget support

## 2.2 New varieties/ prototypes submitted to Variety Release Committee for release

In the crops sub-sector, a total of 27 candidate varieties were submitted (Table 2) to the National Variety Release Committee (NVRC) of MAAIF. The candidate varieties have superior attributes over the current existing varieties concerning yield advantage, pest and disease resistance, adaptation to drought-prone environments, and culinary attributes. All the technologies developed target men, women, youth, and children.

## 2.3 Financial Performance

During the financial year 2019/20 reporting period, Ministry of Finance Planning and Economic Development released to NARO Vote 142 Uganda shillings 57.1 billion as support to the development and recurrent expenditures of the Secretariat and her sixteen

Institutes and satellites. This was a 72% performance against budget. The funds thus released were disbursed to the Institutes as soon as the warrants were approved.

The financial year recurrent budget was released at 92% and disbursed to the implementers; however, there was a 51% funding gap against the development budget. In line with the agreements signed with international collaborators, NARO contributed a total of shilling 991 million. Included in the financial statements is an accrual of UGX 808mn for the unpaid obligation.

Non-Tax Revenue collected and transferred to treasury during the financial year at the various institutes amounted to 3.8 billion. Below is the table showing the budget performance of FY 2019/20.

**Table 2: Uganda Shillings**

Funding Source	Approved Annual Budget UGX Billions	Annual Budget Release 2019/2020 UGX Billions	FY 2019/20 Expenditure UGX Billions	Percentage Released Vs Budget	Percentage Disbursed Vs Released
Wage Recurrent Budget	22.472	22.472	22.472	100%	100%
Non-Wage Recurrent Budget	19.717	16.337	16.337	83%	100%
Development Budget	37.473	18.294	18.294	49%	100%
	79.662	57.103	57.103	72%	100%
External Financing	0.000	0.000	0.000	0%	0%
<b>Total</b>	<b>79.662</b>	<b>57.103</b>	<b>57.103</b>	<b>72%</b>	<b>100%</b>



**Table 3: Statement of Financial Performance [Based on classification of expenditures by nature]**

	Note	Actual 30 June 2020 (Shs)	Actual 30 June 2019 (Shs)
<b>OPERATING REVENUE</b>			
Taxes	2		
External Assistance	3		
Transfers received from Treasury- UCF	4	57,103,273,305	63,186,060,832
Transfers received from Other Government units	5		
Non Tax revenue	6	3,814,163,998	3,610,929,693
Total operating revenue		60,917,437,303	66,796,990,525
<b>OPERATING EXPENSES</b>			
Employee costs	7	28,725,755,325	28,725,867,375
Goods and services consumed	8	22,661,132,095	17,509,599,035
Consumption of property, plant & equipment	9	4,514,407,497	16,797,584,532
Subsidies	10		
Transfers to other Organisations	11	1,818,315,835	760,000,000
Social benefits	12	57,124,500	65,750,000
Other operating expenses	13	530,000,000	
Total operating expenses		58,306,735,252	63,858,800,942
Excess of revenue over expenditure from operating activities		2,610,702,051	2,938,189,583
Foreign exchange loss /Gain	14		
Finance costs	15		
Transfers to Treasury	16(a)	3,029,371,089	3,610,929,693
Excess of Revenue over expenditure for the year		(418,669,038)	(672,740,110)

## 2.4 Statutory Compliance of NARO to existing frameworks

NARO has to a great extent ensured to address all the areas or gaps from previous assessments/to ensure

compliance with NPA, PPDA, Equal Opportunity, and BAMU guidelines and frameworks. During the reporting period, NARO complied well with the ratings of various frameworks as indicated below;

- NPA on project performance 70%
- PPDA 2018/19 score 77.3%
- Equal opportunity score 76%
- Reputation index 72%
- NARO JASAR for FY 2018/19 attained 100%

- Audited accounts for FY 2018/19 secured “Unqualified Opinion”

This clearly shows that NARO is a healthy and compliant institution.



## GENERATION OF AGRICULTURAL TECHNOLOGIES

The mandate of NARO is to research crops, forestry, livestock, fisheries, and natural resources while protecting the environment. The details of NARO-generated technologies are in the ensuing sections.

### 3.1 Crops sub-sector

NARO researches national priority commodities and other national strategic commodities. These include crops (such as plantains, cassava, sweet potatoes, millet, sorghum, maize, beans, groundnuts, and sesame), livestock and export crops (coffee, cotton, tea, and tobacco) coffee, tea, cotton, bananas, rice, maize, and vegetables. NARO researches national priority commodities and other national strategic commodities. These include crops (such as plantains, cassava, sweet potatoes, millet, sorghum, maize, beans, groundnuts, and sesame), livestock and export crops (coffee, cotton, tea, and tobacco) coffee, tea, cotton, bananas, rice, maize, and vegetables.

#### 3.1.1 Production technologies generated

As highlighted in table X, NARO achieved the targets of all the planned production technologies attributed majorly to off-budget projects contributions.

##### i. Rice

Seven (7) rice varieties have been submitted to the NVRC. These varieties include; NARO Rice 1 also known as Kafu (Code PR 107), NARO Rice 2 also known as TOCI (Code MET 12), NARO Rice 3 also known as Ayago (Code AGRA 55), and NARO Rice 4, also known as Oraa (Code ARU 1189), NARO Rice 5 also known as Achomai (Code IR 1052). The fol-

lowing varieties were released: Arize Gold 644, and Chiga-1. The developed varieties have a yield potential ranging from 4.9- 6.5 tons/ha.

Their key attributes include; maturing within 95-135 days with a good aromatic taste, texture that extends and soft on cooking, and non-pasty preferred by the majority of women. Unlike existing varieties, all the new varieties are aromatic and yield more by 1 tonne per hectare. All these varieties are resistant to Rice Yellow Mottle Virus, Rice Blast, and Bacterial Leaf Streak.

These varieties will be most beneficial to farmers within the low land areas in Uganda. Figures 1- 4 show different rice varieties with their special attributes.



*Figure 1 Code name: PR107, another name Kafu*

#### Special attributes

Plant height: Culm length, very short (52), Flag leaf: large, short, attitude, erect Leaf:



Collar color- light green; Color ACYN: light gold internodes: Grain: awnless, color straw colored grains, size grains 35grams/1000grains slightly bigger than the preferred SUPA V88Milled grain: white, short. Milling: Milling % (64), Whole grain (84), Quality: Amylose content (21.6), Alkali spreading value (5.9), Gel consistency (63 mm).



Figure 2: NARORICE 2, MET 12, another name TOCI

### Special attributes

**Plant height:** Culm length, short (73), **Flag leaf:** Col- lar color, large, short, attitude, semi-erect leaf: collar color-green; Ligule color: Yellowish green. **Color ACYN:** light gold internodes. **Grain:** awned, col- or straw color with purple tip, size Long big grains lines SUPA V88, Milled grain: white, short, milling: Milling % (64), Whole grain (83), Quality: Amylose content (20.1), Alkali spreading value (7.1), Gel consistency (65 mm).



Figure 3: NARORICE-3, AGRA 55, other names Ayago

### Special attributes

**Plant height:** Culm length, short (76), **Flag leaf:** large, short, attitude, semi-erect Leaf: collar color-green; Ligule color: Yellowish green; Color ACYN: light gold internodes. Grain: awnless, color straw-colored grains, size slender like Basmati, grain tip purple.

**Milled grain:** white, short; Milling: Milling % (62), Whole grain (83), Quality: Amylose content (22).



Figure 4: NARO RICE 4 ARU 1189, ORAA

### Special attributes

**Plant height:** Culm length, very short (54), **Flag leaf:** large, short, attitude, semi-erect.

**Leaf:** collar color-green; Ligule color: Light Purple;

**Color ACYN:** green internodes: basal leaf sheath has purple lines; Purple leaf margins;

**Grain:** awnless, color Golden, medium grains lines KOMBOKA, Lemma: coloration of keel tip (Purple tip). Milled grain: white, short; Milling: Milling % (68), Whole grain (81), **Quality:** Amylose content (23.1), Alkali spreading value (6.9), Gel consistency (66 mm)

Relatedly, NARORICE-5, Code IR1052 (Achomai), has the following attributes; Early Maturity: 130 Days after Planting, 50% flowering: early (105 Days after Planting, Yield: 6,400 tons/ha, Culm length: 54cm, Plant height: Culm length, very short (54 cm),

overall height. Panicle type: Panicle exertion. Flag leaf: large, short, attitude, semi-erect Leaf: collar color-green; Ligule color: Yellowish green Color of internodes no ACYN underlying: light gold Grain: awnless, lemma color straw, size long big grains lines SUPA V88, Milled grain: white, short Milling: Milling % (65), Whole grain (85), Quality: Amylose content (21.8), Alkali spreading value (7.2), Gel consistency (65 mm). Taste: Highly Aromatic. Texture: extends, soft on cooking, non-pasty. Resistance to: RYMV, Rice blast, and BLS

## ii. Maize

Four (4) Drought Tolerant Maize Varieties with yield potential averaging 8.5 tonnes per hectare have been submitted for release.

These are; ADV2309W, ADV2310W, UH5961, and UH 5962. The varieties were developed to respond to biotic and abiotic stress, increase in the seed sector competitiveness for both regional and domestic market demand for exclusive variety promotion in addition to enhancing on-farm grains.

The ADV239W and ADV2310W (Figure 5) are tolerant to foliar disease of Grey Leaf Spot (GLS), Maize Lethal Necrosis Disease (MSN), Turicum, and common rust disease. The special attributes for ADV2309W and ADV2310W include 110-130 days to maturity and yield 6-8 t/ha, while the UH5961 and UH5962 (Figure 6) are bred for mid-altitude DT with a maturity period of 120-130 days and yields of 7-8t/ha. In maize farming, women and youth are more involved in weeding and harvesting.

These early maturing varieties will require less weeding time hence giving women and youth more time to household activities.



Figure 5: ADV 2309W and ADV2310W Varieties



Figure 6: UH5961 and UH5962 Varieties

## iii. Sorghum

Two candidate sorghum varieties were submitted to the NVRC. The released NARO sorghum hybrids varieties are; PAC 501 and PAC 537. The special attributes of Variety PAC 537 are; medium maturing 110-120 days, high yield potential of 3200-3500kg/ha, tolerant to shoot fly and stem borer, tolerant drought, and lodging. Six (6) low tannin sorghum lines are under NPT (other key traits are; Striga and stem borer resistant, tolerant to drought). Women prefer the low tannin sorghum for food and the shorter plant height makes it easy to harvest by all.





Figure 1: Sorghum Variety (PAC537)

Medium maturity (120 days)  
Less waxy glume cover  
Leaf angle is 45 degrees  
Compact elliptical panicle  
Shorter plant height (160-170 cm)  
Light yellow leaf midrib Less thick stem



Figure 2: Sorghum Variety (PAC501)

Early maturity (100-110days)  
Waxier glume cover  
Greater than 45 degrees  
Semi compact inverted pyramidal panicle.  
Plant height (190-200) cm  
Slivery white mid rib

#### iv. Vegetables

Vegetables are important sources of many nutrients necessary for the growth and development of chil-

dren as well as expectant mothers. These nutrients include potassium, folic acid, Vitamins A and C. To increase production levels of vegetables, NARO has submitted for release twelve (12) vegetables. These comprise of two varieties of each namely; tomatoes, eggplants, cabbage, Kale, cucumber, and Chinese cabbage, and high yielding of the varieties.



Figure 9: Pink Top and Ten Ten tomato varieties.

The Kale varieties of matjang and jelguijok are high-yielding with more leaves on the plant, soft with a palatable test and they do not flower during the hot weather.

Two eggplant varieties have been submitted for release (Miggeuni and Heukmi). Miggeuni is highly tolerant to the bacterial wilt and fusarium crown rot and long fruit size. Heukmi is highly resistant to bacterial wilt and fusarium crown rot and big fruit size.

Onnuri and Hogirl cabbage varieties were also released. They have a longer duration before bursting



can take place as compared to Baraka F1 and Queen F1. Onnuri and Hogirl are tolerant to soft rot and downy mildew as compared to the existing varieties.

Additionally, the Chinese cabbage varieties, Bualm-3ho and Noranja on average are high yielding 1.1 to 6.2 kgs and 0.9 to 5.8 kgs respectively. Generally, Noranja and Bulam3ho varieties have less disease infection as compared to local varieties. Noranja is more resistant to Diamond back moth.

Cucumber varieties - Gangryuk-samcheok and Sinbi-nakhap - were also released. Their special attributes include; resistance to cucumber mosaic virus, resistance to powdery mildew, fruit yield tonnage for Gangryuk-samcheok and Sinbi-nakhap is 21.4 t/ha and 9.6 t/ha respectively.

**Potatoes:** The crop is considered both a staple food and main source of income. In Uganda, it is a food security crop and is grown in the highland areas of South Western districts of Kabale and Kisoro as well as the mountain slopes in eastern Uganda in parts of Mbale and Sebei region. The supply of potato from farmers in south western region contributes 60% and those in Eastern highlands of Uganda contributing 40%. NARO presented two varieties to the variety release committee this FY 2019/2020. These are



Marketable yield is 27 tons/ha  
 Better crisping properties than 20151.5 and NAROPOT 4  
 Resistant to late blight  
 Has dry matter content of 21  
 Reducing sugar 10mg/g



Marketable yield is 37 tons/ha  
 Better crisping than NAROPOT 4  
 Resistant to late blight  
 Has dry matter content of 24  
 Reducing sugar 8.5mg/g



Marketable yield is 25 tons/ha  
 Good for crisping  
 Resistant to late blight  
 Has dry matter content of 23  
 Reducing sugar 7.2 mg/g

### v. Tea research

Tea research and development activities focused on identifying high-quality specialty tea clones for commercialization, tea agroforestry, and climate and landscape smart tea practices.

A total of 140 tea accessions at Rwebitaba Tea Research Centre were analysed and characterized using eight biochemical markers that included polyphenols, catechins flavonoids, fermentation rate,

crude fiber, caffeine, colour, and brightness. Based on the high fermentation rate and polyphenol content, 14 tea clones were found superior for black tea, and thus potential candidates for commercialisation. Further evaluation of these clones for agronomic and resistance traits, is ongoing.

To understand the contribution of agroforestry trees in tea farming, a survey was conducted in tea-growing areas of Kabarole and Kyenjojo.

The results revealed a need for increased adaption of agroforestry trees in tea farming as one of the major promising climate-smart practices contributing significantly to the sequestration of greenhouse gases. Furthermore, NARO in collaboration with its partners, especially Solidaridad, Rainforest Alliance, and Smallholder Tea estate factories developed a Manual on Tea Climate and Landscape Smart Tea Practices for Uganda. The manual will support sustainable climate and landscape smart practices for tea production in Uganda.

NARO also built the capacity of 250 key tea stakeholders in sustainable tea production.



*Intercropping of tea with trees.*

## vi. Banana

NARO is increasing banana productivity in Uganda and contributing to banana production in the region. Banana program led the IITA, Tanzanian and Ugandan Agronomy teams to achieve key successes after executing good agronomic interventions where overall banana productivity was increased from below 10 to an average 19 ton/ha/yr. for participating farmers [Fig 1].

There was a phenomenal increase in the proportion of farmers who attained yields of 25t/h/yr., shifting from 2.7% in 2017 to 35% farmers in 2020. By 2020, farmers producing between below 5 t/h/yr reduced from 26% and completely disappeared. The observed increase in productivity and the shift recorded in performance levels of farmers was supported by improving the implementation of existing management practices, incorporation of NARO's improved hybrids and inorganic fertilisers for soil nutrition in a novel stepwise intensification pathway [Fig X]. For Soil nutrition, a fertilizer optimization decision support tool was developed and promotion plots were established in Tanzania and Uganda with a reach of up to 330 farmers.

### 3.1.2 Bio-technology

Biotechnology research focused on addressing the challenge of nutrition deficiency in bananas and devastating diseases in cassava namely: Cassava Brown Streak Disease (CBSD) and Cassava Mosaic Disease



(CMD). Under banana research, two biotechnology research products: Hybrid M9 [Kabana 5] and Nakitembe, enhanced with pro-vitamin A [pVA], were approved by National Biosafety Committee. The two varieties have further been advanced to four multi-locational confined field evaluation trials representing banana agroecological zones in Buginyanya, Mbarara, Bulindi, and Kawanda.

In addition, evaluation of transgenic cassava plants with genes for enhanced ammonia and nitrogen dioxide uptake is also ongoing and so far, at least five (5) cassava varieties have been evaluated. Trials for validation of resistance to Cassava Brown Streak Virus established in Namulonge showcase promising results of GMO cassava plants are tolerant to CBSD (details - Figures 11 and 12) and Serere. Advanced Yield Trials were established in four (4) locations (Namulonge, Tororo, Serere, and Arua) with 32 clones (22 white and 10 yellow-fleshed).



Figure 4: Top GMO Cassava plants with no CBSD Symptoms, Bottom: Non-GMO cassava plants showing CBSD symptoms



Figure 5: Clean storage roots of GMO cassava plants with no CBSD symptoms, compared to heavily diseased roots of Non-GMO

Also, advances were made on the GM potato against late blight resistance by using 3R genes extracted from wild relatives of the potato. The transgenic potato lines have consistently shown field resis-



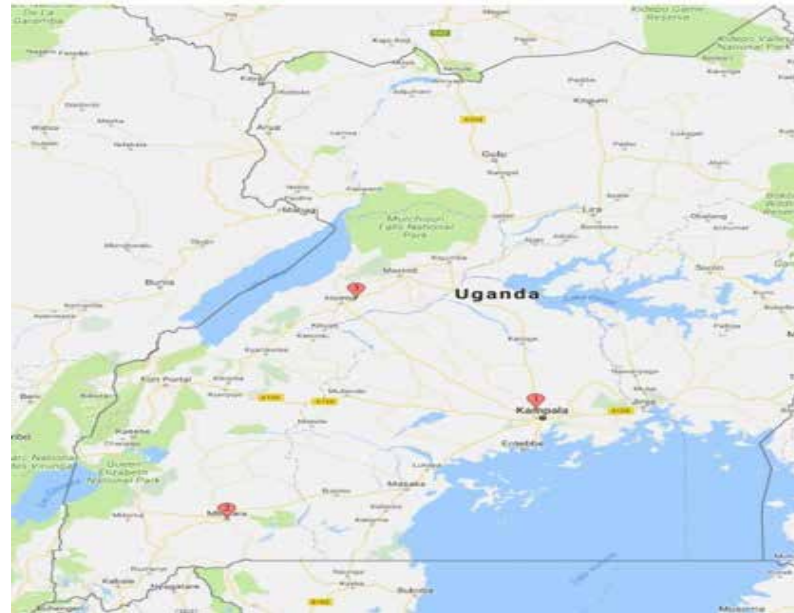
tance to late blight. One-line vic.172 has been tested under confinement in multi-locational trials at Kachwekano, Rwebitaba, and Buginyanya, and currently data collection for the regulatory phase are ongoing.

**Biotechnology products for pest and disease resistance:** In biotechnology, the banana program advanced the previously developed transgenic bananas with genes of resistance to banana weevils, nematodes, and banana bacterial wilt [BXW] to confined field trails for the critical stage of proving the concept of transgenic resistance. The National Biosafety Committee of MoSTI and Inspector of MAAIF commissioned the planting of the fifth confined field trail for transgenic bananas at NARL-Kawanda.

### Biotechnology products with enhanced PVA

NARO uses Bio fortification as one of the tools to alleviate micronutrient deficiency targeting vitamin A deficiency to contribute to a healthy and productive population to foster national development. In collaboration with partners, the banana program has been developing pro-vitamin A enriched cooking bananas to alleviate the problem of vitamin A deficiency (VAD), a silent killer, because people suffering from VAD usually experience night blindness which eventually progresses into preventable permanent blindness. Individuals with VAD are at higher risks of contracting many tropical infectious diseases due to poor immunity. As a result, VAD kills more people than HIV, malaria, and tuberculosis combined.

In 2019-2020, the Banana program progressed previously developed transgenic Matooke bananas, Hybrid M9, and Nakitembe with genes that enhance the production of pro vitamin A [pVA]. Twelve [12] transgenic lines were multiplied and 5600 plants were planted in confined field trails at four multilocation sites in Kawanda, Mbarara, Bulindi in Hoima district, and Buginyanya in Bulambuli district.



Selected sites for multi-location confined field trials: Kawanda (1), Mbarara (2), Bulindi (3), and Buginyanya (4).



A group photo of the banana team and partners at the planting of the M9 trial in Bulindi in September 2019.



**Stakeholder engagement in communities that host the transgenic bananas with enhanced PVA at Mbarara site in November 2019**

## 1. 2.2 Livestock sub-sector

During the FY 2019/20 livestock research in NARO focused on vaccine development, forage seed and feed production, maintenance of elite livestock herds, and relocation and operationalization of Nakyesasa and Maruzi campuses. The approach is from production to product support by circular research interventions.

### 1. 2.2.1 Vaccine Research and Development

NARO has constituted a Vaccinology Research program at NaLIRRI under which all vaccine research and development is being undertaken. The team has embarked on developing three vaccine products (Anti-tick, FMD, and ASF vaccines research). Developing livestock vaccines will enhance food and nutrition security, household incomes, and household insurance. Ticks are the most economically important livestock pests, which affect livestock health. The death of an animal affects the stability of a household. Hence, women are safe and secure where their animals are healthy. Key achievements are as follows: -

### 2. 2.2.2 Development of anti-tick vaccines

Four candidate anti-tick vaccine candidates namely *Rhipicephalus appendiculatus* (NARO-RA), *Amblyomma variegatum* (NARO-AV), *Rhipicephalus decoloratus* (NARO-RD), and a *cocktail vaccine* (NARO-CV) were formulated and evaluated on 50 experimental cattle comprising of indigenous and Friesian crosses in an on-station evaluation trial at Nakyesasa. The cross-protective efficacy of NARO-RA, NARO-AV, NARO-RD, and NARO-CV vaccines against the three ticks (The brown ear tick, blue tick, and bont tick) was 88, 88, 50 and 63% respectively. Overall, the mean cross-protective efficacy for all the vaccine candidates was 75%. Other than NARO-CV, all the other vaccines performed better than the only commercial anti-tick vaccine whose efficacy against cattle tick species (*Boophilus microplus*) is 50%. It is worth noting that the latter vaccine is the only commercial anti-tick vaccine in the whole world currently used to control cattle ticks in Cuba. The two NARO vaccines namely NARO-RA and NARO-AV that demonstrated high efficacy levels against native tick species in Uganda present an exciting possibility for sustainable control and management of tick burdens in Uganda's livestock sector. The results of the study were synthesized into a high-profile manuscript, which was submitted to the world's leading journal in vaccinomics called "Vaccines" with Impact Factor 4.76. The manuscript has been reviewed and the authors have been asked to address minor comments prior to publication.

### 3. 2.2.3 Foot and mouth disease vaccine development:

Efforts towards the development of a Foot and Mouth Disease (FMD) vaccine during the FY 2019/20 focused on institutional capacity building for serotyping native FMD virus strains through the acquisition of an Antigen Elisa Fast IZLER Kit capable of serotyping the circulating FMD virus serotypes in one day. NARO acquired serotype-specific primer sets for serotyping four different serotypes (O, A, SAT1, and SAT2.). A total of 42 suspected FMD field sam-

ples were screened and serotyped, and the results showed that O and A were the circulating FMD virus strains in three sampled regions of Uganda. Also, a reliable virus repository (pathogen bank) capable to maintain pathogens at negative 80°C to enable long-term storage of different viruses and pathogens has been established. In addition, NARO has established a National FMD vaccine evaluation platform to support the country in the evaluation of imported FMD vaccines before they are used in the country. Connectedly, the imported Foot and mouth disease Vaccines from Kenya and Botswana are being evaluated on station at Nakyesasa to guide Government on their effectiveness in the Ugandan environment.

#### 4. 2.2.4 Development of soft tick colony:

As a step towards developing efficacious vaccines against ASF virus of genotype X, NARO has developed the first-ever soft tick colony in Uganda. The soft ticks, collected from Western Uganda, are the primary reservoirs of the ASF virus from warthogs and are suspected to maintain ASF outbreaks from the wild to the domestic pigs. The ticks are being multiplied and carefully prepared for isolation of circulating ASF virus strains in Uganda. In addition, NARO scientists collected viruses from an active outbreak from Eastern Uganda and these are currently being studied for the development of the most common genotype IX ASF.

#### 5. 2.2.5 Improve tick control

NARO has provided information to dairy farmers about the choice of method used in chemical acaricide application for more effective control of ticks and tick-borne diseases. At an average herd size of 80 head of cattle, a farmer has to either invest US\$ 107.7 million (US\$ 28,710) in a motorised pump, US\$ 145.1 million (US\$ 38,695) in a spray race, or US\$ 266.4 million (US\$ 71,040) in a bucket pump every 20 years. However, for more cost-effective use of each of these methods, a farmer with a herd size of 40 - 112 should use a bucket pump, a motorised pump if the herd size is 35 - 170, or a spray race for a farm keeping 100 - 600 head of cattle.

#### 6. 2.2.6 Forage improvement and conservation

Livestock forages are very important in households practicing zero grazing. They are also known as primary boosters of milk production. Women, mothers, children, the elderly, and the sick are the prime beneficiaries of milk and milk products. In the effort to develop high-yielding, drought-resilient, and highly nutritious forage varieties for livestock, NARO has established a vibrant forage improvement program. In the FY 2019/2020, NARO has developed four Lablab candidate lines namely NAROLAB-1, NAROLAB-2, NAROLAB-3, and NAROLAB-4 with high levels of crude protein amounting to 31, 28.6, 28.2, and 27.7% respectively as compared to commercial lablab variety (Rongai variety) with a crude protein content of 24.5%. The candidate lines are currently under multi-locational trials in preparation for official release by the national variety release committee. As regards to the conservation of native and exotic forage and pasture germplasm, NARO continues to maintain and conserve over 300 species of native fodder grasses, pasture grasses, herbaceous forage legumes, and fodder tree species to safe guard against genetic erosion of indigenous germplasm. Current efforts are underway to assemble, characterize and evaluate over 1000 lines of forage germplasm in East and Southern Africa for food and feed.

#### 7. 2.2.7 Forage seed production and feed preservation

To address the challenge of scarcity of livestock feed, NARO continues to be the leading producer of forage seed and conserved feed in the country. In the FY 2019/2020, NARO produced over 315 Metric tonnes (MT) of hay and silage that was availed to farmers across the country to address the challenge of dry season feed scarcity. NARO has also supported farmers with feed conservation equipment at a cost-recovery basis to enable mechanised hay and silage production on over 500 acres resulting in the production of over 10,000 tons of conserved feed notably silage. As regards forage seed production, NARO continues to be the leading producer of elite forage/pasture seed



to address the national forage seed demands. During FY 2019/2020, NARO produced over 2 metric tons of foundation seed for *Chloris gayana* that was availed to farmers to rehabilitate over 300 acres of degraded pasture in the cattle corridor of Uganda notably in Nakasongola, Nakaseke, Masindi, Kiruhura, Koboga, Kyankwanzi, Mbarara, Sembabule and Karamoja region.

### Centrosema pubescens staked on bamboo stakes



*Chairperson NARO Governing council together with Parliamentary committee on trade at Nakyesasa looking at pasture conservation section*

### Genetic improvement and conservation of

### indigenous cattle and goat breeds

Desirous to enhance the productivity of native livestock breeds coupled with the need to safeguard against genetic erosion, NARO has continued to improve and conserve indigenous cattle breeds notably Ankole cattle mainly at MbaZARDI, Small East African Zebu at Serere, and Nganda cattle at Kamenyamigo.

NARO has continued to facilitate community-led goat improvement schemes in Hoima, Nakapiripiri, Napak, and Masindi Districts to select elite Mubede and Small East African indigenous goat breeds. The intervention focuses on systematically, identifying and selecting elite young male goats and use them for breeding within the goat farming communities in the above districts. During the financial year 2019/2020, a total of 16 and 18 elite breeding bucks were selected and exchanged among members of breeding groups in Kyabigambire and Buseruka sub-counties respectively. The breeding objective is to improve body weight at six months from 10 kg to 18 kg, and twinning ability from 30 to 50 %. During financial 2019/2020, the intervention results in elite goats with 15kg at six months. Consequently, the participating farmers were able to sell 136 elite breeding animals at 300,000/= each compared to the 100,000- 150,000/= they used to sell at the local market before the intervention.



*Participatory buck selection*



*Hoima Enumerator with breeding stock sold by the CBBP members*

## 8. 2.2.8 Evaluation of exotic dairy breeds in Uganda conditions

Desirous to guide the country on the best dairy breed under Ugandan conditions, NARO introduced the Viking Jersey dairy breed. During the FY 2019/20, NARO has evaluated the performance of Viking Jersey calves under intensive production systems. The results of the study revealed that the average daily weight gains of the calves during the pre-weaning phase ranged from 392.9 g/day to 654.8 g/day with an average of 532.6 g/day. During the post-weaning phase, the mean daily weight gain for all calves was 450 g/day. Because Jersey is a small animal with a mature live weight of about 320kg, results on growth performance revealed that the calves reached 60% of the mature live weight (210kg) in 16 months. Attaining 60% of mature live weight implies that the animal has attained sexual maturity and has reached mating weight. Therefore, as compared to other exotic dairy breeds like the Friesians and Ayrshire that attain mating weight in 24 months, Jersey can be mated between 14 and 16 months. NARO will continue evaluating the performance of the breed in various parameters including feed utilisation efficiency, biogas production potential, adaptability, and disease tolerance among others.



*Viking Jersey at Nakyesasa*

## 9. 2.2.9 Relocation and Operationalization of NaLIRRI at Nakyesasa and Maruzi

NARO has continued to transfer NaLIRRI to Nakyesasa (Wakiso district) and Maruzi (Apac district)



campuses following the establishment of a phosphate fertilizer production complex at Tororo where NaLIRRI was housed. During the FY 2019/20, NARO has made significant progress towards acquiring a land title for 10 square miles of Maruzi ranch. The title has been processed and awaits transfer into NARO's name. To strengthen capacity for large scale mechanised feed and forage production to address the feed scarcity challenge in the country particularly during drought, NARO has established an implement and machinery workshop equipped among others with two tractors, hay baler, forage choppers, planter, boom sprayer and ploughing implements at Maruzi. To sustain availability and supply of quality forage/pasture seed and conserved feed resources notably hay and haylage to livestock farmers in Uganda, NARO established and maintained over 500 acres of forage production fields for different forages including *chloris gayana*, fodder maize, lablab, Brachiaria and Alfalfa among others at Maruzi and Nakyesasa resulting in production of 315 tons of conserved feed resources and over 2 metric tons of forage foundation seed.



Baled hay for livestock feed during the dry season prepared by NARO Livestock Resources Research institute

## 10. 2.2.10 Stingless bee research

NARO is increasing the potential of stingless bees in Uganda towards improved pollination, medicine, and ecology. So far, four (4) stingless bee species have been identified (*Meliponula bocandei*, *M. ferruginea*, *M. nebulata*, and *Plebeina hilderbrandtii*). *M. bocandei* and

*M. ferruginea* so far exhibit potential for commercial value and are under evaluation. Two stingless beehive prototypes (NAROSBH 1 & NAROSBH 7) have been developed and are being tested for the domestication of *M. bocandei*, *M. ferruginea*, and *P. hilderbrandtii*. Three novel and high-value stingless bee products (honey, pollen, and propolis) for use in the food and pharmaceutical industries have been developed and are being profiled physio-chemical properties.

## 11. 2.2.11 Rangeland improvement

NARO has demonstrated that rangelands can be improved and enhanced to reduce drought-related constraints, reduce livestock migration, and boost household dry season feeding in the Karamoja sub-region. In this effort, NARO rehabilitated 85 acres of degraded pasture and established 35 acres of improved drought-tolerant dry fodder banks in Nakapiripirit, Nabilatuk, and Moroto districts. Rehabilitation of degraded pastures involved removal of unpalatable species, the introduction of improved grass and legume species namely *Chloris Guyana*, *Cenchrus Ciliaris*, *Centrosema pubescens*, and *Glycine max*. In addition, there was the conservation of the improved pastures during the wet season and controlled rational grazing of the rehabilitated fields during the dry season that October – April with a peak between January to March. Results obtained indicated that the biomass dry matter weight of rehabilitated sites was six (6) times that of non-rehabilitated sites. The total area under pastures rehabilitated (115 acres) could sustain 300 livestock units of 250 Kg for during the peak period of the dry spell of 95 days. Besides, fodder production from 47 acres could sustain 300 livestock units for 101 days without migrating. This implies that by rehabilitating and implementing protective grazing on one (1) square mile, pastoral communities raising 3,000 to 8,000 livestock units per kraal can retain 1500 livestock units without migration. This would save kraals average losses due to mortality of 15 percent of the herd during migration valued at not less than shillings 225,000,000 per annum per kraal. Five (5) Beneficiary committees of nine (9) members each comprising of kraal lead-



ers, local council leaders, elders, representatives of livestock owners, herdsmen leaders, land owner/host farmers, women and youth mobilisers, animal health workers, Village Health Teams (VHTs) and community demonstration site attendants have been established, skilled and tasked to ensure post-project sustainability in all project sites.

## 2. 2.3 Fisheries Sub-sector

The objective of agricultural research is to promote agriculture and related industry to contribute to the improvement of the quality of life and livelihoods of the people having regard to the protection of the environment and support the development and implementation of national policy with relevant information and knowledge.

### 1. 2.3.1 Accessing the Improved Nile Tilapia Seed

NARO received reports of slow growth rates of farmed fish reported by many farmers in the Country. Through a selective breeding programme at NAFIRRI, Kajansi, NARO improved the Nile tilapia growth rates to an average of 2.47g/day from 0.52g/day. The improved and fast-growing Nile tilapia strain was multiplied and accessed by fish farmers (108,688 quality fish seed and 1,340 broodstock (100g to 400g). The Nile tilapia seed together with about 30,415 African Catfish fingerlings were supplied to six (06) fish seed multipliers and 136 farmers in 29 districts of Uganda and within the region (Kenya, Rwanda, Tanzania, and DR Congo). Farmers were also equipped with the best management practices to ensure quality production of both outgrow and seed.

To further support seed multiplication and brood stock rearing, NAFIRRI facilities have been renovated, and the improvement at ARDC has increased the annual production capacity of fish seed (catfish and Tilapia) from 2 (two) to 16 (sixteen) million. The facilities include; renovation of an indoor ADB tilapia hatchery under a recirculation aquaculture system, eight (08) outdoor brood stock earthen ponds, and six (06) concrete tanks for nursing African catfish

fry. The seed multiplication and brood stock rearing have been strengthened with an additional two thousand Nile tilapia (2000) brood stock were collected from Lake Victoria and Lake Albert and acclimatized on-station to enhance the selective breeding programme of the species.



**Quality African catfish fingerlings (2-3 g) produced at NaFIRRI- KARDC ready for dispatch to fish seed multipliers and farmers**



**Plastic bags for packaging fingerlings for fish farmers**

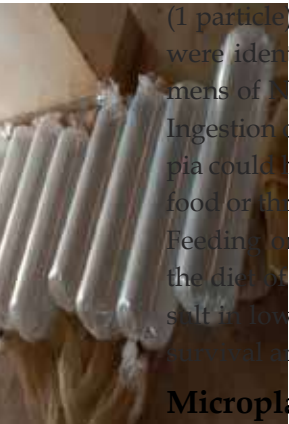
### 2.3.2 The increasing presence and risks of micro plastic pollution

NARO in the previous Annual Report 2018-2019 reported the growing presence of micro plastics on Lake Victoria. The abundance, diversity, and type of plastics in sediment and water in other parts of the Lake are being established to aid planning and mitigation measures for plastic pollution to conserve the Lake Victoria fishery. In addition, distribution maps of hotspots of micro plastic occurrence and diversity in sediment and water of Lake Victoria have been produced.

#### **Microplastic pollution in Lake Victoria and impact on fish**

It is known that plastic wastes stay for hundreds of years in the environment. During such a period of their stay, large-sized plastics fragment into many smaller plastics referred to as microplastics (less than 5 mm in size). Concentrations of microplastics in sur-

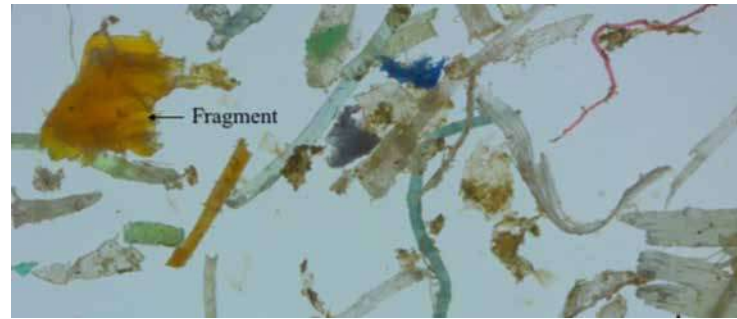
face water of the lake in areas of Bwondha (Mayuge district), Masese (Jinja district), Gaba (Kampala), Kasenyi (Wakiso), Ddimbo (Masaka), and Kasensero (Rakai) fish landing sites, as well as in the offshore pelagic waters of the lake were determined. A total of 166 fish belonging to six genera were examined (Table 1). Four microplastic particles coloured blue (1 particle), green (2 particles), and black (1 particle) were identified in the stomachs of three fish specimens of Nile tilapia, comprising 1.8% of all the fish. Ingestion of such coloured microplastics by Nile tilapia could have been a result of fish perceiving it as its food or through accidental intake via ingested water. Feeding on microplastic debris by fish implies that the diet of fish will be less nutritious, which may result in low energy intake consequently affecting the survival and reproduction of fish.



**Microplastic abundance in surface waters of the lake**

**ags packed with Nile tilapia fin-  
at NaFIRRI ready for dispatch to  
ers**

Microplastics were widely distributed in the surface water of the lake and occurred in varying quantities, sizes, and colours (Figure 1), with all water samples collected containing microplastics. The quantities in near-shore areas far exceeded that observed in the offshore pelagic waters (Figure 2). Microplastic abundance was in the range of 2,834 to 329,167 particles per square kilometer in near shore areas and 1,488 to 19,248 particles per square kilometers in the offshore pelagic waters of the lake. The abundance of microplastics was highest in areas of the lake surrounded by urban areas with intensive human activities. In these areas, micro plastic abundance was in the range of 103,333–329,167 particles per square kilometer. In addition, areas of the lake influenced by rivers Kagera and Katonga presented lower abundance (2,834 to 20,840 particles per square kilometers). In the nears shore areas of the lake, 36% of the microplastics were of the size less than 1 mm while in the offshore pelagic water, 79.4% were of the size less than 1 mm. These small and coloured microplastics are of the size similar to that of the small organisms such as algae, invertebrates, and plant debris utilised as food by wild fish in the lake.



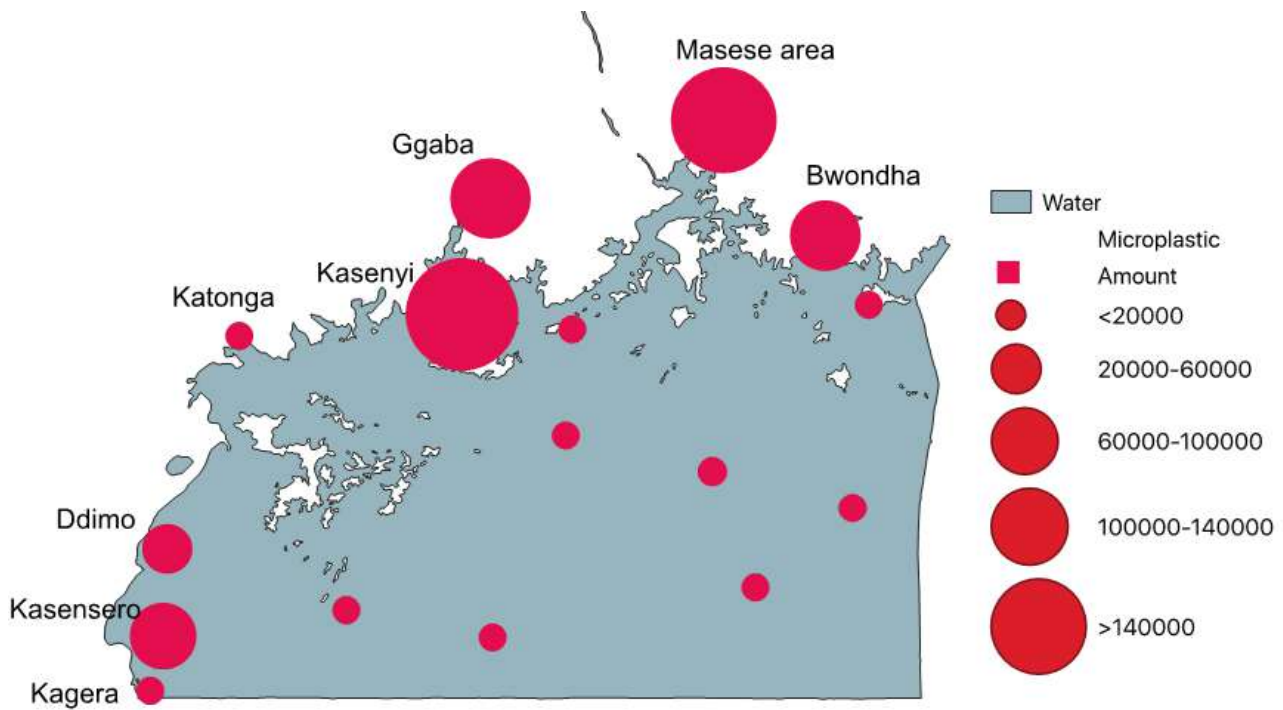
Sample photograph of microplastic filtered from surface water. Photo was taken under a microscope.

**Micro plastic ingested by fish**

Table 1. Species, number, size, weight of individuals, and percent occurrence of microplastics in fish gut examined for fish from Lake Victoria.

Fish species	Common name	site	No of fish	TL/FL (cm)
<i>Oreochromis niloticus</i>	Nile tilapia	Entebbe	15	19-35
		Gaba	22	15-20
		Masese	7	16-17
<i>Lates niloticus</i>	Nile perch	Entebbe	8	35-47
		Masese	103	10-45
<i>Coptodon zilli</i>	Redbelly tilapia	Entebbe	1	29
		Masese	1	20
<i>Mormyrus kannume</i>	Elephant snout fish	Masese	2	26-28
<i>Brycinus nurse</i>	African tetras	Masese	3	17-18
<i>Synodontis sp.</i>	Squeakers	Masese	4	11-15

TL- Total Length, FL- Fork Length



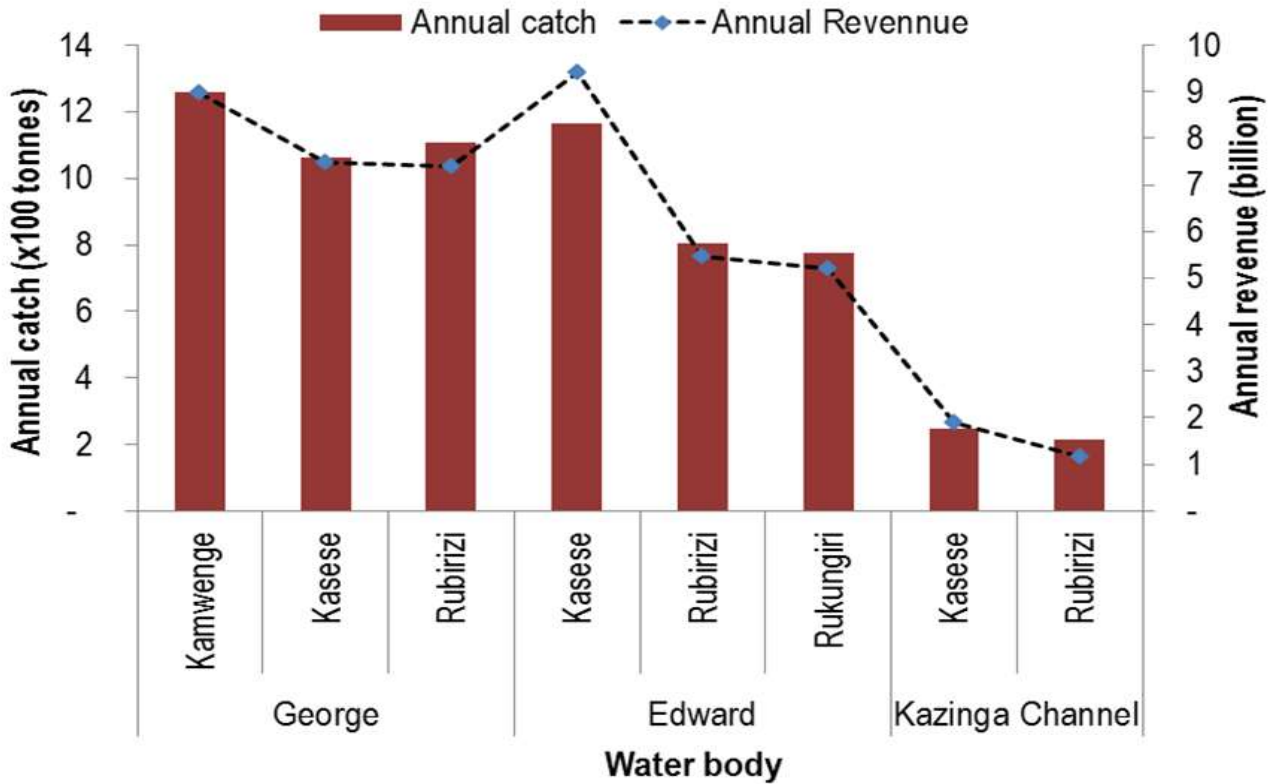
Map of Lake Victoria showing amount (measured as number of plastic particles per square km) and distribution of microplastic.

## 2. 2.3.3 Monitoring fish stocks in the Minor lakes of Western Uganda

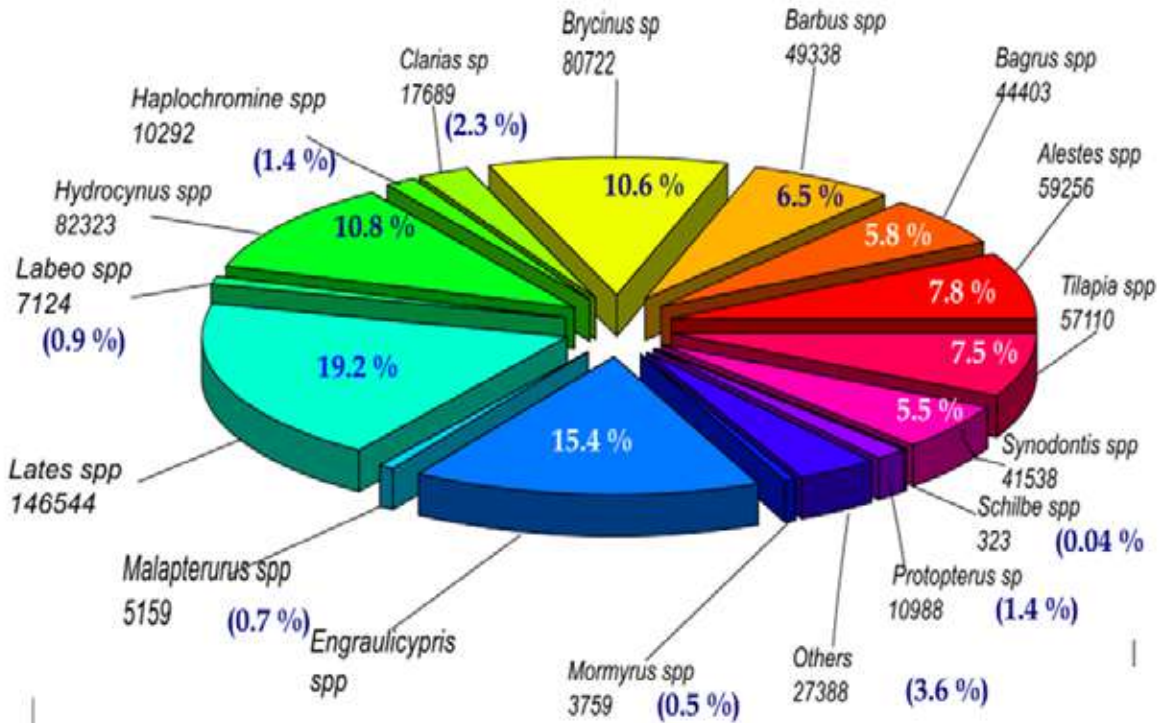
### Monitoring fish stocks in lakes Albert, Edward, George and the Kazinga Channel

Monitoring fish stocks in relation to species composition, abundances, distribution, catch, and fishing effort is required for sound management of the fish resource. Catch Assessment Surveys (CASs) in particular are important tools for monitoring trends in the fish catches and exploitation patterns to inform development planning and management decisions for improving the fisheries sub-sector. Catch Assessment Surveys conducted in August 2019 estimated the annual fish production and economic value of fish catch at 335,000 tonnes (t) and 700 billion (bn) for Lake Albert and 6,630 t and ~ 47 bn for lakes Edward, George, and the Kazinga Channel. While the small species; *Engraulicypris nurse* (Muziri) and *Brycinus nurse* (Ragooge) dominated the annual catch on Lake Albert by ~ 60%, their contribution to the annual economic revenue remained low due to high post-harvest losses estimate at 40%. This resulted mainly from inadequate and inappropriate post-harvest handling facilities, thus the need to prioritize innovations for processing and handling the small fish species to promote them for human consumption rather than their current predominant use as animal feed.





Comparison of annual catch (tonnes) and value of catch (bn Uganda shillings) for lakes Edward, George, and Kazinga Channel in 2019 presented by District





participated in the action research. Integration of Calliandra on farms also improves soil fertility and reduces overdependence on natural forests for firewood.

#### 2.4.2 Eliminating bronze bug and Red Lerp Psyllid in eucalyptus plantations.

Biological agents (4,650 *Cleruchoides nockae* and 2,000 *Psyllaephagus bliteus*) bred on station and released against bronze bug and Red Lerp Psyllid in the eucalyptus growing fields in Eastern and Western AEZs. The project is being implemented in Soroti, Mbale, Kumi, Hoima, Kyankwanzi, Masindi, Arua, Adjumani, and Pakwach. Field performance of *C. nockae* and *P. bliteus* bio-agents in the field rated at over 70 % effectiveness. Sampling for resistant Eucalyptus species/hybrids done in Eastern and Western AEZs. Leaf samples from susceptible and resistant Eucalyptus trees were collected for genetic identification. The biological control agents, particularly *P. bliteus* released much earlier are a success and have saved over 50,000 ha of Eucalyptus equivalent to 1.75 trillion Uganda Shillings from being wiped out.



*Eucalyptus leaves severely infested with the Bronze bug for which biological control agents were introduced.*

#### 2. 2.4.4 Forestry, Soil and Water management

A total of 550 households were supported in the use of water management technologies namely; contour grass strips, terraces, and unlined, run-off ponds for irrigation in Eastern Uganda. Significant improvement in soil health has been observed as indicated by improved crop yields. Although several technologies to address soil degradation and improve land productivity exist, adoption by farm-

ers has been slow. This has been attributed mainly to (i) the dysfunctional extension system and (ii) the weak implementation of land management policies/regulations. Innovation Platforms (IPs) have shown promise for improving stakeholder interaction, information flow, access to extension advice, collective action through by-law enforcement, and hence the potential for scaling up promising technologies. A study was conducted in eastern Uganda to improve understanding of how IPs can improve the adoption of soil and water conservation technologies in the fragile highland ecosystems. The focus of the IP was soil erosion control and the major activities included (i) Establishment of an IP commitment and training of members on critical skills required in group dynamics (ii) facilitating the formation of lower-level groups (IP clusters) to implement soil erosion control in micro-catchments (iii) capacity building on soil erosion control using contour bands stabilized with multipurpose trees (*Calliandra*, *Grevillea*) and (v) Facilitating formulation of by-laws to foster the implementation of soil erosion control and landscape-level.

A Farmer-Field School (FFS) approach was used to implement the component on capacity building on soil erosion control using one of the micro-catchments of the study area. Farmers were able to collectively established 4,000 meters of contour bands and reduced run-off and erosion significantly. From this experience, the IP has extended to implement FFS on other technologies such as fodder-bank establishment from *Calliandra* along contours bands, manure management for banana production and collective marketing of banana have been initiated. These interrelated technologies are contributing towards improving the banana value chain, which plays a significant role in the food and income security of the majority of households in the area. If institutionalized within the local context, this approach has the potential to galvanize the start-up of institutional arrangements that sustain landscape-level adoption of sustainable land management practices.





Contour bands established at landscape level in Ugobero, eastern Uganda, to control soil erosion, maintain soil fertility and water quality

### 3. 2.4.5 Tissue culture propagation for bamboo.

Forestry research has optimized a protocol for tissue culture mass micro propagation of bamboo seedlings that will eventually sustain the raw material base for the development of various value-added bamboo products. Further, over 50,000 bamboo seedlings involving two species – Giant bamboo (*Dendrocalamus giganteus*) and common bamboo (*Bambusa vulgaris*) have so far been conventionally produced in Kifu green houses. Some species of bamboo, especially the giant ones, do not root easily. Tissue culture technology improves changes of raising large quantities of such seedlings in a much shorter time.

## 4. 2.5 Agricultural engineering

### 2.5.1 NARORAMP Pump improvement

NARO developed the second prototype of ram pump (NARORAMP-2). Use of the ram pump has increased the vegetable cropping regime from 2 to 3 per year and farmers along rivers and streams can now grow vegetables and earn a living all year round. The ram pump prototype of (NARORAMP-2) with a higher discharge of 1,440 lts /hr at a delivery head of 4m in comparison to the NARORAMP -1 that has a pump discharge of 600 litres/hr. at 5.8 m head, irrigates 0.5 to 1 acre per day, and suitable for hilly areas.

#### NARORAMP-2

### Attributes



- Pump discharge: 1,440 litres/hr. at 4 m head;
- Irrigates 1 to 2 acres per day;
- Suitable for women, men, and youth
- Suitable for hilly areas especially vegetable production.

### Advantage

Operated by the energy of a water fall. No need for fuel or electricity

### Benefits

Use of the ram pump has increased vegetable cropping regimes from 2 to 3 per year and farmers along rivers and streams with small water falls can now grow vegetables and earn a living all year round.

**Note:** NARORAMP-2 is new prototype

### 2.5.2 The fish smoking kiln

NARO developed the second generation of commercial food-grade fish smoking kiln (NAROFIK-3-D4 and NAROFIK-3-D6) with a capacity of 400 to 700 Kg/day. The fish kiln processes high-quality smoked fish and has reduced cancer-causing compounds in our smoked fish from 40,000 ppb to 0.88 ppb well below the maximum limit of 2 ppb set by EU markets. This has enabled Ugandan smoked fish competitive in the export market. The expected lifespan of the entire kiln assembly is 20 years without any major repairs. After 20 years a new heat insulation system

will have to be built on the stainless-steel part of the dehydration chamber. In addition, new smoke generation and filter units are fabricated thus producing a new kiln using the same stainless-steel section of the dehydration chamber. When in operation, the kiln should be placed in a well-aerated housing structure.



*NARO PAH-Safe Fish Smoking Kiln - NAROFIK-3-D6*

### 2.5.3 Agro machinery hire enterprise (Farmer financing model, machinery hire service model, and marketing model)

NARO is promoting smallholder agricultural machinery hire service enterprises that increase access to farm machinery for farmers while creating jobs for rural people and the youth. Beneficiary/host farmers were trained on Animal traction, processing services cassava and rice, maize shelling. The farmers were trained on financial management, record keeping, and operational costs, and management involved in running such a business. To this effort, a total of 60 multi-crop planters, 27 NARO lightweight rice threshers, 23 food grade cassava chippers, 75 Ox-weeders were distributed to 63 farmer entrepreneurs in 25 sub-counties, in Acholi sub-region and Adjumani district. Furthermore, the skills of 488 (40% women) farmer entrepreneurs and equipment operators in Kitgum, Lamwo, and Agago districts was enhanced in operating equipment hire service as business and processing high-quality cassava chips and flour. 4 hire service types exist (Private Company operated, Single person owned operated, Group owned operated and Government-owned) in the districts of Amuru, Nwoya, Gulu, Omoro, Kitgum, and Lamwo. The single person ownership is the most widely used. Most hired equipment are 4 Wheel tractors, Ox-ploughs, Rice threshers, and Maize shellers.







*Training on how to operate a cassava chipper was carried out in all the 9 districts of Acholi sub-region.*

## 2.6 Value Addition

In a bid to promote agro-industrialization and create niche markets, NARO has directed part of its efforts to value the addition of different products from milk fortification, feeds formulae for cattle and fish, poultry, and two maize snacks proto-types among others.

### 2.6.1 Maize snack

Two snack prototypes of a nutrient-dense (pro-vitamin A, protein, Iron, and Zinc) Market-Smart Aro Nutro Instant Maize Snack were developed.

### 2.6.2 Maize bran-based feeds

Two (2) clay-based anti-aflatoxin formulae were designed and developed for pre-treatment of maize bran-based feeds. Treatment of maize bran with the aflatoxin binder (developed from the locally selected

minerals) reduces the aflatoxin content in the animal feeds by 80-98%, a percentage higher than any commercially available aflatoxin binder on the market. This significantly reduces the risks associated with the consumption of aflatoxins in fish and livestock products.

### 2.6.3 Livestock value addition

Milk fortification was undertaken to improve micro-nutrient status and alleviate common health problems. Development of safe and stable milk-based nutraceutical products with anti-ulcer, diabetes and cancer properties are ongoing.

In addition, plant-based pharmaceutical compounds: tannins, phenols, flavonoid, antioxidants, anthocyanin for evaluation of anti-cancer, anti-ulcer and anti-diabetic properties were extracted, bulked and constituted in milk-based products. To date, 50 plant species were screened for the availability of target biochemical compounds. 11 plants were pre-selected based on Frap values, availability in the community and ease of extraction. The 5 best plants based on the above criteria were chosen for fortification in yoghurt samples. In addition, a complete blood profiling protocol for testing in mice based on the production of antibodies and other blood parameters against the target ailments has been completed for submission to the research and ethics committee for approval.

A total of four (4) starter culture formulae for processing milk products (1 for ghee; 2 for yoghurt and 1 for probiotic yoghurt) were developed. This has improved the quality of traditionally produced products (yoghurt, butter and ghee) of at least 2 cottage industries in which about 500 women are involved in dairy product processing and marketing.

Two feed formulae for cattle (1 dairy meal and calve starter). This has improved calf growth by 17% and increased milk production by 46% where these diets are in use.

Four (4) feed formulae for poultry (2 broilers; starter



and grower; 2 layers; chick and growers), the rations produced by the use of these formulae significantly increase growth rate/weight gain and egg production

### 2.6.3 Fish value addition products

Production of value-added products (fish sausages). Received additional support to upgrade production line from 0.5 tonnes to 10 tonnes per day at Wakiso district. Prior COVID-19, produced 3 tonnes per day for local and regional markets (Kenya, DRC & Rwanda).

Live fish sales have increased from 100 kg to about 500 kg per day in Wandegeya Market. The NAFIRRI support through *MSINGI* installed a cold chain to increase sales to more than 5 tonnes per day. COVID-19 affected sales during lockdown when markets were closed.

Three Market-oriented fish products were generated (Nile perch oil for optimizing protocols for Nile perch oil production; Plant N (bio-control agent for fish pathogens); Waste water cleaning algae).

A feed mill at Kajjansi ARDC has been repaired and the production of 9 ton/week fish feeds including powder and pellets for sale to farmers is ongoing.

### 2.6.4 Value addition in Forestry – Forestry for Life and Health

A database of tree and shrub species used in diabetes treatment in Uganda was assembled and will contribute to efforts towards the development of a herbal cure for diabetes in Uganda. The disease burden of diabetes in Uganda is one of the highest in Sub-Saharan Africa, with a prevalence rate of 8% and it is estimated that about 500,000 people will be diabetic by 2025 if the interventions are not scaled up. Like any other chronic disease, management of diabetes is long term and yet the treatment is not easily affordable and accessible. As a result, most diabetic patients in Uganda primarily use herbal remedies to manage diabetes due to their alleged efficacy and

fewer side effects compared to conventional drugs. However, there is increasing concern about the toxicity of herbal remedies and concern from conservationists about the sustainability of plant species that are used in the management of diabetes in Uganda.

NaFORRI set out to identify the woody species used in the management of diabetes in the four Agricultural Ecological Zones (AEZ) of Uganda with the intent of developing an anti-diabetic drug/remedy from some of the woody species and contributing to their conservation. Reviews and ethnobotanical surveys were conducted from late 2019 to early 2020 and findings revealed that a total of 112 plant species are being used as anti-diabetics, 54 of which are woody species mostly from the Moraceae and Fabaceae families harvested mostly from the wild. The main plant parts used are bark and roots. The findings suggest that woody species play a vital role as anti-diabetics and since harvesting from wild populations is not sustainable, there is a need to propagate and domesticate most of the woody anti-diabetic species in Uganda. Plant samples of the key anti-diabetic woody species were collected and are being analysed at National Chemotherapeutics Research Laboratory for their anti-hyperglycemic potential. Pictorial of interviews conducted with Traditional Medical Practitioners in the districts Oyam, Kitgum, Apac, (Gulu, Bundibugyo and Moroto).





*Pictorial of interviews conducted with Traditional Medical Practitioners in the districts of Moroto and Apac.*



*Samples collected for chemical analysis*







## 04

## RESEARCH EXTENSION INTERFACE

### Chapter 3.1 Delivery of technologies to uptake pathways:

**3.1.1 Seed multiplication:** NARO has continued to provide breeders, foundation, basic seed, seedlings and vegetative seed materials to farmers and technology uptake pathways (farmers, farmer groups, NGOs, MSIPS, and Local Governments).

NARO produced substantial quantities of breeder (pre-basic) seed, foundation (basic) seed, seedlings and vegetative planting materials of several commodities and provided to technology uptake pathways (farmers, farmer groups, NGOs, MSIPS, Local Governments). The assorted quantities of the breeder and foundation seed of crop varieties produced in FY 2019/2020 are summaries in table 5 while that for vegetative materials and seedlings of superior varieties of crops like cassava, sweet potato, banana, potato, horticultural crops, coffee, tea, and trees is provided in table 6.

**Table 2: Breeder and Foundation seed of improved crop varieties produced by NARO in FY 2019/20**

PARI	Crop and quantity of seed (Kgs)										
		Rice	S o r - ghum	F i n - ger m i l - let					Cow- pea	S i m - sim	Soya bean
NACRRI											5,250
NASARI			125	125			50	125	100		
AbiZARDI	6,100	4,520				1,982				83	1,160
BugiZARDI	300	500			378	3,500					
MbaZARDI						3,500					400
Ngetta	2,300	1,700				480		4,610			4,963
Nabuin	6,000										
Rwebitaba		2,222				7,167					
<b>Total</b>		<b>8,942</b>	<b>125</b>	<b>125</b>	<b>378</b>		<b>50</b>	<b>4,735</b>	<b>100</b>	<b>83</b>	<b>6,523</b>

**Table 3: Vegetative planting materials and seedlings of superior varieties of different crops and tree species produced by NARO in FY 2019/20**

PARI	Crop and quantity of planting material									
	Cassa- va (Bags)	Sweet potato (Bags)	B a - nana suck- ers	Potato tubers (Kgs)	Potato seed- ling	*Cof- fee seed- ling	C o f - f e e seed (Kgs)	Tea seed- ling	*Fruit	T r e e seed- ling
NARL			200						4,000	1,000
NACORRI							1,122			
NAFORRI									15,731	
AbiZARDI	430	235		1,600						
BugiZARDI	2,500	1,200	1,200	800	7,000	50,500			350	
Bulindi	3,500	1,250	500			2,250			5,500	
KaZARDI				35,000					5320	
Mukono	50	12				17,061			1,418	1,260
Ngetta	670									2,250
Rwebitaba			1,500	6,954	21,811			30,000		
Kiige									38,000	
<b>Total</b>	<b>7,150</b>	<b>2,697</b>	<b>3,400</b>	<b>44,354</b>			<b>1,122</b>	<b>30,000</b>	<b>70,319</b>	

\* Fruit (mango, citrus, avocado, apples, guava) seedlings

\*Coffee clonally propagated plantlets of CWD-r varieties of Robusta coffee is 298, 2000 seedlings and seedlings and seed of Arabica coffee produced were 36,164 and 1,122 kg respectively.

**Livestock and fish seed were produced and distributed to various farmers:**

- Assorted seeds of 5 improved pasture varieties including NARO Napier 1, 2, 3 and Kakamega and *Brachiaria Mulato* were produced and distributed at Mbarara ZARDI
- Assorted research products including *Chloris gayana*, *Cenchrus ciliaris*; Napier stunt tolerant planting material, silage, Hay, Haylage, Viking Jersey Semen, Fleckvick Semen, forage conservation technology was produced at NALIRRI,
- Four (4) improved livestock breeds (Sahiwal crossbreed, Cambrough pigs, Toggenburg goats breed & Bovian Brown chicken produced and distributed to farmers at Nabuin ZARDI,
- 250 bags of forages, 2000 Nile tilapia fish seed, and 32 piglets were distributed at Bulindi ZARDI. 20,000 high quality tilapia fingerlings were produced and distributed to farmers at Mukono ZARDI;

Five (5) technologies on fish seed (1,000,000)/broodstock, live foods for juvenile fish (artemia, Moina and rotifers), fish feed formulations (dry rations)

**3.1.2 Technology exhibitions:** In the FY 2019/2020, NARO's strategic positioning took center stage at the national policy level, media fraternity and the agricultural sector at large. The NARO online portal is almost



ready and will be available for use in the next financial year making our relevance resonate with the new norms in the post-COVID-19 era. Other achievements registered to improve NARO Visibility were;

Five (5) high-level dialogues and strategic meetings were organized with: Parliamentary Committee on Budget (PACOB); Parliamentary Committees on Agriculture and Trade; Ministry of Public Service; Ministry of Science, Technology and Innovation; Cabinet; and Permanent Secretary and Secretary to Treasury of MoFPED,



Group Photo: NARO Management with Parliamentary Committee members at NaLIRRI.

### **South to South Forum on China Africa Cooperation**

NARO participated in the South-to-South, Forum on China-Africa Cooperation (FOCAC) meetings that focused on the relevance and input of agricultural research into sustainable food security. The forum brings together the countries that have developed solutions with countries that are seeking to apply and adapt them to their context. SSTC initiatives target three key levels of interventions: Policy Level; providing policy upstream support to policymakers, Institutional level; promoting knowledge exchange among experts and Grassroots level; supporting the work of farmers, agriculturalists and practitioners.

NARO technologies, innovations and management practices were promoted using different channels *viz.* the World Food Day event at Bulindi ZARDI; Nile Jinja Agricultural show; NRM youth event in Kololo, and Harvest Money Expo at Namboole in partnership with New Vision Group. Also, in partnership with Daily Mon-

itor held four (4) *Farm Clinics* at NaCORI, Ngetta ZARDI, BugiZARDI and MuZARDI. A total of 6,232 (42% women) beneficiaries attended. Other avenues of technology promotion included Television and Radio talk shows.

Furthermore, NARO dedicated resources towards the streamlining of its online visibility, which all stakeholders will benefit from in the next financial year as a contribution to mitigating the effects of COVID-19.

### 1.1.3 *Technology incubation*

NARO developed a one-year incubation plan to guide the establishment of the incubation function. The incubation plan 2020/2021 details key milestones to be achieved in four main phases. The first phase is focused on identifying and establishing a system for running, managing and sustaining a centralized Incubation / Innovation hub. The second phase focuses on building and equipping the central incubation hub while the third phase is focused on implementing the various incubation activities, initiatives and services. The final phase involves the extension of the incubation services through the establishment of decentralized regional incubation centers and a virtual incubation facility.

It is expected that the NARO incubation plan shall guide the Incubation function in strategically combining and designing business development processes, infrastructure and people, to nurture and transform ideas into products, processes and services suitable for the market.

### 1.1.4 *Multi-stakeholder Innovation Platforms supported*

To demystify the belief of agriculture being labour intensive and time-consuming, NARO established several mechanization platforms to empower farmers into profitable farming. Three Mother Demonstration gardens were established to work as innovation platforms for piloting mechanizations in Akera central village, Lagoro sub-county, Kitgum district; Aliwara

village, Itirikwa sub-county, Adjumani district and Laminto village, Paicho sub-county, Gulu district. Each of the mother gardens measured 8 acres. The 8 acres were divided into 30 plots each measuring 20 X 50 meters. 4 mechanization technologies (Hand hoe, Animal Draft Power (ADP), ADP-Conservation Agriculture (CA) and Two Wheel Tractor (2WT)) were demonstrated on each of the mother gardens. Maize, beans and soybean were the test crops used in technology comparative assessment.



Figure XX: *Ploughing with 2WT*



Figure XX: *Ploughing with Oxen*





Figure XX: Planting with 2WT



Figure XX: Farmers using various agro of machinery in Northern Uganda



Figure XX: Planting with Oxen



Figure XX: Weeding with 2WT

### 3.1.4.2 Banana communication platform

The platform embraces online media channels for the dissemination of banana-related technologies and innovations. Banana produced the 'Banana and I' drama series as another information dissemination channel accessed via [YouTube](#). A total of 15 video screening sessions were conducted with 2,266 people participating.

Communication was extended into social media platforms, as well as print material. Membership on the Banana Facebook page (Fig. 4) running as the Uganda Bananas Farmers group increased to over 20,000 members. The outstanding communication material was the banana extension guide, which when uploaded online was subsequently downloaded 100,000 times on both the Banana Agronomy platform and the Banana Cooperative Union platform.

This was phenomenal because 100,000 deliveries through online downloads are equivalent to USD 346,000 that would have been required for the production and delivery of hard copies to end-users. Banana also used the conventional communication channels where 5,050 copies of print materials were distributed in Tanzania.



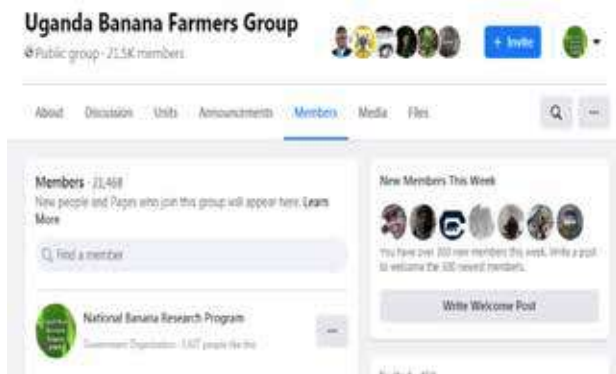


Fig 4. Banana Facebook group membership

To steer the initiatives towards the agenda for banana industrialization in Uganda, the program started a “*Banana commercialization advisory platform [BACO-MAP]*” which includes an engagement of representatives of private sector technology users, regulators of policy [trade, MAAIF], business supports systems and the Uganda banana cooperative union. As a result, market studies for selected banana technologies were initiated to guide prioritization for commercialization.



Fig. 6 NARO scientist demonstrating how banana corm is prepared for farmers in Lira District

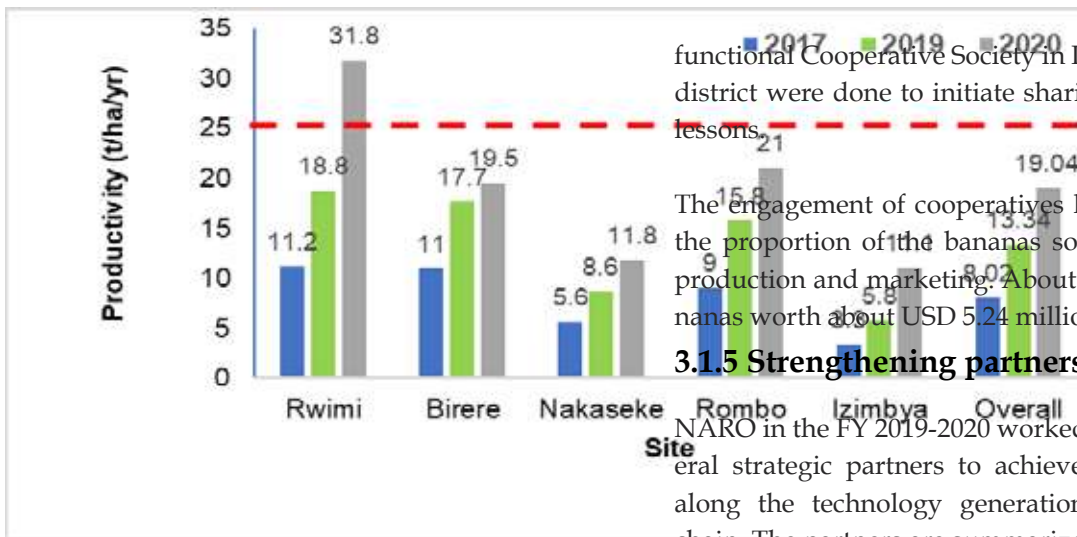
Fig. 5 Left – visitors at the banana demonstration plot during Nani Nani show in Mwanza and Right - Training farmers on how to use the communication materials in Izimbya, Tanzania

### 3.1.4.3 Bananas commercialization Platform in Northern Uganda

NARO through Banana Research Program established that bananas traded in and through Northern Uganda – Lango and Acholi sub-regions were worth UGX 17.84 billion per year. Therefore, this made banana the most profitable enterprise when compared to the traditional crops such as cassava, maize, rice, simsim, soybean, groundnuts and cotton. To tap into the existing market for bananas, 101 demonstration plots were established as learning sites with good agronomic practices starting in already established plantations to drive commercial banana production (Fig.6).

### 3.1.4.4 Banana community seed system Platform:

A community seed system and a new niche market for banana seed were created where foundation seed for 4 released matooke hybrids [*Kabana 6H, NAROBAN2, NAROBAN3 and NAROBAN4*] were given to local seed producers with a focus of initiating a local micro seed system within the farming communities of Nakaseke, Isingiro and Bunyangabu districts of Uganda (Fig. 7). In all the districts where the platform is working, it has been demonstrated that banana yields are on the increase due to the promotion and use of new banana varieties over the years. A 5-way stepwise approach has been developed to intensify banana productivity in the areas of production (Fig. 7).



**Fig 6: Average banana productivity across 3 Sites in Uganda and 2 sites in Tanzania during 2017, 2019 and 2020**

functional Cooperative Society in Rugaaga – Isingiro district were done to initiate sharing of key success lessons.

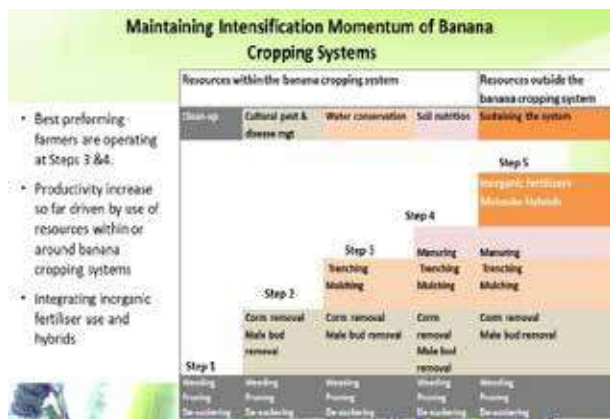
The engagement of cooperatives led to a change in the proportion of the bananas sold through group production and marketing. About 43,464 tons of bananas worth about USD 5.24 million were produced.

**3.1.5 Strengthening partnerships:**

NARO in the FY 2019-2020 worked closely with several strategic partners to achieve various outputs along the technology generation and promotion chain. The partners are summarized below;

**Table 4: Summary of partner categories NARO worked within FY 2019 -2020**

Partner Category
Uganda Government MDAs
District Local Governments
Farming Households
Farmer Organizations/Cooperatives
CSOs/NGOs/CBOs
Commercial Seed Companies
Local Community Based Seed Entities
Fish farms/hatcheries
United Nations Agencies
CGIAR centers
Development partners
International research centers
Regional partnerships
National Universities
International and Regional Universities



**Fig. 7 The 5-Way Stepwise intensification pathway**

**3.1.4.5 Banana Marketing Platform**

A Cooperative Union was established to aid farmers in accessing profitable markets. NARO’s Banana Research Program embraced the value of building stronger partnerships through the formation of cooperative societies. Up to 25 cooperative societies came together and registered to form the Uganda Banana Cooperative union. To address issues of un-informed market intelligence, pricing and linkages, an exchange visit of 100 farmer representatives to a







## 04

## AGRICULTURE CAPACITY STRENGTHENING

### 4.1 Human Resource Capacity Development:

#### 4.1 Human Resource Capacity Development

To ensure that NARO delivers on its mandates and objectives, during the FY 2019/20 the Organization made a bold and pragmatic move to enhance the capacity and capability of its human resources at all levels. For instance, over 80 NARO staff are registered with different professional bodies to enable them perform their functions. A total of 34 and 54 NARO staff completed their PhD and Masters degrees respectively. In addition, NARO enhanced the skills and competencies of several staff in different areas.

NARO is committed to attracting, developing and retaining adequate, competent and motivated human resources to support its transformation agenda. The following key achievements were registered.

##### 4.1.1 Staff registered to professional bodies

NARO staff have been registered with different professional bodies to enable them to perform their functions. NARO paid all their annual subscription fees of the year 2020 to the respective professional bodies of; Association of Internal Auditors, Engineers Registration Board, Uganda Veterinary Association, Institute of Chartered Public Accountants, Uganda human resource managers, Federation of Uganda Employers and Association of Chartered Certified Accountants.

Table 5: Subscription to professional bodies

	Professional body
1.	Engineers Registration Board
2.	Association of Internal Auditors
3.	Uganda Veterinary Association
4.	Institute of Chartered Public Accountants
5.	Association of Chartered Certified Accountants
6.	Uganda Human Resource managers Association
7.	Federation of Uganda Employers (FUE)

##### 4.1.2 Staff Performance System and onboarding

The implementation of a new staff Performance appraisal system has improved organizational performance. NARO staffs are now self-driven to achieve set targets. During the period NARO recruited 13 staff. These include: (i) Deputy Director-General ATP; Director Rwebitaba; Director NAFIRI and Director MUZARDI. In addition, seven (7) Program Leaders, and two consultants were recruited (Director Grants and Head Resource Mobilization. The officers are already on board and carrying out their respective activities.

##### 4.1.3 Long-term and short-term staff training

- A total of 34 and 54 NARO staff completed their PhD and Masters degrees respectively. One (1) staff completed bachelors and 18 staff completed various short courses.
- A total number of 24 staff are currently enrolled for PhD, two (2) for Masters and one (1) staff for professional training.

#### 4.1.4 Short-term trainings

- The Directorate of Human Resources conducted a series of short term trainings as in the table below:

**Table 6: NARO Staff Training by DHR**

Short term course	No of participants
Induction of new staff	65
Training of PARI Directors and Human Resource officers in performance.	40
Leadership/management training for PARI Directors	35

NARO enhanced skills and competencies in other different areas of leadership and management such as:

- NARO Environmental Social Safeguards'/gender focal persons (48) were trained on gender analysis and strategy development. In addition, a gender assessment was conducted in 4 institutes and gender monitoring tools were developed to determine the gender responsiveness of NARO research undertakings.
- The Biometrics Research Support Unit (BRSU) conducted in-house training to twenty-seven NARO scientists and technicians in three (3) PARIs namely, Ngetta ZARDI (7), Nabuin ZARDI (13) and Abi ZARDI (7). This was in a bid to promote e-data management practices, integrity, quality assurance and quality control in the design and implementation of agricultural research. The BRSU extended support/training in reinvigorating researcher's skills in data analysis and interpretation

of research results.

#### 4.1.2 Infrastructural Development

The research infrastructure improvement for the FY 2019/20 focused mainly on physical infrastructure development projects in Rwebitaba ZARDI, NaSARRI, NaLIRRI, and Nabuin ZARDI. These included renovations (5) and new constructions (6) that have either been completed or nearing completion. The key achievements made are as follows:

*Rwebitaba ZARDI:* The administration block has been completed and awaiting handover, while the laboratory and conference facilities are near completion (Fig 13).

*Fig. 6 Newly constructed research infrastructure at Rwebitaba ZARDI*



*Figure 7: Some of the renovated research infrastructure at NaSARRI*

**NaSARRI:** The renovation of an office block, stores and workshops facilities plus construction of glass and screen houses, are completed (Fig14).

**NaLIRRI:** Infrastructures under development are: Milk quality control platform and production storage almost complete; calf-barn, vaccine and waste management facilities completed; expendable calf groupings and Isolation calf pens are on-going.

**Nabuin ZARDI:** Infrastructure development is for two (2) screen houses for crop protection and crop improvement that have been completed and Staff houses (phase 2 under rehabilitation)

**NAFIRRI:** Rehabilitation of the hatchery and pump house as well as repairs of tanks to enhance fish seed and fish feed production completed.

**NaFORRI:** Renovation of a Guest House is 80% completed.

**Ngetta ZARDI:** Renovation of fishponds undertaken in preparation for demonstration of improved aquaculture practices.

**NARL:** Renovation of Food Biosciences Agribusiness laboratory is ongoing.

**4.1.2 Financial resources**

NARO’s annual budget for FY 2019/20 was UGX 79.661 billion from the Government of Uganda. The annual budget release was UGX 57.102 billion with 100 percent performance. A total of 116 off-budget projects supported by development partners to a tune of UGX 41.173 billion were also implemented.

**4.1.3 Intellectual Property Management**

This involves the management of NARO intellectual assets and portfolio including but not limited to Intellectual property (IP) enables technologies generated in or by NARO. IP management cycle involves generation, identification, protection, commercialization and enforcement of IP.

To guide and protect NARO’s inventions, innova-

tions and assets, the following policies, guidelines and/or plans were developed.

- NARO technology, assets and services commercialization policy
- NARO technology, assets and services commercialization guidelines
- Framework for access and licensing of NARO plant varieties
- NARO incubation plan.

**4.1.4 Information Communication Technology (ICT)**

NARO continued to build a standard and usable ICT environment with the following achievements made: There were upgrades of server management software, computers and software to prevent potential vulnerability issues, Improved telephony and intercom services through the acquisition and implementation of an E1 circuit connectivity, which allows placement of calls external to NARO. NARO also upgraded her ICT capacity in a bid to cope with the COVID-19 pandemic and effects, to enable staff work from home and conduct zoom meetings.

**4.1.5 Planning, Monitoring and Evaluation**

To plan, track and report the performance of NARO, the PM&E unit monitoring, rep During the year of performance function for a b ing implementa support to resou development. T the NARO Strat effect, the unit c Plan (2018/19 – of the aspired 1 the internal effor



to assess the progress and interventions. Specifically, the following achievements were registered;



## **4.1.5 Other resource mobilization initiatives**

### **4.1.5.1 Procurements**

The procurement activities within the work plan for the financial year 2019/20 comprised of three categories namely goods and non-consultancy services, consultancy services and civil works as well as micro procurements. The implementation of the three categories in terms of the various stages involved in the procurement cycle, as well as the current status, are presented in Tables 12, 13 and 14. However, some of the procurements were affected by a lack of funds and therefore contracts not signed.

### **4.1.4 Socio-economic and cross cutting research**

NARO continued to register considerable achievements in the implementation of its gender and diversity programs. Stakeholder skills enhancement programs have been designed and implemented to cater for all gender categories.

### **4.1.5 Gender mainstreaming in agricultural research for development**

During the FY 2019/2020 NARO registered considerable achievements in the implementation of its gender and diversity programs. To ensure that all gender categories (children, women, youth, the elderly and persons with disabilities) benefit from its technological development and dissemination initiatives at the grassroots the organization endeavored to develop technologies and knowledge generated in various disciplines to cater for production challenges. Furthermore, stakeholder skills enhancement programs were designed and implemented to cater for all-gender categories.

### **4.1.5.2 Gender assessment and monitoring tools developed:**

Gender assessment and monitoring tools were developed to integrate gender in research at all PARIs, 4 institutes were consulted and guided on the im-

plementation of gender actions in their projects especially ensuring that women's voices are included in decision-making, accessing and controlling production factors, engaged in research, extension and capacity building processes; and interests of youth in agriculture, food, income insecurity and poor nutrition.

### **4.1.5.3 Engagements in management of social risks**

NARO was engaged in the management of social risks. This involved building capacity of the local communities including institute workers, staff and community personnel to address social concerns including child labour, HIV/AIDS, gender and sexual harassment.







06

# CONSERVATION OF NATURAL RESOURCES AND BIODIVERSITY

## 5.1. Efforts and Progress in conservation of agricultural resources, natural resources and Biodiversity

### 5.1.2 *Shea Butter research: NAFORRI, NGETTA*

**Shea nut germplasm in Northern Uganda**  
 The Vitellaria paradoxa (Shea nut tree) is an important indigenous tree species found along the Shea belt of Africa. It has undergone domestication in the savannah parklands of Africa for over 1000 years. The tree is either eaten through fruit or used for cosmetic, culinary and aviation fuel, making it a good source of household income. It grows in the wild and there is no definite source of Shea tree germplasm in the country. NARO-Ngetta ZARDI in collaboration with the World Agroforestry Centre (ICRAF) has been managing a 1-acre Shea nut tree gene bank in Uganda. This is the first gene bank of its kind in the country specifically holding Shea

tree accessions from the entire range of the species in Uganda. The gene bank has not only been used to study nursery tree generation but has also been utilized as a research platform by National Research Institutes, Makerere University and international agencies (ICRAF).

Fresh Shea fruits were collected from the districts of Otuke (Adwari subcounty), Amuru (Atiak s/c), Lamwo (Palabek) and Pader (Kilak) respectively.

**5.1.1 Conservation facilities: NACRRI, NARL - PGRC and NAFORRI**

## EX-SITU CONSERVATION OF FOREST GENETIC RESOURCES

Ex-situ conservation is critical for conserving plant genetic resources and must be encouraged and promoted with the help of adequate financial and technical resources. At NaFORRI, conservation measures, involving arboretum, seed orchards, provenance stands, seed stands and herbarium have been employed to ensure that representative samples of naturally occurring genetic diversity in forest plant resources are preserved for current and future use.

### NaFORRI ARBORETUM

Uganda is endowed with more than 900 native tree species of which at least 60 tree species are listed as threatened according to the IUCN Red List. With the continuous destruction of native habitats of

many native plant species due to deforestation, industrialization, urban expansion, more tree species are bound to be threatened and might eventually be extinct in the long run. Growing demands for fuel-wood, timber, food, fiber, and agricultural security, as well as intergenerational equity, demand that we do everything possible to protect and preserve the rich genetic resources that we have inherited for current and future uses.

Therefore, to conserve forest genetic resources in Uganda in face of myriad anthropogenic pressures, NaFORRI has established an arboretum (4 ha) (Ex-situ conservation) within Kifu Research Forest, which will host at least 20 priority tree species. In addition to the conservation of forest genetic resources, the arboretum will be used for purposes of research, education, provenance and seed stands and as a convenient source for herbarium materials for use and

exchange.

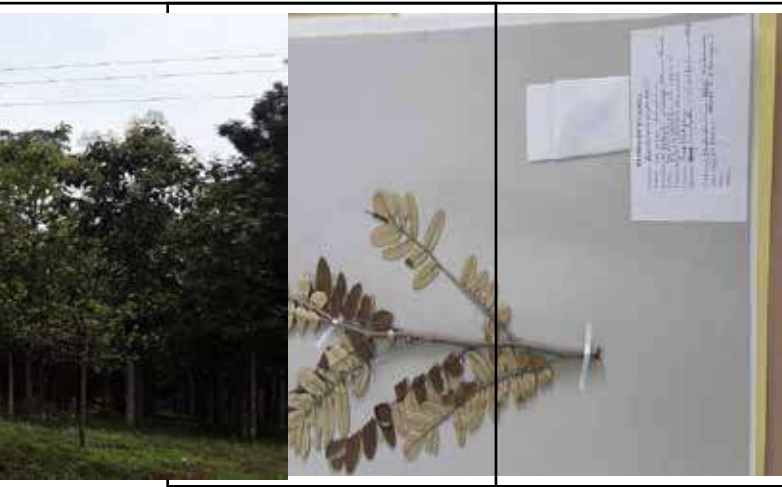


*Provenance stands for Tectona grandis and Grevillea robusta*

### NaFORRI HERBARIUM

The National Forestry Resources Research Institute Herbarium consists of 1500 collections of preserved plant specimens dried, pressed and their associated collections data and library materials. The collections are remarkable and unique sources of information about plants and the ecosphere they inhabit. They provide the comparative material that is essential for research and studies in taxonomy, systematics, ecology, anatomy, morphology, conservation biology, biodiversity and ethno botany as well as being used for teaching and by the public.





Collections in the herbarium have very valuable sources of information to define conservation priorities, improve decisions taken on rare and/or threatened species and apply conservation efforts with much efficiency. They facilitate the evolutionary study of a plant, along with tracing changes in phenology and species morphology linked to climate change

### 5.1.3 Natural resource management in Karamoja - Gum Arabica research Nabuin

#### Promoting the Acacia Senegal tree for Gum Arabic production and Dryland Agroforestry in Karamoja sub region.

Gum Arabic, also known as acacia gum is a natural gum made of the hardened sap of various species of the acacia tree species commonly found in Karamoja subregion. The most dominant acacia tree species in the region are Acacia Senegal and Acacia Seyal.

The acacia trees thrive well in dryland stressing environments. The drier conditions also favor the production of gum Arabic, as compared to areas with less stressed trees where the yield of gum is lower or none at all. Gum Arabic production for the market can provide alternative income to these communities that experience stressing environment which grossly affects crop production, making livestock keeping the only survival means.



**Acacia Senegal gum**



**Acacia Senegal seed**

**Fig 1: Seeds and gum of Acacia Senegal**

Research is promoting deliberate conservation, harvesting and marketing of gum Arabic in the Karamoja sub-region. We produce seedlings and also train farmers to produce seedlings for income. We also build the capacity of farmers in the region to deliberately plant and manage the acacia trees for commercial production through the access to seedlings and information.





**Fig 2: Gum Arabic experiment in a screen house at Nabuin ZARDI (seedlings of *Acacia Senegal*)**

Gum Arabic has several economic uses demanded globally. These include an emulsifier in beverages, a thickener in icing, fillings, chewing gum, hard and gummy candies and other confectionary treats, a binder in watercolor paints, pharmaceutical drugs and cosmetics so that the mixture takes on a uniform mixture, a suspending or viscosity increasing agent especially syrups, a wine fining agent, a water lickable adhesive for example on postage stamps, envelopes and cigarette wrapping papers. It also has shelf life-enhancing properties and the ability to dissolve and stay stable in water. In photography print, Acacia gum permanently binds the color pigments and dissolves them permanently on the paper

At the moment locals use these acacia trees mainly for fencing, fuelwood, poles, crafts, medicine, intercropping, fibre and minimal extraction of tannin. The intensity of usage for fencing, fuel (charcoal/firewood) and building poles threaten the tree population in the sub region. This heightens the need to change the mindsets of the locals to conserve the tree resource especially in the face of this changing environment.

Research enlists a joint effort from local governments, development partners and community structures in addressing the current challenges affecting the production of gum Arabic for the market. Some of these include cutting of the tree resource for charcoal production which is on the rise. Limited knowl-

edge of the production, marketing and development of the gum Arabic industry in the region. Limited local capacity in production and marketing of gum Arabic. And, lack of knowledge on supporting policy statements for gum Arabic production in the region.

#### **5.1.4 Indigenous vegetables: MUKONO ZARDI, NACRRI**

##### **indigenous vegetable Conservation**

A demonstration on local vegetables was established on-station to showcase the performance of three indigenous vegetables (Spider plant, Red Amaranthus, and Nakati) under different soil amendments (fertilizers) namely; poultry manure (layers), cow dung, NPK (17:17;17) and a combination of NPK with Poultry manure & NPK with cow dung. Where a combination was used, the NPK was applied after germination. The plots where poultry manure was applied germinated faster than the plots with the other treatments. The combination of poultry manure resulted in a better crop for the three indigenous vegetables in terms of the crop vigour, plant height, leaf size and harvestable yield and matured earlier than the other combinations. This was followed by plots where poultry manure was used. Mukono ZARDI produced seed for (Spider plant (Jjobyo), Red Amaranthus (Bbugga), and Nakati seeds to a total of 50kilogramme. The seed was packed in branded sachets and availed to stakeholders during outreach activities.

In addition, the institute managed to reach out to the public by exhibiting peri-urban vegetable technologies at World Food day celebrations held at Bulindi ZARDI on 16<sup>th</sup> October 2019. More than 2,000 stakeholders were sensitized on the importance of vegetable production and utilization. Food towers, sack, bucket and box garden technologies used to showcase the use of peri-urban technologies. We further managed to brand and disseminate pocket brochures of indigenous vegetables i.e. Spider plant

(Jjobyo), Red Amaranthus (Bbugga) and Nakati (*Solanum aethiopicum*).



*Mr. Frank Niwagba of MUZARDI talks to primary pupils about quality indigenous vegetable seed at WFD celebrations held at Bulindi ZARDI on 16<sup>th</sup> October 2019.*



*Red Amaranthus vegetables planted for seed at Ntawo station*

18 students and 1 staff from Wisconsin University (USA) were also trained at MUZARDI (Mukono station) on the importance of indigenous vegetables in the African setting.

During the previous ATAAS project; Mukono ZARDI provided irrigation technologies to farmer groups in the zone. A monitoring visit made after the project in 2019 indicated that four farmer groups that were supported with irrigation technologies adopted vegetable production which included growing indigenous vegetables i.e. Amaranthus, tomatoes and cabbage. From 1 acre of tomato, Tukwatirenganeku Farmer Group in Nakasongola had earned 6 million

shillings as opposed to 600,000/= they earned from 1 acre of maize.

### **5.1.7 Indigenous, Exotic and Improved breeds/Stock - NALIRRI, NAFIRRI, Abi, Buginyanya, Kachwekano, Mbarara and Nabuin**

#### **□ 5.2. Managing Invasive Species - Fall Army Worm**

#### **A tracking and monitoring system for fall armyworms developed**

Fall armyworm (FAW), *Spodoptera frugiperda*, is a very destructive pest of maize, a staple food crop in Uganda therefore the need for monitoring and management of FAW population is an effective strategy for its management. A technology was developed based on two pheromones (Chem Tica from the USA and Russel IPM from the UK). Using traps (containers) these pheromones are placed to the inside top of the cover of the container, with the bottom also laced with a 10% DDVP insecticidal strip. This strip minimizes the escape of any fall armyworms that have entered the trap. The pheromones inside the trap, attract only male fall armyworms making it helpful in controlling the population of FAW in gardens.

This approach in combination with field scouting has proved effective in controlling FAW infestation of maize gardens. The lures have been recommended for use by farming communities or farmer groups to safeguard maize crops from damage by fall armyworms, particularly in North-western Farmlands for Chem Tica, and Russell IPM lures in Lake Victoria Crescent & Mbale Farmlands agro-ecological zones.

The research was funded by the Food and Agriculture Organization (FAO) of the United Nations as part of ongoing initiatives on community fall armyworm monitoring in Africa.



**Fall armyworm bucket trap**

### □ 5.3 Managing Invasive Species - Kariba Weed

#### *Invasive Weed Species Management;*

National Invasive Species Coordination Unit mandate covers the detection of obnoxious organisms, both foreign and local, evaluation of their socio-economic impacts on the environment and human well-being and managing these negative impacts through an integrated management approach. Specifically, the Unit promotes the use of natural enemies (biological control) of invasive species which is a domain of entomologists.

Occurrence and infestation levels of Kariba weed on water bodies in the Lake Kyoga basin were mapped and an estimated 141.31 ha (based on landing sites and swamps that were visited) of water surface area was covered with Kariba weed. Two Kariba weed hotspots were identified; Lake Nakuwa and Lumbuyee swamp

Six communities within the vicinity of Lake Kyoga and Lake Nakuwa were integrated into Bio-control of Kariba weed. One (1) weevil rearing facility was set up and stocked with weevils at Budipa landing site on L. Nakuwa and 15 facility managers trained in Buyende and Kaliro. Bio-control agents established in Nile-Kyoga-Albert fish production systems

and 16 sites with weevil recoveries and damage on L. Kyoga and L. Nakuwa identified. Breeding stock of 5000 weevils maintained at Namulonge, 24800 adult weevils released in L. Kyoga, L. Nakuwa and Kibimba dam.

Awareness on the impacts and management of invasive species was achieved through a stakeholder engagement meeting with KCCA on dodder weed spread, impacts and management, the publication of two (2) information materials; **Poster** developed "Management of Kariba weed (*Salvinia molesta*) on Uganda's water bodies", and an **Article** on dodder weed and its management published in New Vision in January 2020.

NARO and developing partners have been expended efforts in controlling the aquatic invasive weeds effectively clearing the danger of the Kariba weed (*Salvinia molesta*). The efforts in controlling aquatic invasive weeds were directed to Kariba weed (*Salvinia molesta*) management on Lakes Kyoga, Kwana and Kibimba dam which was previously known Kariba weed hotspots are now over 90% clear of the weed due to the deployment of an integrated management approach using bio-agents (*Cyrtobagous salviniae* weevils) and mechanical removal. Information on Kariba weed occurrence and infestation levels, and a map of Kariba weed occurrence for five water bodies in the country were developed. The latest information shows that Lake Nakuwa in Kaliro district and Lumbuyee swamp in Buyende district are now the new Kariba weed hotspots.

To accelerate the control of Kariba weed, a total of 23,000 adult weevils from the 2 lakeshore rearing facilities and Namulonge rearing stations were released in Lake Kyoga, Lake Nakuwa and Kibimba dam (Bugiri district). The skills of five weevil rearing facility managers identified from the local communities were enhanced on weevil rearing at Budipa Landing site on Lake Nakuwa. One weevil rearing facility was set up and stocked with 560 weevils at Budipa Landing site on Lake Nakuwa and informa-



tion on Kariba weed management was developed and disseminated to communities living around Uganda's water bodies.



□

### **C. salviniae weevil release on Lake Nakuwa**

All this work has been in partnership with Generations Root Foundation-Buyende. This organization brought to NARO's attention the occurrence of Kariba weed on Lake Nakuwa. They have played a pivotal role in NARO's engagement with affected communities around Lake Nakuwa and in ensuring meticulous management of the weevil rearing facility at Budipa.





07

## THE DEVELOPMENT INITIATIVE FOR NORTHERN UGANDA SUPPORT NARO

### □ New Off-budget projects

Over the past few years, a significant funding contribution to agricultural research interventions of NARO has been attributed to off-budget projects. In the FY 2019/20, a total of 114 off-budget projects amounting to a total value of UGX 42.9 Billion was to be implemented. In this 2019/20 report, the following key off-budget projects under implementation are presented;

**1. Development Initiative for Northern Uganda (DINU):** This project seeks to chase poverty and hunger in northern Uganda by diversifying food systems for food and nutrition security, poverty reduction and inclusive development. With an implementation period of 40 months, the DINU project targets eight (8) districts in two (2) Livelihood Sub-Regions of Acholi and Lango. It has a total indicative budget of **6,375,941.00 EUR** of which, **5,738,346.90 EUR** is the requested EU contribution. The consortium partners include; SOLIDARIDAD, SG 2000, PALM Corps, Lira University, AUPWAE, AGRENES and Muni University.

**Climate Smart Agriculture (CSA) Project:** In August 2019, the CSA Concept was developed, presented and approved by ASWG for submission to MFPED Development Committee. Relatedly, the process of securing a Consultant (CIAT Nairobi) to conduct a Climate Risk Profiling for the different agro-ecological zones (12) and four (4) value chains is ongoing. NARO and MAAIF teams will participate in Climate Risk Profiling activity with CIAT for capacity building. The CSA concept note is scheduled for presentation to the Development Committee (MFPED) on 11th August 2020.

**3. Developing a Market-Oriented and Environmentally Sustainable Beef Meat Industry in Uganda Project (MOBIP):** This project seeks to improve the competitiveness and productivity of the beef sub-sector through fostering gender responsive, inclusive and sustainable rangelands, and agroforestry and water resources management in Uganda.

**4. The Livestock Agribusiness Incubation Programme (LAIP):** (ADB; DC)

**5. NARO Feed the Future Collaboration:** is both a research and development initiative that aims to promote the use and commercialization of improved crop & livestock technologies with yield & nutrition enhancing characteristics. It seeks to achieve 3 specific objectives; facilitate the release and commercialization of NARO varieties, develop improved crop and animal technologies in response to emerging threats and market demands, align research to market needs and mobilize domestic resources to facilitate agricultural research.



The project is implemented by 6(six) NARO institutes targeting 8 commodities; Root crops (cassava and sweet potatoes), Coffee, Semi-arid/dryland crops (sorghum, millet and green gram), Banana, Beans, Maize, Potato

and Livestock across the four regions of Uganda. It started in January 2020 with a budget of 10M USD.

#### 1. **7.1.3 Planning and review workshops for Competitive Grant Scheme (CGS) projects:**

Developed a replacement retooling project, “Support to NARO (Project Code P0382)” for GoU funding, provided leadership in the development of two (2) project proposals. Of these, the Development Initiative for Northern Uganda (DINU) Project (FED/2019/412-808) worth UGX 25.5 billion has been awarded by European Union (EU) with an implementation period of 40 months beginning March 2020.

The second project is on Climate Smart Agriculture (CSA). The Concept Note has been developed, approved by Agricultural Sector Working Group (ASWG) for submission to the Ministry of Finance, Economic Planning and Development (MFPED)-Development Committee, Sensitized PARIs on the planned implementation of an effective PM&E system, Conducted, provided leadership and guidance in three (3) planning and review workshops for Competitive Grant Scheme (CGS) projects,

Conducted a monitoring exercise on all the 40 CGS Cohort V Projects, Prepared and disseminated quarterly, half-yearly, JASAR and annual, reports for Office of the Prime Minister; MFPED and MAAIF, provided support to Audit Unit in ensuring value for money and compliance, developed ad-hoc papers, contribution to budget speech and Ministerial Policy Statement to Parliament, and Developed the 2020/2021 NARO Work plan.







08

# REPORT AND AUDITED ACCOUNTS



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**REPORT OF THE AUDITOR GENERAL ON THE AUDIT OF FINANCIAL STATEMENTS OF  
NATIONAL AGRICULTURAL RESEARCH ORGANISATION  
FOR THE YEAR ENDED 30<sup>TH</sup> JUNE, 2020**

**THE RT. HON. SPEAKER OF PARLIAMENT**

**Opinion**

I have audited the accompanying financial statements of National Agricultural Research Organisation which comprise the statement of Financial Position as at 30<sup>th</sup> June 2020, the Statement of Financial Performance, Statement of Changes in Equity and Statement of Cash Flows together with other accompanying statements for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In my opinion, the financial statements of National Agricultural Research Organisation for the year ended 30<sup>th</sup> June 2020 are prepared, in all material respects, in accordance with section 51 of the Public Finance Management, 2015 and the Financial Reporting Guide, 2018.

**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 Auditor's Responsibilities for the Audit of the Financial Statements section of my report. I am independent of National Agricultural Research Organisation in accordance with the Constitution of the Republic of Uganda, 1995 (as amended), the National Audit Act, 2008, the International Organization of Supreme Audit Institutions (INTOSAI) Code of Ethics, the International Ethics Standards Board for Accountants Code of Ethics for Professional Accountants (Parts A and B) (IESBA Code), and other 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 is sufficient and appropriate to provide a basis for my opinion.

**Key Audit Matter**

Key audit matters are those matters that, in my professional judgment, were of most significance in my audit of the financial statements of the current period. These matters were addressed in the context of my audit of the financial statements as a whole, and in forming my opinion thereon, and I do not provide a separate opinion on these matters. I have determined the matters described below to be key audit matters communicated in my report.

**1.0 Implementation of the approved budget**

Every year, government plans and allocates funds to MDAs for implementation of activities that would enable the country to attain sustainable development. I observed that MDAs have challenges with regard to implementation of planned activities, which negatively affects service delivery and improvement of the people's wellbeing. As a result, the implementation of the approved budget was considered a key audit matter and during the office-wide planning, I identified risks common with MDAs which include; non-implementation of strategic plans, underperformance of revenue, implementation of off-budget activities, under absorption of funds, insufficient quantification of outputs, partial and non-implementation of outputs, diversion of funds and challenges in budget monitoring and reporting of performance.



National Agricultural Research Organisation (NARO) has the mandate of coordination and oversight of all aspects of agricultural research in Uganda.

To achieve this mandate, NARO planned to implement a number of both recurrent and development deliverables under various programmes. A review of the entity's ministerial statement and budget revealed that the entity had an approved budget of UGX.79,661,795,673, out of which UGX.57,103,273,304 was released. The table below shows a summary of the key deliverables of the entity for the financial year 2019/20.

**Table: Showing key deliverables for NARO for the year**

Sn	Key deliverables	Amount Spent (UGX) Bn	Cumulative percentage of Actual expenditure
i.	Generation of agricultural technologies	8.09	14
ii.	Research extension interface promoted and strengthened	3.49	20
iii.	Agricultural research capacity strengthened	39.38	89
iv.	Government Buildings and Administrative Infrastructure	3.07	95
v.	Purchase of Specialised Machinery & Equipment	1.46	97

The entity planned to achieve its deliverables through implementation of 9 outputs with a budget of UGX.79.66Bn, I sampled all outputs worth UGX.79.6Bn representing 100% of the total budget.

The outbreak of the Covid Pandemic affected the implementation of the 2019/20 budget especially activities in the last half of the financial year. As a result, a number of activities were not implemented due to budget cuts and lock down measures instituted to control the spread of the pandemic.

From the procedures undertaken, I noted the following:

No	Observation	Recommendation																				
1.1	<p><b>Implementation of the strategic plan</b></p> <p>The overall Government National Development Plan (NDP II) expired at the end of FY 2019/20. Contrary to the NDP II, the National Agricultural Research Organisation had an approved strategic plan for the period 2018/19-2027/28, which set out both the long term and short term targets to be achieved during the 10 year duration of the strategic plan.</p> <p>This being the second year of implementation of the entity's strategic plan, I undertook an assessment of the achievement of the entity's' strategic targets/goals.</p> <p>I noted that at the time of the audit (June 2020), the strategic targets were not quantified therefore I was unable to measure the extent of performance in the two financial years. However there was an indication of underperformance in terms of funding as per table below</p> <table border="1"> <thead> <tr> <th>No</th> <th>Financial year</th> <th>Planned amount UGX. (BN)</th> <th>Actual amount UGX. (BN)</th> <th>Deficit (UGX.)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>2018-19</td> <td>110.0</td> <td>63.186</td> <td>46.814</td> </tr> <tr> <td>2</td> <td>2019-20</td> <td>115.5</td> <td>57.103</td> <td>58.397</td> </tr> <tr> <td></td> <td></td> <td><b>225.5</b></td> <td><b>120.289</b></td> <td><b>105.211</b></td> </tr> </tbody> </table>	No	Financial year	Planned amount UGX. (BN)	Actual amount UGX. (BN)	Deficit (UGX.)	1	2018-19	110.0	63.186	46.814	2	2019-20	115.5	57.103	58.397			<b>225.5</b>	<b>120.289</b>	<b>105.211</b>	<p>I urged the Accounting Officer to ensure that the promised actions are implemented.</p>
No	Financial year	Planned amount UGX. (BN)	Actual amount UGX. (BN)	Deficit (UGX.)																		
1	2018-19	110.0	63.186	46.814																		
2	2019-20	115.5	57.103	58.397																		
		<b>225.5</b>	<b>120.289</b>	<b>105.211</b>																		

1. Other Key matters
  - A. Domestic Arrears





## CHALLENGES AND RECOMMENDATIONS

NARO is facing challenges in implementing its mandate on agricultural research service delivery. The following are the key outstanding challenges of NARO;

### 11.1.1 Under budget support to effectively conduct agricultural research

Most of NARO's budget is under **support to NARO** (GoU Development expenditure) and mainly caters to capital items. The expenditures on core technology generation and dissemination and maintenance of infrastructure are categorized as consumptive expenditure and restricted to about 20% of the total budget. Workshops, travel inland and supplies are considered consumptive items and yet the operations of the organization require continuous engagement with Ugandan farming communities in diverse settings, environments and seasons, diverse fora, with diverse needs, which all require workshop engagements, travel to areas of concern and contribution of the right improved agricultural inputs which are site specific. NARO has continued to request MoFPED to provide a budget code for the purpose.

### 11.1.2 Meeting high expectations with inadequate and unsustainable funding:

In light of the above challenge, which has affected the generation and dissemination of agricultural technologies and; adequate engagement of stakeholders, NARO meets challenges in narrowing the gap of stakeholder expectations.

### 11.1.3 Working with limited research infrastructure:

There have been concerted efforts and funding from GoU and partners towards the improvement of agricultural research infrastructure. The current infrastructure can contribute but is inadequate to undertake cutting-edge research and respond to emerging issues. Existing Facilities such as laboratories, scientific equipment, staff houses and transport need to contribute effectively to agricultural research service delivery. There is a need to improve infrastructure to adequately contribute to agriculture transformation.

### 11.1.4 operating under competing land use interests:

NARO conducts agricultural research service delivery of short term (1month-3years) and long term (5years-100years) nature. This requires utilizing land with secure land ownership. NARO is operating under an uncertain, insecure land ownership regime with distressing pressure from other interested parties with alternative development plans on land designated for agricultural research. This has slowed down investments in research infrastructure and interrupted the effective implementation of land-use plans. This warrants investment in securing land (mapping, profiling and titling) for agricultural research.

### 11.1.5 Relocation of NaLIRRI to Maruzi via Nakyesasa.

NARO has remained committed to operationalizing NaLIRRI in Maruzi. This undertaking now faces a vivid challenge. While the project is posted on the Integrated Bank Projects (IBP), a system hosted by MoFPED, it has no direct budget allocation. In addition, it has received meager support by encumbering Support for NARO P0382 for the last two consecutive fiscal years. (P0382 is a GOU development expenditure budget code for support for NARO project in the PIP in the MoFPED). Consequently, the relocation of NaLIRRI to Maruzi now faces a possible risk of being removed from the PIP by MoFPED thereby potentially delaying the project operationalization.

### 11.1.6 Covid-19 Pandemic.

NARO closed some of its operations for 12 weeks following the covid-19 outbreak from March 2020. Before the closure of offices, NARO Management assessed the impact of COVID-19 related restrictions on the implementation of the scheduled work for the FY 2019/20 Work Plan to refocus efforts in areas that could still be delivered while working remotely.

COVID-19 on NARO and the mitigation strategies and measures are undertaken to address the impact.

Effect of COVID 19 Pandemic	Mitigation measures
Budget Cuts	Reduced operations
Lean Staff (30%)	Remote working and working in shifts Re-prioritized activities
Unpreparedness with remote working tools	Staff keen to adapt to the new normal
Reduced field monitoring affected data collection	Re-prioritized activities
Slowed down in research and support services	Maintain lean staff at every PARI

**Table 8: Challenges and their respective actions taken**

Challenges	Actions being taken
Effectively researching budget support	NARO is engaging with MoFPED to provide a code for the purpose.
Meeting expectations with inadequate and unsustainable funding	Engaging the Government of Uganda to deliberately increase spending on agricultural research and staff. Generating internal revenues to support Agricultural research.
Working with limited research infrastructure	Sourcing for more funds to construct adequate centralized lab facilities that respond to emergencies. NARO is in the process to have its Laboratories accredited and certified by International agencies.
Operating under competing land use interests	Efforts continue to secure all NARO land.

### Lessons Learnt

Partnerships with local, regional and international partners are key in the generation and dissemination of agricultural technologies. Strengthening institutional partnerships and collaborations also goes a long way in offsetting infrastructural limitations in the short term. Efforts should therefore continue to support the formation of these partnerships and more especially those in the private sector where donor support is tilted.

Communities easily participate in development interventions through existing community-based organizations that have a good record of trust, openness and accountability to the people.







## PUBLICATIONS AND INFORMATION RESOURCES

### 12.1.1 List of publications FY 2019-2020

#### NACRRI

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Maize Lethal Necrosis Disease in Major Maize Growing Agroecological Zones of Uganda. Annual Research & Review in Biology, Pp 1-17.

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### Farming information

167. Brochures for indigenous vegetables (i.e. *Spider plant, red Amaranthus and Solanum aethiopicum*) developed
168. Improved pasture utilization (paddock design and management guidelines)
169. Training manual - apple growing & management developed

**NARO Secretariat**

Plot 11-13, Lugard Avenue, Entebbe

P. O. Box 295, Entebbe, Uganda

**Tel:** +256 (0) 41 320512, +256 (0) 41 320 341

**Fax:** +256 (0) 41 321 070

**Email:** dgnaro@naro.go.ug

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

**National Crops Resources Research Institute (NACRRI)**

**Location:** Namulonge, Wakiso District,

**Tel:** +256 (0) 414 573 016

**Email:** info@nacrii.go.ug

**National Coffee Research Institute (NACORI)**

**Location:** Kituza, Mukono District,

**Tel:** +256 (0)434 121369,

**Email:** directornacori@gmail.com

**Buginyanya Zonal Agricultural Research & Development Institute (Buginyanya ZARDI)**

**Location:** Buginyanya, Bulambuli District,

**Tel:** +256 (0) 414 320 341

**Email:** directorbugizardi@rocketmail.com

**Bulindi Zonal Agricultural Research & Development Institute (Bulindi ZARDI)**

**Location:** Bulindi, Hoima District,

**Tel:** +256 (0) 465 443 276

**Email:** bulindizardu@yahoo.com

**National Fisheries Resources Research Institute (NaFIRRI)**

**Location:** Jinja,

**Tel:** +256 (0) 434 121 369

**National Forestry Resources Research Institute (NaFORRI)**

**Location:** Kifu, Mukono District,

**Tel:** +256 (0) 414 383 028

**Email:** director@naforri.org.ug

**Kachwekano Zonal Agricultural Research & Development Institute (Kachwekano ZARDI)**

**Location:** Kabale District,

**Tel:** +256 (0) 486 426495

**Email:** kazardi.director@gmail.com

**Mbarara Zonal Agricultural Research & Development Institute (Mbarara ZARDI)**

**Location:** Mbarara District,

**Tel:** +256 (0) 414 668 976

**Email:** naro-mbr@utlonline.co.ug

**National Livestock Resources Research Institute (NALIRRI)**

Location: Maruzi, Apac District  
Nakyesasa, Wakiso District  
Tel: +256 (0) 454 448 360  
Email: [liridir@gmail.com](mailto:liridir@gmail.com)  
National Agricultural Research Laboratories  
(NARL)

Location: Kawanda, Wakiso District,  
Tel: +256 (0) 414 567 649  
Email: [director@narl.go.ug](mailto:director@narl.go.ug)  
Mukono Zonal Agricultural Research &  
Development Institute (Mukono ZARDI)

Location: Ntawo, Mukono District,  
Tel: +256 (0) 414 290 232  
Email: [director@muzardi.go.ug](mailto:director@muzardi.go.ug)  
Nabuin Zonal Agricultural Research &  
Development Institute (Nabuin ZARDI)

Location: Moroto District  
Tel: +256 (0) 454 660 693  
Email: [nabuinzardi@yahoo.com](mailto:nabuinzardi@yahoo.com)  
National Semi-Arid Resources Research Institute  
(NaSARRI)

Location: Serere District,  
Tel: +256 (0) 454 454 663  
Email: [director@nasarri.go.ug](mailto:director@nasarri.go.ug)  
Abi Zonal Agricultural Research & Development  
Institute (Abi ZARDI)

Location: Arua District,  
Tel: +256 (0) 772 673458  
Email: [naroabizardi@yahoo.com](mailto:naroabizardi@yahoo.com)

Ngetta Zonal Agricultural Research &  
Development Institute (Ngetta ZARDI)

Location: Lira District,  
Tel: +256 (0) 414 690335  
Email: [narongettaardc@yahoo.com](mailto:narongettaardc@yahoo.com)

Rwebitaba Zonal Agricultural Research &  
Development Institute

Location: Fort Portal, Kabarole District  
Tel: +256 (0) 483 427520  
Email: [rwebitabadirector@gmail.com](mailto:rwebitabadirector@gmail.com)



