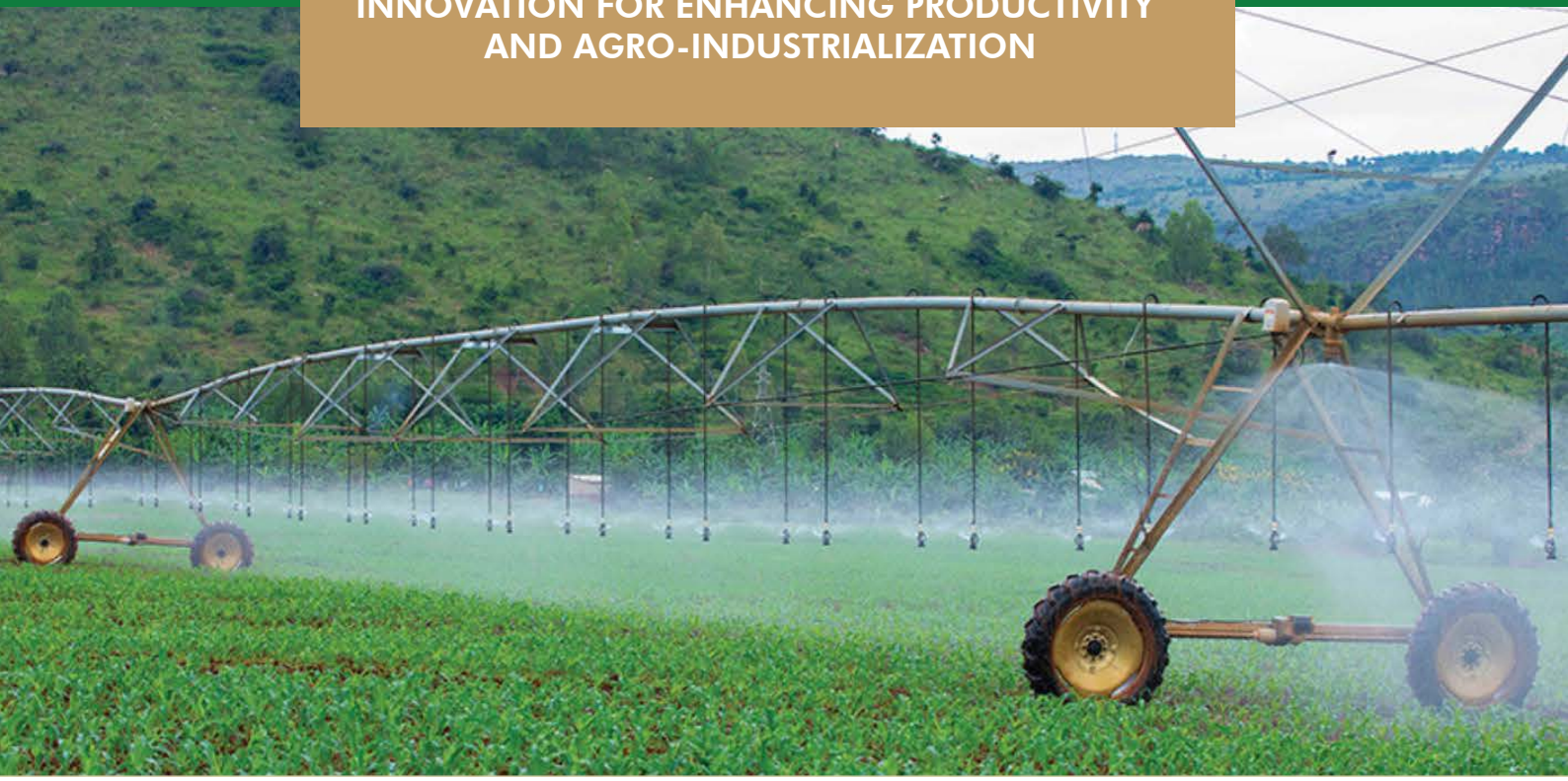
NARO

MAKERERE UNIVERSITY

THE 3RD NATIONAL AGRICULTURAL RESEARCH ORGANISATION AND MAKERERE UNIVERSITY (NARO-MAK) JOINT SCIENTIFIC CONFERENCE

CONFERENCE REPORT

THEME
INNOVATION FOR ENHANCING PRODUCTIVITY AND AGRO-INDUSTRIALIZATION



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14th - 16th March, 2023
Speke Resort and Conference Centre Munyonyo, Kampala, Uganda

The 3rd National Agricultural Research Organisation and Makerere University (NARO-MAK) Joint Scientific Conference

Conference Report

14th – 16th March 2023

Speke Resort and Conference Centre Munyonyo,

Kampala, Uganda

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FOREWORD

Researchers across the globe are focusing on science, technology and innovation (STI), as a key driver for national and regional economic growth. It is widely acknowledged that STI plays a vital role in achievement of sustainable development goals, as they among others, can enhance productivity and induce transformation of the economy. This cuts across all sectors including agriculture, the backbone of most countries especially in Africa.

It is critical that scientific findings, knowledge, and discoveries should be communicated to a range of stakeholders in order to facilitate uptake and application for impact. Information and knowledge dissemination, however, has largely been a weak link in the agricultural research and development chain. Against this background, the National Agricultural Research Organisation (NARO) and Makerere University (Mak) initiated biennial scientific conferences, dubbed the "NARO-MAK Joint Scientific Conference", to facilitate scientific knowledge dissemination to wider audiences nationally and globally. It is also worthy to note that the Biennial NARO-MAK Joint Scientific Conferences conducted since 2016 have contributed to encouraging young scientists conduct impactful research, and strengthening their capacity to share the research results with targeted beneficiaries along the agriculture value chain, for transformation of the agricultural sector. Products of these conferences include recommendations that point out technical and policy interventions needed for enhancing socio-economic transformation and services to communities. This 3rd biennial conference held on 14 – 16 March 2023 at Speke Resort Munyonyo, Kampala, focused on "Innovations for Enhancing Productivity and Agro-industrialization".

The conference report presents highlights of the three-days' conference undertakings and outputs. The published report provides information useful to various stakeholders including scientific community, policy makers, commercial players such as farmers and industry. We envisage that when the relevant ministries, departments and agencies (MDAs) pick out recommendations relevant to their mandates and act upon them, agricultural productivity, agro-industrialisation, agricultural transformation and socio-economic growth will be enhanced in Uganda and beyond.

We are grateful to the organising committee and the sponsors of the conference for their timely and valuable contribution. We thank the participants for the finances and time put into making the conference successful. The persons who compiled this report cannot be forgotten. Finally, we appreciate, in advance, those who are going to read and make use of the report content.

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Dr. Ambrose Agona
Director General,
National Agricultural Research Organisation

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Prof. Barnabas Nawangwe
Vice Chancellor,
Makerere University

ACKNOWLEDGEMENT

The Conference Organising Committee (COC) is extremely grateful to the Government of the Republic of Uganda for creating and maintaining an enabling, safe and supportive environment that allows research work to be done and this kind of conferences to be held. It is noted with appreciation that funding from the Government to the host institutions; the National Agricultural Research Organisation (NARO) and Makerere University (the College of Agricultural and Environmental Sciences - CAES), enabled preparations and running of this conference.

We greatly appreciate the sponsors of this conference: both current and prospective partners, collaborators and "friends" of NARO and Makerere University who supported the conference financially (direct or in-kind) and morally. These include, USAID Feed the Future – Uganda Institutional and Systems Strengthening Activity and the Agricultural Research Activity, aBi Development, CABI-Africa, the World Bank, the Food and Agricultural Organisation (FAO Uganda), Africa One Health University Network (AFROHUN) – c/o Prof. William Bazeyo, and Prof. Nicholas Kiggundu. Without this support the conference would not have been a reality.

Greatly appreciated are presenters of both oral and poster papers for the hard work and willingness to share their knowledge at this conference. The presence of policy makers, development partners, members of the private sector and all of you in your respective capacities cannot be taken for granted. Thank you for participating in this conference.

We sincerely appreciate and thank the Rt. Hon. Prime Minister of Uganda, the Hon. Minister of Water and Environment and the Hon, Minister of the Ministry of Agriculture Animal Industry and Fisheries for creating time to officiate the opening and closing of this important conference.

The efforts of the COC is also hereby acknowledged. Specifically, the COC comprised the following persons: Dr. Imelda N. Kashaija (Chairperson), Dr. Yazidhi Bamutaze (Co-Chairperson) Dr. Moreen Uwimbabazi, Mr. Joseph Mbihayeimaana, Ms. Victoria Mbigidde, Ms. Christine Elong, Dr. Cassius Aruho, Dr. Titus Alicai, Dr, Abel Atukwase, Prof. Bernard Bashaasha, Dr. Alice Turinawe, Dr. Jesca Nakavuma, Mr. Albert Muhumuza, Dr. Jeninah Karungi, Ms. Mary Nantale and Dr. Isaac Dramadri. The services and support given by the rapporteur team led by Mr. Napoleon Kajunju are highly esteemed too.

The abstracts of the papers presented were peer reviewed. The time and experience of reviewers listed below is greatly valued, and we hereby thank you: Prof. Nelson Turyahabwe, Dr. Prossy Isubikalu, Dr. Experito Muyanja, Dr. Tonny Obua, Dr. Robert Kawuki. Dr. Michael Otim, Dr. S.B. Mukasa, Dr. Florence Lwiza, Dr. Paul Aseete, Dr. Kanifa Kamatara, Dr. Pius Lutakome, Dr. Swidiq Mugerwa, Dr. Peace Musiimenta, Dr. Donald Kugonza, Dr. Jimmy Lamo, Dr. Joel Buyinza, Eng. Alphonse Candia, Eng. Dr. Florence Kiyimba, Dr. John Wasige, Ms. Catherine Agoe and Dr. Bernard Fungo. Equally acknowledged here are the COC members who doubled as reviewers, and the team that prepared this conference report.

EDITORS

1. Dr. Imelda N. Kashaija, NARO Secretariat
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1.0 INTRODUCTION

1.1 Conference overview

The National Agricultural Research Organisation (NARO) and Makerere University organised a conference dubbed the NARO-MAK Joint Scientific Conference (shortened as NARO-MAK conference). This biennial conference is aimed at bringing together researchers and other stakeholders to discuss the latest innovations and research findings in the agriculture and related sectors, and make strategies and recommendations for addressing challenges limiting the sector's transformation agenda.

The 3rd NARO-MAK Joint Scientific Conference was conducted on 14th to 16th March 2023 at Speke Resort and Conference Centre Munyonyo, Kampala, Uganda. The overall conference theme, "Innovations for Enhancing Productivity and Agro-industrialization", was well aligned with Uganda's National Development Plan III. It was deemed a pertinent topic for Africa and other developing countries that are still reliant on agriculture as their main source of livelihoods.

The main conference theme was delivered through seven sub-themes namely:

1. Challenges and opportunities in mechanization and agro-industrialization,
2. Modernizing post-harvest management and food safety systems,
3. Intensifying crop productivity and seed systems,
4. Accelerating development of the animal resources based Industry,
5. Managing interactions among agriculture, fragile ecosystems, and changing environment,
6. Embracing ICT based innovations for agricultural transformation and
7. Mainstreaming crosscutting emerging and livelihood-impacting aspects such as COVID-19, Youth Future Proofing and Gender into national strategic plans.

A total of 294 participants from agricultural research and academic institutions, national and international non-governmental organisations, private sector practitioners, development partners and policy makers physically participated in the conference. The latter category included the Prime Minister of the Republic of Uganda, and the Minister of Agriculture, Animal Industry and Fisheries, represented by the State Minister. The conference also attracted 21 participants from development partners and international non-governmental organisations including USAID, aBi Development Limited, World Bank, FAO and CABI-Africa. The participants consisted of a number of researchers from NARO (127), Makerere University (36), Gulu University (1), Busitema University (1), Sokoine University of Agriculture in Morogoro, Tanzania (1), and the Faculty of Agriculture, Dalhousie University in Canada (1) - Prof. Tessema Astatkie).

Other than researchers, four persons from the private sector, 18 representatives of local governments, and three media houses actively participated in the conference. Additionally, over 800 persons virtually participated in the conference via livestreaming on the NARO social media handles

and YouTube page. The first day of the conference had slightly over 800 viewers, while day two and three had 400 and 420 viewers respectively.

This report provides a summary of key points and recommendations that emerged during the three days of the conference. They are an outcome of presentations and discussions from six plenary sessions where seven keynote addresses and two panel discussions were held, as well as seven parallel sessions which featured 116 oral and 17 poster presentations. The conference also attracted exhibitors who showcased latest technologies across the conference sub-themes.

1.2 Official opening

The 3rd NARO-MAK Joint Scientific Conference was opened by the Prime Minister of the Republic of Uganda, the Right Hon. Robinah Nabbanja. The other dignitaries who graced the official opening included the Minister of State for Animal Industry, Hon. Bright Rwamirama; who represented, the Minister of Agriculture, Animal Industry and Fisheries (MAAIF), Hon. Frank Tumwebaze; the NARO Council Chairperson, Dr. William Olaho-Mukani; the Director General, NARO, Dr. Ambrose Agona; the Vice Chancellor, Makerere University, Prof. Barnabas Nawangwe; the NARO Deputy Director General - Research Coordination, Dr. Yona Baguma; the NARO Deputy Director General - Agriculture Technology Promotion, Dr. Sadik Kassim; the Principal, College of Agricultural and Environmental Sciences (CAES), Prof. Gorettie Nabanoga; and the Chief of Party, Feed the Future – Uganda Institutional and Systems Strengthening (ISS) Activity, Mr. Anthony Nyungu. Below are highlights of the speeches and remarks delivered by the above-mentioned dignitaries during the opening ceremony.

The Right Hon. Robinah Nabbanja (4th from left) with NARO, Makerere University and Feed the Future ISSA officials after opening the conference.

1.2.1 The Chairperson, Conference Organising Committee, Dr. Imelda N. Kashaija

The conference organising committee chairperson welcomed guests to the 3rd Biennial NARO-MAK Joint Scientific Conference, which should have been held in 2020 but was postponed due to the COVID-19 pandemic. She highlighted the theme of the conference; "Innovations for Enhancing Productivity and Agro-industrialization" and emphasized its alignment with Uganda's National Development Plan III and the agriculture sector as a whole. She also noted that the conference theme speaks to the entire African continent since majority of its economies rely on agricultural sector as a key source of livelihood.

Dr. Kashaija underscored the main objective of the conference as being to promote dialogue on the challenges affecting the agricultural sector, and to

guide formulation of policies that address key issues denoted. She acknowledged the Government of Uganda (GoU) for creating an enabling environment for research and funding. She expressed gratefulness to the sponsors of the conference, namely, USAID-Feed the Future, aBi Development Ltd, CABI Africa, World Bank, FAO, AFROHUN and Prof. Nicholas Kiggundu in his individual capacity. She appreciated the key note speakers and all the conference participants for their time. Last but not least, the chairperson extended special thanks to the Conference Organizing Committee for their tireless and selfless efforts put into organising the conference.

1.2.2 The Principal, CAES, Makerere University, Prof. Gorettie Nabanoga

Prof. Nabanoga noted that transforming the agriculture sector requires intentional innovativeness, and that CAES has been at the forefront of it by producing cutting edge innovations, which include a soil testing kit for rapid soil assessment; Kebera ICT best solutions for detecting toxic substances in food; three-wheeled multipurpose tractor; bio-fertilizer formulations to increase food security; automated spray drier for making powdered eggs (refractance window drier technology) green low-cost touchless technology and communal automated water pump; livestock milk booster from sugar cane industrial waste; value added potato and sorghum products; and diseases, pests and climate tolerant crop varieties.

The college is also fully engaged in horticulture research to transform the vegetable and flower industry. It has rejuvenated training for production and innovation at the university's Continuing Agricultural Education Centre (CAEC) at Kabanyolo, and has launched CAES botanical garden for in-situ conservation of indigenous species aimed at combating climate change.

1.2.3 The Vice Chancellor, Makerere University, Prof. Barnabas Nawangwe

The Vice Chancellor noted that Makerere University engages in strategic partnerships to address society challenges through training, research and community outreach. He emphasized that the theme of the conference was timely as Makerere University was aspiring to become a research-led university and keen at fostering innovativeness among the staff and students.

The Vice Chancellor commended the government of Uganda for providing over 90 billion Uganda shillings to support 750 research projects that have generated high-impact innovations in the last four years. He said that Makerere University has set up a research and innovations hub to boost innovations to transform the economy.

The Vice Chancellor emphasized the need for enhancement of partnerships with the private sector and NARO and noted that the university is very intentional about innovations and selecting the right partners to work with. He called upon all stakeholders to improve agricultural productivity to address the food needs of the growing population amidst challenges of climate change and deteriorating soil fertility. He thanked NARO management for the cordial partnership, and researchers for diligently supervising the MSc and PhD students of Makerere University.

1.2.4 The Director General, NARO, Dr. Ambrose Agona

The Director General reminded participants that the core mandate of the National Agricultural Research Organisation (NARO) is to coordinate and oversee agricultural research in the country. He challenged all researchers in any national agricultural research system (NARS) to strive towards increased *per capita* income and ensure household food security in the wake of increasing land fragmentation. He noted that for our countries to achieve their development goals, issues of food insecurity, climate change and industrialization need to be addressed. On this note, he emphasized the importance of science and innovation in ensuring a vibrant and resilient agricultural sector in Uganda. He noted that agro-industrialisation enables product development, intensification and differentiation. It increases employment opportunities, food security, incomes and nutrition. On the other hand, he stressed the need for food industries to be located near the source of raw materials if there is to be sustainable agro-industrialisation, as most agricultural products are bulky and perishable. To awaken researchers and other actors' spirit for contribution to national development, the DG posed the following two questions to the participants. Firstly, what have you done and what have you contributed to the 4th revolution of science and technology? Secondly, the government has invested in agricultural research through NARO and universities, infrastructure such as roads and ICT; if Government stopped funding research today, what value proposition are you pledging to the country?

About the youth, he advised that before engaging them in productive agriculture and development projects, it is important to first understand their typology and tailor interventions for inclusivity. He highlighted the youth typology as: i) educated youth with no opportunities, ii) educated youth who consider agriculture as dirty and are not motivated to make their hands dirty, iii) youth who are intellectually challenged, are motivated to work but have no opportunities, iv) youth who are intellectually challenged and are not motivated to work. He concluded by emphasizing that science and innovation are key to the transformation of agriculture; to increase productivity, mitigate effects of climate change and reduce poverty.

1.2.5 The Chairperson, NARO Governing Council, Dr. William Olaho Mukani

Noted that NARO is focused on technology development and transfer as well as human capital development. He appreciated the conference, noting that it was one of the avenues for knowledge and technology transfer. He emphasized the need for the conference to produce policy recommendations for the governments, to guide in handling of emergency issues such as COVID-19, climate change effects and political instability. He noted the need to promote partnerships in research and development, and requested the government of Uganda to provide more funding to scientists and researchers to enable establishment of viable collaborations among all engaged in agricultural research. He encouraged the COC to bring on board the other universities into the organisation of, and active participation in the subsequent scientific

conferences. He observed that the initial presentations and discussions had brought out vital issues that need policy intervention. These included the necessity to (i) fast track establishment of fertilizer industry in eastern Uganda, (ii) boost and support wheat farmers to minimise its shortage due to challenges in its main supplying countries, (iii) support strategies for better adoption of research technologies and innovations, and safeguard technologies and innovations developed by scientists.

1.2.6 The Chief of Party, USAID Feed the Future Institutional and Systems Strengthening Activity, Mr. Anthony Nyungu

The USAID-FtF- ISS Chief of Party enlightened on the goal of the Activity he leads in Uganda. He informed the house that working with the Government of Uganda, FtF ISS Activity contributes towards enhancing capacities of the ministries, departments and agencies as well as the private sector apex organisation to better deliver on their mandates. The Activity supports adoption of relevant technologies for more efficient service delivery, and also works on priority policy instruments that enable better operations of the various actors as they go about their work. Additionally, it intervenes to strengthen synergy among actors within the agricultural market system. He appreciated the NARO-MAK conference as he found it an avenue utilisable to enable the private sector to have credible evidence on issues affecting them. The knowledge gained from the conference helps the private sector apex organisation to have more informed dialogue with FtF ISS, regarding the priorities they wish to be supported. Mr. Nyungu cited fertiliser as an example of issues affecting the private sector, yet one which FtF ISS could support to obtain a solution if the issue is presented to it with credible evidence. The Chief of Party pledged to continue working with the organisers of such a conference to further the agenda of supporting MDAs and the private sector organisations.

1.2.6 The Minister of State for Animal Industry, Hon. Bright Rwamirama

Hon. Bright Rwamirama who represented the Minister of Agriculture, Animal Industry and Fisheries (MAAIF), expressed happiness on noticing that NARO and Makerere University were contributing towards finding solutions to the numerous challenges faced by the Ugandan farming communities. With delight, he commended the two institutions' input into increasing agricultural productivity in order for the citizens to meet both nutritional and food security, and income needs. He appreciated the conference, noting that its objective of sharing research-based knowledge among research and development (R&D) actors, the farming communities and private sector actors is worthy, as it leads to increasing adoption of agricultural technologies. He appreciated the NARO and Mak scientists produced technologies and innovations such as the released resilient crop varieties especially those commercialised, the in-rod in development of livestock vacines, the Aflasafe to control the notorious aflatoxin issues and many others. He said that in order to increase agriculture production and productivity, MAAIF and its agencies works with key players along the agriculture value chains.

The ministry therefore embraces partnerships and collaborations such as the NARO-MAK conference based, because they help in solving local challenges. On this note, the Hon. Rwamirama encouraged the organisers to strive and increase participation of farmers and the private sector organisations/ companies so as to pick solutions and innovations from the conference presentations, networking and exhibitions, and adopt them for solving their production constraints. He encouraged NARO and Mak to strengthen the partnerships, and to bring on board other universities especially those with agricultural colleges or faculties, in order to widen the scope of knowledge base for subsequent conferences. For this, he pledged the ministries support in case of a need for it, and encouraged the organisers to inform the ministry.

He retaliated government's commitment to improving agricultural value chains to avoid future catastrophes. The minister assured the audience that the proposed fertilizer factory in Uganda will be constructed to enable easy access to the much-needed fertilizers in the country. He made it clear that His Excellence the President of the Republic of Uganda is very supportive of scientific research, and will go to any length to support any innovation in science. He concluded by acknowledging that the NARO-MAK conference is an opportunity to demonstrate Uganda's capacity for providing solutions to agriculture production, and to provide accountability to the public in terms of the scientific outputs. He also indicated that the conference will leave a mark in the agricultural sector in Uganda in terms of policy and knowledge on innovations, and that he will inform the Uganda Government about its outcomes.

1.2.7 The Prime Minister of Uganda and Chief Guest, Rt. Hon. Robinah Nabbanja

The Rt. Hon. Prime Minister expressed government's appreciation of the research undertaken by NARO and Makerere University, noting that it has generated technologies and innovations which are contributing to the transformation of the agricultural sector. She observed that with the continuously increasing population, pressure is exerted on soils leading them to get exhausted, thus the strong need for affordable fertilizers. Acknowledging the God-given gift to Uganda, she asserted that the has the potential to feed the whole world; the reason Uganda Government is doing its best to harness the gift. She informed the audience that the Parish Development Model (PDM) is the government's blueprint for technology transfer from the scientists to the public. Through PDM, government shall ensure that there are enough extension staff at sub-counties and, shall continue to strengthen use of ICT, to ensure sustainable agricultural transformation. The chief guest embraced the conference theme, noting that it focused on providing knowledge and solutions to crucial challenges limiting social-economic transformation of farmers from subsistence to commercial agriculture. That is, constraints in food safety systems, seed systems, accelerating animal-based resources, value addition and ICT. She retaliated government's commitment to review the fertilizer policy and fast track its implementation. She informed the audience that government pledges to improve funding to NARO and Makerere University, and would like to implement a model where farmers will access quality seed through NARO and Uganda prisons.

The Rt. Hon Prime Minister informed the participants that while the country is still recovering from COVID-19 effects, the Uganda Government is committed to using the available resources diligently to ensure prosperity for all. She also noted that the President, HE Y.K.T. Museveni is making several international trips to source markets for Uganda's agricultural produce. She called upon the media fraternity to stand together with the government to protect and develop the country through positive reporting and avoid information that has a negative effect on markets for agricultural produce, tourism and investment. She further called upon the private sector to utilize the funds that the government

has put in commercial banks, SACCOs, "Emyogga" and PDM to accelerate national economic development. She called upon NARO and Mak to regularly share innovations and research outputs with the media to facilitate their wide dissemination and enhance technology adoption.

1.3 Official Closing

The 3rd NARO-MAK Joint Scientific Conference was closed by the Minister of State for Animal Industry, Hon. Bright Rwamirama. The other dignitaries who graced the official closing session included the Deputy Chairperson of the Parliament Committee on Agriculture, Animal Industry and Fisheries, Dr. Agnes Atim Apea; the NARO Governing Council Chairperson, Dr William Olaho Mukani; the Director General, NARO, Dr. Ambrose Agona; the Vice Chancellor, Makerere University, Prof. Barnabas Nawangwe; the NARO Deputy Director General - Research Coordination, Dr. Yona Baguma; the NARO Deputy Director General - Agricultural Technology Promotion, Dr. Sadik Kassim; the Principal, College of Agricultural and Environmental Sciences, Prof. Gorettie Nabanoga; and the Sustainability Specialist, aBi Development Ltd, Mr. Richard Mwesigwa.

The summary of the closing remarks by the above indicated dignitaries is presented below.

1.3.1 The Sustainability Specialist, aBi Ltd, Mr. Richard Mwesigwa

In his remarks, Mr. Richard Mwesigwa pointed out the challenges facing smallholder and commercial farmers in light of increasing population and food demands. He thanked scientists and researchers who have developed technologies that are tailored to the needs of farmers. He emphasized that aBi Development Ltd is dedicated to supporting researchers in developing more technologies that are relevant and adaptive to the changes taking place in agriculture. He added that the conference was timely as it addressed the challenges posed by climate change, such as floods and erratic rains; and generating strategies to ensure that farmers are more resilient and updated with new information and technologies. Mr. Mwesigwa stated that aBi Development Ltd is willing to support the uptake and dissemination of new technologies, and called for more outreach efforts into dissemination of these technologies to all the stakeholders.

1.3.2 The Deputy Director General - Research Coordination, NARO, Dr. Yona Baguma

Dr. Yona Baguma, congratulated the researchers and scientists on a successful conference. He emphasized the need to move towards a more vibrant research system with the mandate to decrease

the number of farmers engaged in subsistence farming and increase the contribution of the agricultural sector GDP from the current 24%. In order to achieve this, he prayed to government for increased investment in agriculture and the development of a vibrant scientific innovation system that includes socio-economic development policy. To further this goal, Dr. Baguma suggested the incorporation of IT in agriculture through the establishment of an e-working group to identify and prioritize agricultural needs for transformation. He also stressed the need for a vibrant seed system, focusing on forestry, crop, and livestock sectors for economic transformation, as well as the establishment of appropriate infrastructure. Finally, Dr. Baguma called for the creation of an appropriate research fund to establish a coherent research system.

1.3.3 The Chairperson, Conference Organising Committee, Dr. Imelda Kashaija

As a chairperson of the Conference Organising Committee (COC), Dr. Kashaija expressed her gratitude to everyone who contributed to the success of the conference. She specifically thanked the conference organizing committee members for their excellent work. Their dedication and hard work made it possible to hold a successful conference. She recognized the efforts made by the keynote speakers and participants for sharing their research findings, knowledge and experiences. She noted that the conference provided a platform for researchers, scientists, farmers and policy makers to engage in fruitful discussions and identify solutions to challenges facing agriculture in Uganda, and Africa and developing countries at large. She emphasized that through the conference report, the conference outcomes will be disseminated to all relevant stakeholders for adaptation of the shared technical knowledge, and implementation of recommendations. The COC chairperson concluded by thanking everyone who contributed any kind and level of resource, time inclusive, and wished all participants safe travels back home.

1.3.4 The Vice Chancellor, Makerere University, Prof. Barnabas Nawangwe

Professor Nawangwe expressed his appreciation for the Minister of State for Animal Industry, Hon. Bright Rwamirama's attendance and participation in both the opening and closing ceremonies of the conference. He noted his pleasure to hear the minister's pledge to inform the government about the key outcomes of the conference. Professor Nawangwe highlighted the work being done by researchers at Makerere University to enhance agriculture development. He noted that only 0.3% of GDP is currently being spent on agriculture research and urged the government to address this issue by investing more in research and technology up-scaling. He also expressed his gratitude for the collaboration between NARO and Mak, and acknowledged the contributions of the organizing committee comprising of NARO and Mak staff.

1.3.5 The Director General, NARO, Dr. Ambrose Agona

Dr. Agona expressed his appreciation for a successful conference and acknowledged the widespread interest in the conference proceedings by all those in physical attendance and the general public who followed online. He thanked all the presenters for sharing their research knowledge with the masses. He emphasized the need for integration of modern science into research without incurring high costs, particularly in the cocoa value chain. He noted the focus on topics such as quantum genomics and bionomics but urged for more attention to be given to economics. He recognized the presence of Hon. Dr. Agnes Atim Apea, the Vice Chairperson of Parliament Committee on Agriculture, Animal Industry and Fisheries, and thanked her for accepting to grace the conference closing ceremony. Finally, he looked forward to the dissemination of shared technologies to smallholder farmers, underscoring the importance of the conference's impact beyond the confines of the conference venue.

1.3.6 The Chairperson NARO Council, Dr. William Olaho Mukani

Dr. Olaho Mukani began by expressing appreciation to the Minister for committing time to attend the conference. He also expressed appreciation to all the participants and presenters for the outstanding presentations. The Chairperson noted the evolution of the vision of the NARO-MAK conferences over the years and appreciated the contributions made towards achieving this vision. The NARO Council Chairperson emphasized the importance of teasing out policy issues as well as innovation and technologies that can be adopted by farmers. In light of this, the Chairperson requested the Conference Organizing Committee to tease out policy issues from all the conference proceedings to inform the development and adoption of appropriate policies to enhance agricultural productivity.

1.3.7 The Deputy Chairperson of the Parliament Committee on Agriculture, Animal Industry and Fisheries, Hon. Dr. Agnes Atim Apea

Hon. Atim expressed her appreciation to the DG NARO and VC Makerere University for their collaboration in organizing the conference. She also thanked the funders of the conference. Hon. Atim emphasized the need for more collaboration with other partners to provide better service to farmers. She urged scientists to confidently speak about their work as researchers and to focus on developing technologies that increase farm yields and farmers' incomes despite limited resources. Hon. Atim highlighted the importance of developing the entire agricultural value chain as well as the need to integrate soft skills in agriculture. She requested scientists and researchers to simplify research outputs for farmers, and encouraged farmers to attend conferences like this one for their own benefit.

1.3.8 The Minister of State for Animal Industry, Hon. Bright Rwamirama

In his closing remarks, Hon. Minister Bright Rwamirama acknowledged and appreciated the presenters and organizers for a well-attended conference. The minister recognized the keynote addresses on all topics, with emphasis on ICT embracement in agriculture, managing interactions, crop productivity intensification and livestock resource-based industry. He emphasized exploiting the opportunity in what Uganda has rather than what has been lost. In this vein, he appreciated the scientists who are working towards fixing the challenges faced by farmers. He noted that the conference provided insights into outputs of research such as the steady increase in export earnings for fish and coffee over the years. He appreciated the fact that it also highlighted policy issues.

On this note, the minister pledged the ministry's continued support for research and innovations. He noted the challenges brought about by fake (counterfeit) agro-chemicals and expressed the ministry's commitment towards establishing an authority to handle the issue. The minister stated that irrigation and fertilizer use are no longer an option and the government is working towards addressing these issues. He also emphasized the need to condemn corruption and enhance development within the country. In conclusion, the Minister thanked everyone for their contributions to the conference and for their time well spent. He urged everyone to work towards up-scaling the ideas and technologies presented and discussed during the conference for the benefit of all Ugandans. He requested that the proceedings be shared with cabinet for further consideration by government.

2.0 CHALLENGES AND OPPORTUNITIES IN MECHANIZATION AND AGRO-INDUSTRIALISATION

2.1 Preamble

To improve productivity of land and labour, timeliness of operations as well as access to markets, it is imperative that most levels of farming and processing are mechanized. In Africa at large and Uganda in particular, fortunes of achieving inclusive and equitable economic growth and an expansion of job market lie in development of small- and medium-scale agro-industrial firms. This sub-theme discussed recent advances and identified research gaps in mechanization and agro-industry. The aim was to contribute to accelerated economic development in Africa.

The key messages under this sub-theme were obtained from presentations and discussion of a keynote address and four (4) technical papers. The keynote paper titled "Challenges and opportunities in mechanization and Agro-industrialization in developing countries" was delivered by Mr. Ollen Wanda, the Manager, Investments Agro-industry, Uganda Development Cooperation.

The keynote paper discussed the challenges and opportunities in mechanization and agro-industrialization in Uganda. Mr. Wanda noted that there is a conducive and stable political and economic environment as well as policy frameworks such as NDP III and Vision 2040 to support mechanization, and to increase technology adoption, agro-industrialization and value addition. However, there is limited investment in, and low adoption of mechanization in Uganda. It was emphasised that a lot more still needs to be done to facilitate implementation of appropriate interventions.

2.2 Key issues

The key issues presented and discussed by the presenters are summarized below:

1. **Limited investments in mechanization:** The funding for research and acquisition of appropriate technologies for mechanization along agricultural value chains is very low in Africa as a whole.
2. **Low adoption of mechanization:** In spite of the agricultural investment scope being broadened with the aim of focusing on socio-economic transformation along its value chain, more focus is still on primary production. This limits the adoption of large-scale mechanization.

2.3 Key Recommendations

1. Governments should provide affordable financial facilities to enable acquisition of appropriate technologies for mechanization and agro-industrialisation.
2. Governments should increase funding in public institutions and universities to strengthen research aimed at generating appropriate technologies to support mechanization along the agricultural value chain.
3. Government should change its planning and budgeting approach from allocating funds only to broad functional areas such as extension, mechanization, irrigation, marketing; to also targeting a few particular (critical) commodities.

3.0 MODERNIZING POST-HARVEST MANAGEMENT AND FOOD SAFETY SYSTEMS

3.1 Preamble

Both domestic and regional demand for Africa's agriculture commodities is on a rapid rise. In addition, the increasing population of urban dwellers demand high quality food and nutrient-rich diets. This has consequently spurred the need for agribusiness dynamism; shifting from low-value smallholder farming system to a higher value-added agri-food sub-sector. This sub-theme covered innovations in food systems with emphasis on post-harvest handling, packaging, processing, nutrition, food safety, waste management and policy. The sub-theme explored appropriate post-harvest management and food safety practices that effectively service the developing trends in the food sub-sector.

Under this sub-theme, the key messages were obtained from presentations and discussions of a keynote address and seventeen (17) technical papers. The keynote paper titled "Opportunities for modernizing post-harvest management for food and nutritional security in Uganda" was delivered by Prof. Archileo N. Kaaya of Makerere University.

He highlighted the causes of postharvest losses (PHL) in Uganda and means of mitigation. He emphasised the need for addressing issues related to weak legal framework and enforcement mechanisms, weak farmer organizations and cooperatives, low awareness and poor mind-set on quality and safety standards, poor postharvest handling infrastructure, climate change effects, and misuse of agro-chemicals.

3.2 Key issues

The key issues emerging from the key note address and the scientific papers presented under this sub-theme are outlined below:

1. **Weak enforcement of existing standards:** A system for quality control that includes surveillance and testing is not fully functional resulting into trade of products that do not conform to existing standards.
2. **Poor post-harvest handling and marketing infrastructure:** Value chain actors lack appropriate infrastructure such as transport, storage and market facilities for handling produce along the entire commodity chain.
3. **Limited knowledge of postharvest handling practices by value chain actors:** Majority of value chain actors have limited understanding of market requirements and the importance of using appropriate postharvest technologies, for different commodities.
4. **Misuse of agro-chemicals:** While there is increased focus on minimising pesticide residues in produce for export, producers for local consumption are not equally attended to. Not much is being done to protect local users of the chemicals, local consumers and the environment against pesticides-based hazards.

3.3 Key recommendations:

1. MAAIF and Uganda National Bureau of Standards (UNBS) should operationalize and enforce the quality standards, including strengthening the private sector self-regulatory function.

2. MAAIF should develop suitable marketing infrastructure focusing on supply systems (cold chain, transportation, packaging and accredited testing labs systems).
3. MAAIF and the Ministry of Trade, Industry and Cooperatives (MTIC) should collaboratively establish postharvest centres in various agro-ecological zones. The centres should at least have facilities for handling produce (including perishables), training actors and creating awareness, across key commodity value chains.
4. Enhance enforcement of existing legal frameworks that will increase compliance to correct pesticide usage as a measure to minimise food contamination.

The Right Hon. Prime Minister delighted on learning about achievements of NARO-NaCORI; production of popular cup coffee.

4.0 ACCELERATING DEVELOPMENT OF THE LIVESTOCK-BASED INDUSTRY

4.1 Preamble

Income growth in both urban and rural communities has resulted into dietary shifts, leading to an increased demand for high quality animal products. Consequently, the demand for foods of animal origin such as meat, fish, eggs and milk is rising rapidly. This sub-theme highlighted the advances in livestock, poultry, and fish production and related value addition technologies. Emphasis was on pest and disease control, feeds and feeding management, water management, extension and marketing, livestock and fisheries economics, and animal resources "seed" systems.

The key messages under this sub-theme were informed by one keynote address and sixteen (16) technical papers. The keynote paper, titled "Accelerating Development of the Livestock Based Industry", was delivered by Dr. Sylvia Baluka Angubua, a national consultant in the European Commission for the Control of Foot and Mouth Disease.

In her keynote address, Dr. Baluka revealed that low quality pastures and, production systems that are not economically viable, environment friendly and socially acceptable, were the principal drivers of low exploitation of the livestock sector in Uganda. These are in addition to inadequate funding of livestock research and development needs, weak extension system and poor linkages among the sub-sector value chain actors. She also noted that the livestock sector was characterized by poor health and inadequate animal welfare, as well as high contribution to greenhouse gas emission which contribute to climate change. She emphasized the need for production of quality pasture even by small acreage holders, for increased livestock sub-sector productivity.

4.2 Key issues

As indicated below, the key issues identified through the presentations and discussions varied from research to management of livestock, fish and poultry; the three major animals focused on.

1. Considering the apparent resilience of indigenous livestock to harsh environments, Uganda's indigenous cattle has not been adequately researched on to explore its genetic potential and management requirements for optimal productivity.

2. Optimum productivity and profitability in livestock farming is rarely attained due to the huge pest and disease burden at farm level; such as tick-borne diseases and, foot and mouth disease (FMD). This leads to food insecurity and loss of income among farming households.

3. Conventional livestock drugs are sometimes not effective, and their prolonged use leads to their resistance in the target pest/pathogen. On the other hand, the effectiveness of plant-based drugs such as *Tithonia diversifolia* (tree marigold / Mexican sunflower) and Azadirachta indica (Neem) as alternatives to conventional drugs, has not been validated.

4. The importation and use of acaricides and other animal drugs is not regulated enough to minimise resistance development among livestock in Uganda.

5. For the fish industry, limited and poor-quality fingerlings supply curtails adequate availability of fish in the country. Most multipliers of fish "seed" (fry and fingerlings) have limited capacity in terms of equipment and knowledge. This leads to low productivity, production and income along

the aquaculture value chain.

6. The enforcement of regulations for deterring overfishing and capturing immature fish is weak, leading to low productivity, production and income from capture fisheries in the Uganda lakes.

7. For poultry, options for managing aflatoxin contamination in feeds are very limited in spite of aflatoxins being one of the leading causes of low commercial poultry performance.

8. In general terms, feed resources for production of quality feed are expensive due to other competing uses such as food, in addition to low productivity at farm level. Alternative feed resources such as insect farming and non-food crop varieties have not been fully exploited.

9. On meat as a commodity, there is limited research on production, preservation and promotion of traditional meat products.

4.3 Key recommendations

1. MAAIF in partnership with other relevant sectors, should heighten the support for awareness creation about the potential of indigenous livestock breeds, poultry and fish inclusive. Similarly, they should increase investment in research and promotion of resultant technologies and innovations that support agro-industrialization.

2. MAAIF should increase investment in both research and extension to enhance availability and utilization of appropriate pest/vectors and disease management measures.

3. MAAIF should strengthen capacity to produce adequate quantities and quality feed, and put in place laws to regulate animal feed production and marketing. The to-be established Food, Animal and Plant Health Authority should play a key role in this.

4. MAAIF, private sector players and National Agricultural Research Systems (NARS) should explore and promote options such as insect farming for production of cheaper feeds that do not compete with human food.

5. MAAIF should increase investment in research in, and awareness creation for management of aflatoxin in livestock feeds

6. MAAIF should enhance enforcement of existing laws and standards governing production and use of pesticides in animals

7. MAAIF and Ministry of Local Government (MoLG) should improve investment in research and market access for traditional meat products.

8. MAAIF, MoTIC and MoLG should strengthen the enforcement of regulations aimed at increased fish productivity, production, processing and marketing.

9. NARO, agricultural universities and other NARS players should include research on biopesticides (plant-based drugs) among their priorities to minimise use of chemical drugs to which pests develop resistance.

5.0 EMBRACING ICT- BASED INNOVATIONS FOR AGRICULTURAL TRANSFORMATION

5.1 Preamble

Information and Communication Technology (ICT) has demonstrated potential to revolutionize the farming sector and benefit all farmers including small land holders, if well embraced. The challenges of traditional agriculture can be significantly addressed through use of ICT to timely provide information on improved technologies aimed at increased productivity, access to markets, as well as banking and financial services. Discussions on the sub-theme addressed aspects of information communication technology infrastructure and other related initiatives applicable to agriculture and natural resource systems' improvements. Aspects of ICT policies, geo-informatics, big data, and artificial intelligence (AI) applications were considered too.

The key messages under this sub-theme were obtained from presentations and discussions of a keynote address and eight (8) technical papers. The key note address was delivered by Mr. Collin Babirukamu, the Director of e-Government Services in the National Information Technology Authority, Uganda (NITA-U).

Mr. Babirukamu emphasised ICT's importance as a tool for accelerated modernization of agricultural value chains. He noted that there is low adoption of ICT-based innovations in agriculture mainly due to limited access, by digital/ICT "engineers", to relevant resources, and adequate accurate information on crop production, agro-inputs, post-harvest handling, storage, and market access. Capacity of majority of farmers to make use of the "internet of things", and financial inclusion for most stakeholders along the agriculture value chain were also identified as limiting factors. He pointed out smart farming, mobile Apps, data analytics connected devices and e-agriculture platforms as the current ICT-based innovations being harnessed in Uganda. Mr. Babirukamu explained that: (i) Smart farming technologies, such as precision agriculture, can help farmers improve crop yield and reduce input costs. This includes using GPS, remote sensors and satellite imagery to monitor soil conditions, water levels, plant growth, as well as using drones to apply fertilizer and pesticides. (ii) Mobile Apps can help farmers access information about agricultural markets and weather forecasts, as well as access agricultural services such as agricultural inputs and financial (cashless) services. (iii) By collecting and analyzing data from various sources, such as crop yield and soil conditions, farmers can optimize their decisions about when and which crops to grow. (iv) Connected devices such as irrigation systems, soil sensors, and weather monitoring systems can help farmers track and optimize their production activities. (v) e-agriculture initiatives can help farmers access information and services, such as credit and insurance, as well as connect with other farmers, buyers and suppliers.

He concluded by calling for establishment of appropriate infra-structure for ICT innovations and development, now that it is clear that digital innovations can enable smarter, safer and more productive farming.

5.2 Key issues

The following key issues were identified:

1. The e-voucher system in Uganda has preconditions that are not supportive of use by wider farming communities. The limiting conditions include having at least one acre of land, being a member of a farmers group and access limited to one member of the family.
2. Despite advances in technology, agriculture has largely remained traditional. There is limited integration of ICT at all levels of the value chain.
3. If available, the system for ensuring appropriate collection and sharing of accurate and adequate data to feed into data analytics is not well known by all key actors and stakeholders.

5.3 Key recommendations

1. MAAIF should make adjustments in the implementation and management of the e-voucher system. The access conditions should be flexible and the target beneficiaries should be increased.
2. NITA-U and the Ministry of ICT and National Guidance should ensure integration of ICT applications along agriculture value chain.
3. NITA-U, the Ministry of ICT and National Guidance and the MAAIF should put in place strategies and guidelines for collection and sharing of data/information for use in developing digital solutions to agriculture sector transformation challenges.

The conference participants absorbedly taking note of new knowledge presented in a keynote address

6.0 INTENSIFYING CROP PRODUCTIVITY AND SEED SYSTEMS

6.1 Preamble

Over the past 50 years, increase in agricultural primary production is largely attained by expanding acreage under cultivation to meet the escalating food demands from a high population growth rate. This is, however, not sustainable since the available arable land area is finite. Intensive approaches that ensure high output per unit land area and efficient labour input are needed to close the yield gap that is characteristic of most major crop production systems in sub-Saharan Africa. This sub-theme addressed agricultural technology generation and uptake systems that impact crop productivity. Specifically, discussions revolved around agronomy, crop protection, seed systems, breeding and biotechnology for sustainable systems in crops and agroforestry.

The key issues under this sub-theme were derived from a key note address and thirty-eight (38) technical papers. The key note address was delivered by Prof. Patrick Okori, the Executive Secretary, Regional Universities Forum for Capacity Building in Agriculture (RUFORUM).

Prof. Okori delivered a keynote paper titled "Intensification of crop productivity in the context of changing food systems". In his address, he informed on how population explosion, land degradation, energy crisis and poor land use systems are reshaping food systems; making them unsustainable and unable to support livelihoods, food and nutrition security. Looking ahead to the next steps, a plea was made for efforts to ensure access to safe and nutritious food, sustainable food production and diversification of crops. Prof. Okori emphasized that attention has to be paid to building resilience to shocks and stress as well as policies that enhance direct uptake of innovative technologies by value chain actors.

6.2 Key Issues

The key issues pointed out from the sub-theme's presentations and discussions were:

1. There is lack of awareness about the importance of using quality seed among farmers. This affects productivity and profitability of the value chain. It also contributes to the existing seed systems across priority commodity value chain are not vibrant enough.
2. Due to over dependency on rain-fed agriculture, primary production is grossly affected by climate change effects especially prolonged droughts and unpredictable rainfall distribution patterns over a season. This leads to reduced production, productivity and profitability.
3. There is often a negative trade balance due to limited production and value addition along a commodity chain, plus inability to meet international standards for particular products.
4. While the national fertiliser policy and strategy were approved by Cabinet in 2016, they have never been implemented.
5. As of now, Uganda does not produce its own fertilisers. This has resulted into limited availability and high cost of both organic and inorganic fertilisers in the country. The situation was worsened by the Russia-Ukraine war. In addition to limited availability, majority of farmers lack adequate knowledge on fertiliser application.

6.3 Key recommendations

1. MAAIF should invest in acquisition and promotion of irrigation technologies to greatly contribute to mitigation of climate change effects.
2. MAAIF and private sector actors should invest in educating primary producers about the importance and benefits of using quality seed.
3. MAAIF should fast track establishment of inorganic fertilizer factory in Uganda.
4. MAAIF should invest in training farmers in application of inorganic fertilizers, as well as production of organic fertilizers using locally available raw materials. Farmer sensitisation for mind-set change towards fertilizer use is equally needed.
5. MAAIF should fast track implementation of the National Fertilizer Policy and Strategy (2016). Likewise, MAAIF, jointly with National Environmental Management Authority (NEMA) should develop and implement the National Irrigation Strategy.
6. MAAIF and Ministry of Trade, Industry and Cooperative (MTIC) should strengthen the enforcement of existing standards for agricultural products, and promote value addition and export to mitigate negative trade balance.
7. MAAIF and MTIC should put in place mechanisms for organising and availing close-to-reach agricultural markets as well as commercial community outlet centres and stores, for smallholder farmers to easily access output markets, improved seed and fertilizers.

NARO showcases the wine, flour and confections made from her newly released orange-flesh varieties of sweet potato

7.0 MANAGING INTERACTIONS AMONG AGRICULTURE, FRAGILE ECOSYSTEMS AND CHANGING ENVIRONMENT

7.1 Preamble

Africa's industrial drive will only benefit the present and future generations if there is systemic change that ensures a resilient, productive and healthy environment. In this sub-theme, conservation, judicial utilization and restoration of natural resources including but not limited to land, soil, water, forests and wetlands were addressed. The key elements covered include climate change research and innovation, climate adaptation and resilience strategies in agricultural value chains, payments for ecosystem services, climate smart agriculture, risk management, infrastructure and bioenergy.

The key issues and recommendations in this sub-theme were drawn from one keynote and 20 technical papers presentations and discussions. The keynote address titled "Sustainable management of agricultural production systems in a changing climate" was delivered by Dr. John Wasige, a senior lecturer at Busitema University.

He highlighted the link between low crop yields in sub-Saharan Africa and, high population, decline in agricultural productivity, land degradation, poor agronomic practices and lack of recycling waste. He proposed the adoption of the grand challenge of 2050 that includes recycling waste, soil and water management, as well as an increase in fertilizer use to sustain crop production and productivity. He urged African countries' governments to develop a mechanization, soil fertility, and irrigation strategy. Use of renewable energy in agriculture, and development of market infrastructure were also emphasised.

7.2 Key issues

The following key issues emerged from the presentations and discussions:

1. Pest and disease control in agriculture is dominated by use of inorganic chemical pesticides (fungicides, insecticides, herbicides). However, most users (farmers and hired labourers) have little knowledge of proper handling of the chemicals. This poses a great risk to our ecosystem especially the water bodies. The above-described situation emanates from lack of tested and trusted techniques of pest and disease control in fragile eco-system.

2. The rate of forest cover depletion is much higher than that of afforestation. If the high deforestation rate is not curbed, climate change, land degradation and their effects will continue to impact negatively on food systems and agro-industrialisation.

7.3 Key recommendations

1. The Ministry of Water and Environment (MWE) and MAAIF should strengthen capacity for enforcement of regulations and standards for use of chemical pesticides and disposal of industrial waste. In addition, they should sensitize the public about the dangers of mishandling chemical pesticides and industrial waste.

2. MWE and MAAIF should invest in development and application of tested and trusted techniques of pest and disease control in fragile eco-system.

3. MAAIF and MWE should promote access and use of alternative energy sources and strengthen enforcement of measures for protection of fragile ecosystems.

8.0 MAINSTREAMING EMERGING CROSS-CUTTING ISSUES: COVID-19, RUSSIA-UKRAINE WAR AND GENDER INTO NATIONAL STRATEGIC PLANS

8.1 Preamble

The key issues in this sub-theme were generated through presentations and discussions of two keynote addresses and four technical papers.

Prof. Robinson Mdegela from Sokoine University of Agriculture in Morogoro, Tanzania delivered a keynote paper titled "Minimising the impact of COVID-19 on agri-food systems". The second one titled "Implications of the Russia-Ukraine war on Uganda's Agriculture" was presented by Ms. Florence Nakkazi of the Economic Policy Research Centre, Uganda.

Regarding COVID-19, Prof Mdegela stressed the negative impact of COVID-19 pandemic on food systems, and emphasized that the pandemic was a complex issue due to the different approaches deployed by different countries. He noted that the lockdowns occasioned by the COVID-19 pandemic caused disruptions in the food supply chain (transport shortages and export bans), food protectionism and panic buying as well as social unrest. Affected too was shortage of labour and other agricultural inputs which led to increased production costs and exaggerated food prices. Subsequently food shortage, and ironically, increase in food wastage, especially fresh produce manifested. Malnutrition in some communities and a decline in economic growth at national levels became conspicuous. Prof. Mdegela concluded his key note address by calling upon scientists to create context-specific awareness and knowledge on the different food systems in the East-African region. He also implored African governments to strengthen and apply a systems approach that will cover all elements in the food system, to ensure that the region will always be resilient to pandemics and other emerging issues.

On the Russia-Ukraine war impact, Ms. Florence Nakkazi used fertilizer and wheat availability as a case in point to demonstrate effects and implications of global trade system disorders on agri-food systems. Focus was put on the Russia-Ukraine war's impact on Uganda's agriculture. She noted that agro-industrialisation, which is one of Uganda's 18 programmes for successful implementation of NDP III, prioritises use of inorganic fertilizers as one of the mechanisms to boost agricultural production and productivity for sustainable supply of agro-based raw materials.

That in order to enhance soil fertility, a Uganda National Fertiliser Policy (2016) was developed, and emphasised increased local production of inorganic fertilizers to lower costs. She also said that the agro-industrialisation programme prioritises agro-processing and value addition in order to reduce the total value of imported cereals and cereal products, and replace them with locally produced products. On the other hand, Ms. Nakkazi observed that seven years down the road, there is still heavy dependency on imported inorganic fertilizer and wheat. She informed that Russia and Ukraine jointly account for 27% of global wheat trade, and over 28% of global production of nitrogen, potassium, and phosphorous (NPK) fertilizers. Both countries are major sources of Uganda's fertilizers and wheat. She noted that the Russia-Ukraine war led

to exponential increase in prices of NPK fertilizers, wheat, petrol and diesel, thus exacerbating the effects of COVID-19 lockdowns. Similarly, the Consumer Price Index (CPI) for selected wheat related products grew exponentially too, negatively disrupting the agri-food systems. Ms. Nakkazi wondered what could be constraining Uganda from operationalizing the fertilizer factories in Tororo as set in the National Fertilizer policy of 2016! She also questioned why the agro-industrialisation strategies are not leveraged on to develop wheat substitutes such as flour from cassava and "matooke" to be used in bakery and pastries; and why organic fertilizers' potential cannot be harnessed. She concluded by imploring the Uganda Government to strive to have self-sufficiency and reduce its import dependency, by boosting wheat production and improving wheat productivity in the short run.

8.2 Key issues

The issues generated through the presentations and discussions are summarised below:

1. There is limited preparedness, at national level, to respond to emergencies such as wars, pandemics and climate change effects that affect agricultural productivity, trade and livelihoods.
2. While the active youth form about 20% (approx. 8 million aged 15-30 years), and most of them are unemployed, majority are not interested in traditional agricultural approaches.

8.3 Key recommendations

1. The Office of the Prime Minister (OPM) should strengthen a systems approach in order to manage the effects of emerging issues. In addition, government should facilitate establishment and maintenance of agro-based industries as well as reserves for essential items like fuel and food.
2. MAAIF, MoICT and National guidance (MoICT&NG), and the Science, Technology and Innovations (STI) ministry should develop approaches that integrate mechanisation and ICT applications along the agriculture value chain, to attract the youth in agriculture.
3. MAAIF, MoICT&NG) and STI should involve youth in developing digital solutions for agricultural sector.

The Right Hon. Prime Minister signing in the book of the Inqaba Biotech East Africa Ltd -Uganda, after explanation of its services, by Mr. Godfrey Biso

9.0 OVERALL RECOMMENDATIONS

10.1 Preamble

From different presentations, speeches, and discussions, the conference brought to light a number of issues that undermine the agricultural sector in Uganda in particular and Africa at large. Topping them was limited use of fertilizers, quality seed and irrigation in the era of climate change. Misuse of chemical pesticides and drugs in attempts to control the increasing infestation of various types of pests and disease incidences came out strongly too. Poor postharvest handling practices, limited value addition, unstable supply and demand of agricultural products as well as volatile market prices were recognised as key challenges too. All the above-mentioned and other constraints were found to greatly contribute to the unending situations of low productivity, production and profitability of most agricultural commodities and enterprises.

The end-user awareness and access to beneficial technical information, knowledge, technologies and innovations was pointed out as one of the limitation to application of appropriate agricultural practices. On the other hand, inadequate investment in research and development (i.e. technology generation, promotion and dissemination) requirements, limited operationalisation of developed policy frameworks and imperfect enforcement of regulations and standards was considered to be the weakest link in the agricultural value chain.

It is noteworthy that the conference recommendations were based on key issues identified to be limiting full achievement of Uganda's goal of agro-industrialisation, and its contribution to the SDGs'. Implementation of these recommendation, therefore, needs support and cooperation of all of us: relevant government ministries, departments and agencies, private sector organisations and companies, civil society organisations and development partners.

The recommendations from the 3rd Biennial NARO-MAK Joint Scientific Conference, are categorised into five (5) functional components as expressed below.

1. Productivity enhancement recommendations

1. Governments, through ministries responsible for finance and economic development, should heighten investments in research and development (R&D) as well as extension in the national agricultural research and extension systems (NARES) in order to achieve enhanced and timely appropriate technology development, dissemination and transfer to intended end-users

2. Governments of developing countries should provide affordable financial facilities to enable acquisition of appropriate technologies for mechanization and agro-industrialisation in their respective countries

3. MAAIF, private sector players and National Agricultural Research Systems (NARS) should explore and promote options of producing feeds that do not compete with human food, and at affordable costs. Examples include insect farming.

4. MAAIF should fast track establishment of the earlier communicated inorganic fertilizer factory in Uganda so as to minimize effects associated with reliance on imported fertilizers.

5. MAAIF should invest in training farmers in application of inorganic fertilizers, as well as production of organic fertilizers using locally available raw materials. Farmer sensitisation for mind-set change towards fertilizer usage is equally needed.

6. MAAIF and private sector actors should invest in educating primary producers about the importance and benefits of using quality seed, to increase its utilisation.

7. MAAIF should make adjustments in the implementation and management of the e-voucher system. The access conditions should be flexible and the target beneficiaries should be increased.

8. The Ministry of Water and Environment (MWE) and MAAIF should invest in development and application of tested and trusted techniques of pest and disease control in fragile eco-system in order to maintain their production equilibrium.

2. Enhancement of agricultural value chains recommendations

9. Government of Uganda should change its planning and budgeting approach from allocating funds only to broad functional areas such as extension, mechanization, irrigation, marketing; to also targeting a few particular (critical) commodity chains.

10. MAAIF and the Ministry of Trade, Industry and Cooperatives (MTIC) should collaboratively establish postharvest centres in various agro-ecological zones. The centres should at least have facilities for handling produce (including perishables), training actors in all aspects of trade, and creating market awareness; for key commodity value chains.

3. Enabling Environment recommendations

11. MAAIF, MWE and Uganda National Bureau of Standards (UNBS) should strengthen capacity for enforcement of regulations and standards (including boosting the private sector self-regulatory function) for use of chemical pesticides (both in plants and animals), and disposal of industrial waste in order to minimise trade of products that do not conform to existing standards. In addition, they should invest in effective sensitisation of the public about the dangers of mishandling chemicals pesticides and industrial waste.

12. MAAIF should strengthen national capacity to produce adequate quantities of quality feed, and put in place laws to regulate animal feed production and marketing. The to-be established Food, Animal and Plant Health Authority should play a key role in this.

13. MAAIF, MTIC and Ministry of Local Government (MoLG) should strengthen the enforcement of regulations aimed at increased fish productivity, production, processing and marketing.

14. NITA-U and Ministry of ICT and National Guidance (MICT&NG) should facilitate and fast-track integration of ICT applications along agriculture value chains.

15. NITA-U, MICT&NG and MAAIF should put in place strategies and guidelines for collection and sharing of data/information for use in developing digital solutions to agriculture sector transformation challenges.

16. MAAIF should fast track implementation of the National Fertilizer Policy and Strategy (2016).

17. MAAIF, jointly with the National Environmental Management Authority (NEMA) should develop and implement the National Irrigation Strategy.

18. MAAIF and MTIC should intensify programmes and systems that promote value addition and export of both plant and animal products, to mitigate negative trade balance.

19. The Office of the Prime Minister (OPM), Uganda, should strengthen a systems approach in order to manage the effects of emerging issues. In addition, government should facilitate establishment and maintenance of agro-based industries as well as reserves for essential items like fuel and food.

20. MAAIF, MICT&NG, and the Science, Technology and Innovations (STI) ministry should develop approaches that integrate mechanisation and ICT applications along the agriculture value chain, to attract the youth in agriculture.

21. MAAIF, MICT&NG) and STI should invest in involving the youth in developing digital solutions for the agricultural sector.

4. Climate change effects management recommendations

22. MAAIF should invest in acquisition and promotion of irrigation technologies to greatly contribute to mitigation of climate change effects.

23. MAAIF and MWE should promote access and use of alternative energy sources and strengthen enforcement of measures for protection of fragile ecosystems against climate change effects, among others.

5. Cross-cutting recommendations

24. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) should carry out regulatory impact assessment on agriculture to come up with the most feasible policy options to curb issues affecting agriculture across the entire agriculture value chain.

25. Government through its relevant ministries, department and agencies should invest in systematic development of the entire agricultural value chain, including incorporation of IT and soft skills, and establishment of an e-working group that identifies and prioritizes agricultural transformation needs.

26. With regard to the biennial scientific conference NARO and Makerere University should widen scope of the conference presentations' knowledge base by bringing on board the other universities, especially those with agricultural colleges or faculties, in the conference organisation.

27. With the support of MAAIF, District Local Governments (DLGs) and Private Sector Foundation Uganda (PSFU), the institutions organising the conference should encourage farmers and agricultural-related private sector companies and organisations to attend such conferences and benefit from the knowledge shared.

The Prime Minister Right Hon Robinah Nabbanja appreciates the works of Uganda's National Oil Palm Project (NOPP), explained by Mr. Anthony Wanyoto

10.0 CONCLUSION

The conference concluded the following:

1. The challenges and opportunities in agricultural mechanization and agro-industrialization are significant. Mechanization can increase efficiency and reduce labour costs, but it requires significant investment and can lead to job losses in some cases. However, with the right policies and investment, mechanization can provide opportunities for entrepreneurship and job creation in the manufacture and maintenance of machinery.

2. Modernizing post-harvest management and food safety systems is essential for reducing post-harvest losses and ensuring food security. Improvements in storage, processing, and packaging can reduce spoilage and improve the quality and safety of food products. It also requires strong regulatory frameworks and investment in training and infrastructure.

3. Intensifying crop productivity and seed systems is essential for meeting the growing demand for food. This involves developing new seed varieties that are more resilient to climate change, pests, and diseases, as well as improving crop management practices such as irrigation and fertilization.

4. Accelerating development of the animal resources based industry is critical for meeting the demand for animal products such as meat, milk, and eggs. This involves improving animal health and productivity, as well as promoting value-added products such as processed meat and dairy products.

5. Managing interactions among agriculture, fragile ecosystems, and changing environment is a critical challenge. Agriculture often has significant impacts on ecosystems and the environment, and climate change exacerbates these impacts. Sustainable land use practices, conservation measures, and climate-smart agriculture can help mitigate these impacts.

6. Embracing ICT-based innovations for agricultural transformation is another key opportunity. Digital technologies can improve the efficiency and effectiveness of agricultural production and supply chains, as well as provide access to critical information such as weather forecasts and market prices. However, access to these technologies is not universal, and there is a need for investment in infrastructure and capacity building to ensure that everyone can benefit from these innovations.

The 3rd NARO-MAK conference participants relaxing at a networking session, after gainfully attending all the sessions

11.0 GALLERY

Rt – Lt: The COC chairperson Dr. Imelda N.Kashaija, Prime Minister Rt. Hon. Robinah Nabbanja, Dr. William Olaho Mukani, Dr. Abel Atukwase

MAAIF minister Hon Bright Rwamirama (5th from right) at the conference opening ceremony

The Right Hon. Robinah Nabbanja keenly listens to the story of Soybean seed availability, by Prof. Phenihas Tukamuhabwa

Some paper presenters attending to questions and comments after their presentations

The Speke ball room, Munyonyo Speke Resort, filled with attentive conference participants

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

Some members of the Conference Organising Committee (COC); happy over the success of their efforts

Participants reposeful over entertainment by Ndere Group

More members of the COC

Group photo: some sponsors, organisers and presenters with the Hon. Minister Bright Rwamirama at closing the conference

Active participation in a parallel session on fisheries

Active participation in a parallel session on Livestock

Participants praying for a smooth running of the conference

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

The MAAIF Minister Hon. Bright Rwamirama ushered in by the COC chairperson, Dr. Imelda N. Kashaija, to officially close the conference

Announcement

Dear Reader,
Please note that NARO-MAK Conference is biennial

Visit ***www.naromakconference.org*** for updates

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