




# NATIONAL CROPS RESOURCES RESEARCH INSTITUTE

## Annual Report 2014-2015

## Crops Research for Impact

NaCRRI
NATIONAL CROPS RESOURCES RESEARCH INSTITUTE

NARO


NATIONAL
RESOURCES

Ejua Peace Clement

The National Crops Resources Research Institute (NaCRRI) is one of the six Agricultural Research Institutes under the co-ordination of the National Agricultural Research Organization (NARO).

NaCRRI's mandate is to conduct research and knowledge generation on crops of strategic national importance including; cassava, sweet potatoes, beans, maize, rice, oil palm, and horticultural crops.

**Vision:** To become a Centre of Excellence for all aspects of crops research and accelerated development.

**Mission:** To generate, develop and disseminate appropriate crop technologies, methods and knowledge while conserving the environment and crop genetic resources.

NATIONAL CROPS RESOURCES RESEARCH INSTITUTE (NaCRRI)



# Acronyms

| | | |
|---|---|---|
| AGRA | - | Alliance for Green Revolution in Africa |
| CIMMYT | - | International Maize and Wheat Improvement Center |
| FAO | - | Food and Agriculture Organization |
| IDRC | - | International Development Research Centre |
| IFAD | - | International Fund for Agricultural Development |
| IITA | - | International Institute of Tropical Agriculture |
| ILRI | - | International Livestock Research Institute |
| MAAIF | - | Ministry of Agriculture, Animal Industry and Fisheries |
| MLN | - | Maize Lethal Necrosis |
| NaCRRI | - | National Crops Resources Research Institute |
| NARO | - | National Agricultural Research Organization |
| NISCU | - | National Invasive Species Coordination Unit |
| RYMV | - | Rice yellow mottle virus |
| UBIC | - | Uganda Bioscience Information Center |
| UBRTC | - | Uganda Biosciences Research and Training Center |
| WEMA | - | Water Efficient Maize for Africa |

# Foreword by the Director



**DR. GODFREY ASEA**
DIRECTOR

I am proud of the tremendous effort of the research teams in accomplishing the key milestones in the year. Sincere appreciation to our development partners who have supported our efforts variously; from reinforcing our contributing towards addressing food and nutrition security, to supporting Uganda's crops research agenda through knowledge exchange, infrastructural, and human capacity development among others.

Welcome to our Annual Report for the Fiscal Year 2014-2015, where we highlight some of the key research activities, popular achievements that have defined the institute, and reflect on opportunities and research areas moving forward. I am proud of the tremendous effort of the research teams in accomplishing the key milestones in the year.

Sincere appreciation to our development partners who have supported our efforts variously; from reinforcing our contributing towards addressing food and nutrition security, to supporting Uganda's crops research agenda through knowledge exchange, infrastructural, and human capacity development among others. Ours is a story of commitment, perseverance, and humbling success in generating research outcomes for impact, for a healthier and wealthier populace. I therefore welcome you to read more about some of the exciting research activities in this report.

NaCRRI epitomizes a nation that is determined to match its internal capacities with the increasing global and regional changes in research and technology for development. I therefore thank the Government of Uganda that has sustained a favorable policy environment for agricultural research and collaborations. Through one such collaboration- with the World Bank, NaCRRI has remained true to its status as a Center of Excellence for Cassava Research in East Africa, with the opening of a multi-storey cassava research office block at the heart of the institute. Its facilities include: offices, a resource center, and conference facility.

Also to be commissioned soon are the Conservation and Nutrition Analysis laboratories to provide safe-keeping on crop species and conduct high-tech analysis on food compositions respectively.

Furthermore, NaCRRI has been chosen by the Government of Uganda, through NARO, to host two newly established units: the National Invasive Species Coordination Unit (NISCU) and the Uganda Biosciences Research and Training Centre (UBRTC).

The NISCU will coordinate all efforts in management of invasive species on biological diversity, ecosystem functioning, climate change and land-use as well as generate and deploy scientific control innovations through cutting edge research while UBRTC is hoped to become a Center of Excellence by carrying out highly specialized crop research, analysis, and training in modern biosciences. I am glad that all these new developments come at a time when NaCRRI is celebrating a decade of service, following NARO reforms under the NARS Act of 2005.

I wish to heartily thank the NaCRRI Advisory Committee for their forthright and beneficial counsel to the management and staff of the institute. At NaCRRI, we are mindful of the relevance of strategic leadership and guidance as we go about our business, and so we highly take the advice of this team and thank them for sharing their knowledge and experience. The term of office of the current members of the Advisory Committee will expire at the end of 2016 and we most earnestly thank them and wish them the best in all their undertakings even outside NaCRRI.

Looking back at FY 2014-2015, we are proud of dedicated team work, increased partnership and continued support that has enabled us come this far. This year, we celebrate the achievements but also reflect together with stakeholders to tackle many of the challenges that still remain ahead of us. Lastly, I take this opportunity to wish you a fruitful 2016, and I look forward to working with you as we continue to pursue our mandate in agricultural research.

**Dr. Godfrey Asea**
**Director**

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# Preface

During the Fiscal Year 2014-2015, NaCRRI made good progress towards enhancing agricultural research outcomes in Uganda, particularly for crops of national importance (cassava, sweet potatoes, beans, maize, rice, oil palm, and horticultural crops). Tremendous efforts were made towards realization of food self-sufficiency, social economic development, and environmental protection and preservation.

In this year, once again, our research work addressed a plethora of crop production challenges such as crop diseases and pests, drought, low nutrient levels, poor crop management practices, and technology dissemination. These research areas formed the basis for key investment for the institute, and were also informed by NARO's overall research agenda as well as the National Strategic Development Plan 11.

Key investment areas for FY 2014/2015 were in crop variety development with emphasis on addressing major biotic and abiotic stresses, human and institutional capacity strengthening, technology promotion and dissemination and value addition. Other focus areas also included bio-fortification of food crops with enriched micro-nutrients as well as environment management while increasing crop productivity in fragile eco-systems such as wetlands.

Through these diverse research areas and robust partnerships, the institute has contributed significantly to addressing production challenges as well as developing and releasing adapted crop varieties to the agro-ecologies in Uganda including the recent two high-yielding cassava and three stress tolerant maize varieties and several pipeline products.

We also explored and continue to use high-end science such as biotechnology and genomics selection to hasten crop breeding processes and address disease and pest problems. Efforts were also directed towards connecting our agricultural research to end-users through robust technology promotion and dissemination pathways and production of diverse knowledge products. This report details all our major achievements for the year and outlines key activities for 2016.

### Where we are going...

In the year ahead, NaCRRI plans to consolidate the efforts highlighted above to leverage efforts towards addressing production constraints in the major food crops in the country. Efforts will be increased in supporting value chains. This will be done through increasing production of early generation seed and strengthening of seed systems for improved delivery of quality planting materials for cassava, sweet potato and indigenous vegetables.

Increased migration to use and adoption of technology-driven databases such as Integrated Breeding Management System and Cassava Base as well as increased automation, mechanization and high throughput operations will be emphasized to accelerate breeding efficiency and increase genetic gains.

Most research programs at the Institute are increasingly using a mix of breeding techniques such as genomics and phenotyping to come up with most workable solution to some of the most problematic crop challenges, including: diseases, pests, nutritional deficiency, and climate change effects such as drought. These approaches, some novel and complex, will define part of our research activities in 2016. Uganda subscribes to the global agenda to tackle major global development challenges such as eradicating hunger, improving nutrition and making food systems more sustainable by 2030; and we at NaCRRI are desirous of contributing to this agenda.

Enhancing nutritional quality and food safety on elements such as combating levels of aflatoxins in maize, integrated pest management options, biofortication and better crop management technologies will equally makeup the thrust of research in the coming year. Understanding socio-economic factors driving adoption and monitoring of varietal movement as well as contributing to policy information will also be our focus this year. Our research agenda in the New Year will focus on forward-looking strategies to address uncertainties and complexities in agriculture in Uganda.



# Funding



## NaCRRI Leverages Government and Donor funding

In the financial year 2014-2015, NaCRRI's funding portfolio included 24 active funding sources valued at $ 2.6 million. Some of the key projects are listed below:

- Strengthening and scaling-up technology service delivery, and promote integration of smallholders in value chains funded by the Government of Uganda.
- Enhance regional specialization in agricultural research and transfer of agricultural technologies across national boundaries funded by the World Bank and partners.
- Develop drought-tolerant and insect-protected maize using conventional and marker-assisted breeding funded by the Bill & Melinda Gates Foundation.
- Increase the use of beans for improved food and nutrition security, income generation and conservation of natural resources in Uganda funded by IDRC.
- Establish a functional cassava seed system in Uganda funded by the Bill & Melinda Gates Foundation.

# Highlights of key achievements in 2014-2015

## New technologies released

There is increased rate of crop variety release and replacement of old varieties that have over time succumbed to pests and diseases. The breeding and product pipelines of various commodities are full with a focus on increased genetic gains. The highlight of FY2014/2015 was variety release for commercialization of 2 cassava varieties resistant to CMD and tolerant to CBSD yield and 3 stress tolerant maize hybrids combining disease resistance, drought and low nitrogen tolerance. The new cassava variety NaroCass 1 which is tolerant to virus diseases, together with the previously released NASE 14 and NASE 3 are now widely used in the beer production industry for example Engule.

## Research extension and farmer interface

In order to increase uptake and adoption of crop technologies, various approaches were employed in 2014/2015 to build awareness and improve knowledge. NaCRRI conducted a total of over 600 adaptive and demonstration trials in the various agro-ecologies in the country. These focused on performance of recently released varieties, improved agronomic practices, and post-harvest handling and storage. Our research work garnered substantial media coverage and presence in the period under review and our online presence and interaction continued to grow on social media platforms.

## Production of early generation seed (EGS) to support quality and timely seed delivery of improved crop varieties

Access to quality seed of improved varieties remains a challenge due to various bottlenecks in the EGS chain – i.e. breeder, pre-basic, and seed. In the FY 2014/2015 significant efforts were made in production and availability of pre-basic and basic seed including 52,476 bags of clean cassava vines; 152.2 t of commercial bean varieties; 4.5 tonnes of rice, 5.2 tonnes of commercial maize varieties; 1,000 bags of clean sweet potato cuttings and 8,100 grafted mango and citrus seedlings. Models for efficient and sustainable seed systems for cassava and sweet potato as well as vegetatively propagated crops continue to be validated. In addition, we piloted and validated models for marker systems for enhancing quality assurance and control alongside seed value chain for maize.

## Functional Laboratories and equipment

The newly established Conservation, Bio-analytical and Molecular Laboratories at the Institute have been adequately equipped with state-of-the-art equipment to conduct cutting-edge research in biotechnology, specialized analytics, pest and pathogen diagnostics, nutrition and food analysis. This has drastically reduced the cost of sample analysis through contracted analyses with other private laboratories.

## Increased use of high throughput technologies for increased genetic gains

The maize breeding team is implementing double haploid induction to speed up the rate of inbred line development using the regional DH facility established in KARLO- Kiboko site, in Kenya and a total of 4 maize populations were induced.

Efficient transformation and regeneration system for two cassava varieties (TME 204 and Ebwanatereka) were optimized.

Cassava breeding team is implementing the use of genomic selection for improvement of cassava for brown streak resistance. With this approach, customized training sets were developed for predicting individual populations by using the most informative populations in the larger pool of genotype and phenotype data and identified one major QTL on chromosome 11 for brown streak resistance explaining 14% of genetic variation.

## Human Capacity and Infrastructure

Seven Scientists graduated with Master's Degrees and 6 with PhDs in diverse competencies in the FY 2014/2015.

The Institute was equipped with new state-of-the-art structures and laboratories to conduct cutting-edge research. Some include; Nutritional and Conservation Laboratories, Cassava Regional Center of Excellence office block, drip irrigation facility, 7 Screen houses and civil works for Rainout shelter drought screening facility started.

## Scores on NARO Competitive Grants

ATAAS funding is supporting a total of 3 projects in NaCRRI in 2014/2015 under the NARO Competitive Grant Scheme on commodities including; mangoes, citrus and maize. Research on maize is focused on evaluating striga control strategies to identify farmer appropriate technologies.

Mango studies are directed at introducing off-season mango production while research on citrus is targeted at developing management packages for reducing losses attributed to citrus leaf & fruit spot diseases as well as fruit-fly damage in major fruits.

# Key Research Challenges and Progress In 2014/2015



## Battling Maize Lethal Necrosis

Maize production continues to be threatened by the spread of the Maize Lethal Necrosis (MLN). The disease was first reported in Uganda in 2012 in three districts in the eastern region; but by 2015, more than 18 districts were affected. In the region, MLN was first reported in Kenya in 2011 with symptoms that include; mottling of the leaves, small cobs with few grains, and necrosis of young leaves, leading to plant death. By the end of 2012, it had spread to Tanzania, Rwanda and Uganda with reports in South Sudan, the Democratic Republic of Congo and Ethiopia. The U.S Department of Agriculture has projected that the disease will spread and intensify across many African countries by 2020.

To reverse the tide and rampant devastation in the country, a robust in-country and regional partnership was established. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and FAO coordinated surveillance and sensitization of all extension agents from Local governments; and developed a national strategy and training manuals to tackle the problem comprehensively. The National Maize Research Program at NaCRRI conducted surveys and in collaboration with the Ohio State University, confirmed two viruses as the casual agents of MLN in Uganda. With support from Bill and Melinda Gates Foundation, the Syngenta Foundation for Sustainable Agriculture, CIMMYT and KALRO, a regional screening facility was established at Naivasha. The latter has screened a total of 385 maize germplasm including inbred lines and hybrids.

In 2015, 19 MLN tolerant inbred lines were acquired from CIMMYT and another 38 resistant inbred lines were sourced from US to initiate a comprehensive breeding program for MLN. Additionally, the first generation of MLN tolerant hybrids were sourced from CIMMYT and entered in national performance trials as "stop gap" varieties. Two of these were commercially released as NH5354 and NARO maize56 (NH5556), being multiplied by NASECO as Bazooka and Victoria Seeds respectively. Uganda also instituted a National Taskforce under the Crop Protection Department at MAAIF, to coordinate control and management of MLN.

## Zero tolerance to cassava brown streak disease

NaCRRI has dedicated a sizeable amount of resources - both human and financial, to tackle attacks of viruses such as Cassava Brown Streak and Cassava Mosaic, that contribute to declining production of the food security crop. According to NaCRRI 2015 Annual Cassava Pests and Diseases Monitoring Survey, the Cassava Brown Streak Disease (CBSD) was the most devastating crop disease in Uganda. The central region was the most affected; with a disease incidence of over 70 percent. This was closely followed by the eastern region with an incidence of up to 50 percent.

CBSD affects the edible part of cassava (storage roots or "tubers"), making them dark and unpalatable. The disease was reported for the first time in Uganda (Mukono and Wakiso districts) about 12 years ago. The high CBSD incidence is attributed to the large numbers of the whitefly vector in these areas, lack of access to disease-free planting material and lack of knowledge on disease management. As part of its research interventions, NaCRRI conducted a mapping exercise to plot CBSD, CMD and virus incidences on farmers' fields in 20 districts and provide up-to-date information needed for disease control decision making.

In addition, farmers were trained on CBSD management and demonstration fields were planted in Lira and Nakaseke districts, to teach farmers the benefits of using virus resistant cassava varieties. Six breeders' trials in Kamuli, Namulonge, Kaberamaido and Arua were monitored for performance against CBSD.

At a regional level, Uganda, represented by NaCRRI, is taking part in multi-tier research interventions to address problems affecting cassava, key among which is CBSD. Five countries in Eastern and Southern Africa have assembled and exchanged their best 25 cassava genotypes and established regional trials to assess CBSD and CMD dual resistance.

Meanwhile, a cassava seed system is now under development to ensure reliable and timely access to clean cassava planting materials by smallholder farmers. The project is set to establish at least 60 cassava seed entrepreneurs to reach over 4,000 smallholder farmers with clean planting material consisting of tolerant varieties such as NASE 14, NASE 18 and NASE 19.



The improved cassava whitefly control, a functional seed system coupled with good management practices will result into reduced spread of cassava-virus diseases and will help to address the need to improve rural incomes, productivity and sustainability of smallholder farmers.

## HOW RYMV AFFECTS RICE PRODUCTIVITY

When the virus attacks during the early germination stage, it prevents the diseased plant from developing panicles. Panicles bear rice flowers. Rice flowers are white, small and oval shaped. This means that RYMV prevents rice from flowering. Rice flowers are what develop in to seed. Spikelets or individual rice flowers are the ones which fill with the milky sap that harden into rice seed. If the virus attacks during flowering, the panicles may not develop normally or may develop but not fill up, making it sterile. In short, RYMV directly attacks the plants ability to produce rice seeds.

**Transmission:**

- Physical contact between infected and healthy plants.
- Insect vectors like beetles and grasshoppers.
- Injuring plants during weeding or transplanting in the presence of virus particles.
- Or, through touching.



### Squaring off with Rice Yellow Mottle Virus

Rice yellow mottle virus (RYMV) is a key viral constraint to rice production in Africa and increasingly in other parts of the world. First identified in Kenya nearly 50 years ago, RYMV can cause yield losses of 10 to 100% depending on the rice variety and period of infection. Early infection normally leads to higher losses. This disease is characterized by yellow or orange leaf discoloration, stunting and sterility. Death of the plant usually occurs as well as grain discoloration.

Growing rice varieties that are resistant to RYMV is the most viable solution to the virus. In addition to this, scientists at NaCRRI, through the Promotion of Rice Development (PRiDE) project are currently at advanced stages of breeding RYMV-resistant rice varieties. This research is focusing on nine groups of rice plants which have been found to have different levels of resistance to RYMV. The process began in 2012 when the nine plants were selected from about 250 plants which had been developed by cross-breeding NERICA 4 and WITA 9 rice varieties.

The first generation of cross-bred seeds resulted in the selection of nine resistant seeds in the second generation after tests were carried out to confirm the RYMV resistance on these nine plants. So far, researchers have identified suitable strains against the disease and more research is being carried out on these strains.

# Key Investment Areas in 2014/2015

## CONTRIBUTING TOWARDS INCREASED FOOD SECURITY AND VALUE ADDITION

### New high-yielding cassava and maize varieties released



In September 2015, NARO, through NaCRRI, officially released two new cassava and three maize varieties for food and/or commercial production in Uganda. The new varieties are of higher agronomic and/or economic value and are markedly distinct from all previously released varieties. The Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF), the custodian of records of all released varieties, approved the release of these two varieties.



The two cassava varieties released: NAROCASS1 and NAROCASS2 are high-yielding, aromatic, and sweet in taste, and thus qualify them for both fresh and processed consumption. In addition, these varieties are resistant to Cassava Mosaic Disease and tolerant to Cassava Brown Streak Disease, both of which are currently the major causes of yield loss in cassava production in Uganda. On the other hand, the three new maize varieties: NH5503, NH5556, and NH5557, are high yielding, disease and drought tolerant. Variety NH5556 is especially tolerant to maize lethal necrosis, a relatively new deadly disease ravaging maize crops in the East African sub-region; hybrid NH5557 can flourish even in poor quality soils. We are optimistic that these varieties will improve food security and enhance incomes of maize farmers. NARO has identified seed growers and/or seed companies to be involved in the bulking-up of these new varieties.

### Boosting off-season mango production



Traditionally, the months of June and December are associated with peak mango harvesting and marketing throughout Uganda. Thus, farmers' annual incomes are only limited to these periods, a situation that is unfortunate. This scenario presents a major obstacle to processors that largely rely on fresh mangoes as a raw material.

In fact, the demand for mangoes during off-season usually goes up to around 24 tonnes per week. During that period, this demand in Uganda is quenched by imports from Kenya and Tanzania. In response to this challenge, NaCRRI scientists are currently exploring the possibility of sustaining optimal mango production during off-season. Currently, two varieties (Tommy atkins and zillate), hvae been induced to flower through application of potassium nitrate. Technically, this initiative is expected to ensure mango harvesting and marketing in February, a month after the end of the second traditional mango season of the year. NaCRRI scientists are optimizing this technology (identifying suitable areas for flower induction and which varieties to promote). Once this technology is proven, it will be promoted in all major mango producing regions.

## Introducing pre-cooked beans for greater food and income security



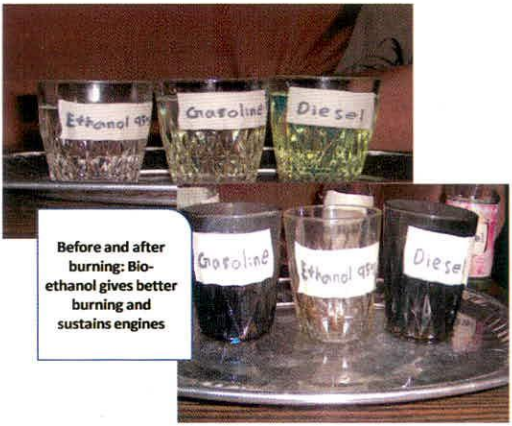
Approximately 85% of the 18 million rural Ugandans grow and depend majorly on beans as food and for income generating purposes. Beans contribute to food security and are an important source of nutrients; providing a cheap source of human dietary protein (45%), calories, zinc, iron, calcium, folic acid, soluble fiber, complex carbohydrates and other essential minerals, good for prevention of diabetes and high blood pressure. However, their consumption is low due to their long cooking time and high fuel requirements. Bean researchers in Uganda are therefore making interventions to improve this state of affairs. Researchers at NaCRRI are part of a national effort to commercialize a precooked bean product that will see consumers cook beans for only 15 minutes, as opposed to hours, before serving. This precooked bean product is envisaged to save almost 80% of cooking fuel.

Other products under development include fortified bean flour which is nutritionally enhanced with calcium, iron, and folic acid to aid in the fight against malnutrition. The Food and Agricultural Organisation of the UN recognizes malnutrition as one of the indicators of food insecurity. In addition, a "Ready-to-eat" bean snack has also been developed and is currently under shelf-life testing stage.

All these products are being developed under the ultimate objective of increasing bean consumption, improving diets, reducing on cooking time and fuel and creating a more lucrative market for bean growers while improving and diets and nutrition of the consumers. To realize

this, farmers have been organised in groups to multiply and supply specially selected bean varieties to pre-cooked bean processing plants, thereby generating income and enhancing the capacity for bean production in the country. A total of 76 farmer groups with a membership of 3092 farmers have already been profiled from 10 districts.

## Adding value to cassava through industrialization




Before and after burning: Bio-ethanol gives better burning and sustains engines

Since cassava was introduced in Uganda 150 years ago, it has largely remained a food security crop for survival of human. Elsewhere, particularly, in Latin America and Asia, cassava has assumed more roles as a feed and/or raw materials for several non-food uses owing to its starch characteristics. NaCRRI has so far released more than 20 improved varieties of cassava, each having unique attributes for food and/or industrial applications. Although it is grown mainly for food, a family can hardly consume 40% of what is yielded. The dilemma then is about how to use the remaining cassava from harvest. One avenue to address this is to use cassava for industrial purposes.

Bioethanol, bio-degradable plastic packaging materials and high quality syrups, all processed from cassava starch are some of the pilot products being developed at the recently inaugurated Nutritional Biochemistry and Physiology laboratory at NaCRRI. Interventions are largely focused on establishing protocols for target industrial applications. Prototypes of the bio-degradable plastic packaging material, bio-ethanol as well as the syrup where unveiled in 2015 and are thus being promoted for private sector commercialization.



## TECHNOLOGIES FOR ENHANCED NUTRITION AND FOOD SAFETY

### Introducing high-nutrient bean varieties




Beans are key sources of zinc and iron recommended for expectant mothers and children for prevention of anemia. Rather than get the required iron and zinc from food supplements which are expensive, the easier option is to eat beans high in zinc and iron. The Legumes breeding program at NaCRRI has identified bean lines with high iron and zinc nutrient content. The Team evaluated and screened some of these lines at multi-location sites in all regions of the country for adaptability, nutrient content, yield performance and palatability. In addition, various palatability tests were conducted with different farmer groups and the most preferred bean lines for consumption and marketing were identified through farmer participatory cooking and tasting.

To enhance easier access to the new high iron and zinc bean varities, seed multiplication for these varieties was initiated and has progressed tremendously with currently about 2.6MT available on-station. This is in addition to initiatives for seed production with individual famers and famers groups. Farmers have been trained in seed production and marketing with the hope that by the time of official variety release, there will be enough seed directly with the famers.

### On-going efforts to bio-fortify food crops at NaCRRI

Vitamin A deficiency in human is associated with retarded growth, increased risk of diseases, and reproductive disorders. Unfortunately, Vitamin A is deficient in many of the food staples commonly grown and consumed in Uganda. Its thus not surprising that Uganda is one of the countries hardest hit by Vitamin A deficiencies.

At NaCRRI, we have recognized this challenge and thus identified three staples for which we are targeting to fortify: cassava, sweetpotato and maize. For sweet potato, tremendous effort in development and promotion of biofortified orange-fleshed sweetpotato varieties has been ongoing for the last few years, and indeed up to nine varieties have been released. For cassava and maize, 15 and seven lines respectively are under advanced evaluations.





### Combating maize aflatoxins

Aflatoxins are re-known poisonous and cancer-causing chemicals that are produced by molds (e.g Aspergillus species) that are resident in grain if not well managed. Maize is no exception to this. This is a widespread problem in sub-Saharan Africa that needs urgent attention. Recent findings in Uganda established that at least 10% of the maize samples collected had aflatoxin content which is above the acceptable level of 10ppbs. Accordingly, maize pathologists at NaCRRI are now engaged in developing interventions to combat the effect of aflatoxins through breeding for resistance, establishing bio-control approaches and the use of bio-technology. Farmers are also being informed about the problem and how best to control and/or limit its effects through proper post-harvest handling.

## USING BIOTECHNOLOGY TO PROVIDE SOLUTIONS TO AGRICULTURAL PROBLEMS IN UGANDA

### Drought, disease and insect problems addressed through use of biotechnology tools



NaCRRI continues to register strides in engaging genetic modification to undertake confined research towards addressing key stresses that limit optimal production of maize, cassava and rice. Notable of these stresses include; drought tolerance as well as virus and insect resistance. Confined field trials (locations where this research is only permitted to be undertaken) at different levels and/or stages are on-going for maize, rice and cassava in different locations of Uganda. As witnessed elsewhere, this technology is expected to generate better crop varieties for Ugandan farmers.

For the case of maize, a few candidate lines have been identified for drought tolerance and insect resistance. For rice, several lines that are tolerant to drought and use soil nitrogen efficiently have been identified. These candidate lines are currently undergoing further evaluations. For cassava, lines that are immune to cassava brown streak disease have also been identified.

## Exploiting genomic selection for rapid cassava and sweetpotato improvement





Both cassava and sweetpotato have been, and will continue to be major crop commodities in Uganda owing to the diverse food and non-food applications they offer as compared to other starch crops. Thus, in order to sustain the increased demand of the crop, it's important that improved varieties are delivered to stakeholders within a short time. This will require that research efforts keep ahead of the key obstacles to higher productivity, disease and insect pests stresses. Thus, Root Crops Programme research team at NaCRRI is exploring use of genomic selection to increase rate of genetic gain in cassava. For sweetpotato, this work is being supported by North Carolina State University though the project "Genomic Tools for Sweetpotato Improvement", while for cassava it's the "Next Generation Cassava Breeding Project" funded by Cornell University, supporting the project. These efforts will significantly reduce the time and resources associated with sweetpotato and cassava breeding in Uganda.

## Developing cassava double haploid protocols aimed at generating better cassava varieties



Elsewhere, proven technologies are being adapted to increase productivity of crops that play pivotal roles OF world, regional and/or country economies. The justification for this is to ensure that research advances keep ahead of yield-robbing obstacles, i.e., new diseases and/or pest outbreaks. Generation and use of double haploids offers promise in reducing of the cassava breeding cycle. This technology has been demonstrated and proven to be effective in several cereal and horticultural crops of economic importance. Accordingly, a team of NaCRRI researchers are keenly involved in on-going global efforts tailored towards the development of the first reproducible protocol for generation of cassava double haploids. This is being explored through standard androgenesis and/or gynogenesis pathways.

## RECONCILING FUTURE FOOD PRODUCTION WITH ENVIRONMENTAL PROTECTION

### Sustainable use of swamps for increased rice production

Food production in East Africa is threatened mainly as a consequence of land degradation and climate variability. With year-round water availability, high resource base quality and the potential to accommodate several food crops, wetlands present production hotspots if food security is to be attained. For instance, they have the potential to meet the growing regional rice demand provided that production is both profitable and sustainable. To this effect, a consortium from Bonn-Köln-Jülich, Germany and other African partners are investigating agronomic options for rice production at different positions of a valley bottom swamp. Results so far indicate that under optimal conditions, farmers' rice yields of 2-3 t/ ha can be increased to 7.4 t/ ha in valley fringes. This study is implemented in wetland systems in East Africa (and hydrological situations) on a total area of 6 ha of fenced conserved or intensively cropped field plots. The study sites were selected for their representativeness of major wetland systems. It's expected that information generated from these long-term research, will guide decision-making, policy recommendations and regional extrapolation for sustainable wetland use.

### Cold tolerant rice for Uganda's cool agro-ecologies

Over the years, rice breeding programme based at NaCRRI, has focused on upland rice varieties. Currently, 11 upland varieties of the NERICA and NAMCHE series have been released and under production in different parts of Uganda. It's worth highlighting that 15% of arable area in Uganda is above 1500m above sea level. These areas are characterized by low night temperatures, which unfortunately, is not suitable for rice production. Thus, concerted efforts are underway by rice breeders at NaCRRI to evaluate and identify outstanding cold tolerant rice varieties.

### Striga management research peaks up

Maize yield losses attributed to Striga infestation have been reported to exceed 70%, especially when the weed infestation combines with other constraints such as diseases, drought, and nitrogen stresses. Striga is a root parasite affecting cereal crops. A single maize plant can be parasitized by over 100 Striga plants, each of which is capable of producing tens of thousands of seeds (20,000 – 200,000) that can remain viable in the soil for several years. Striga is mainly spread through human activities, especially by field tools and implements, on clothes when working from infested to un-infested fields; it can also be spread by animals and the use of Striga contaminated seed. Maize infestation by Striga is negatively impacting on food security and income of farmers in Uganda, particularly the smallholder farmers.



Various control measures including crop rotation and intercropping maize with non-host crops, trap-planting, hand-pulling before flowering, host plant resistance, push-pull and Imazapyr (herbicide) resistance (IR) technologies have been developed. The ongoing research at NaCRRI is focusing on validating the efficacy of intercropping maize with legumes, host plant resistance and IR-technologies towards Striga management in maize production. The research is being conducted in Kasese, Namutumba, Tororo, Pallisa and Bukedea, among other districts.

Promising results are being obtained, particularly on IR-technology were 10 hybrids were selected and advanced to National Performance Trials (NPT) currently being conducted in over 6 agro-ecological zones. Development and evaluation of IR-hybrids is being conducted in collaboration with CIMMYT, NASECO 1996 Ltd, AATF and Africa 2000 Network (A2N)-Uganda. On the other hand, one of the hybrids Longe7H was converted for resistance against the herbicide, Imazapyr, and was ultimately released and deployed as Longe7H-IR, being marketed by NASECO. Regarding host plant resistance over 100 single cross hybrids are being evaluated under preliminary yield trials in Striga hot spots in Pallisa, Tororo and Kasese districts.

Ultimately, this research is expected to deliver an integrated Striga management package that will provide a significant contribution towards reducing maize yield losses that arise from Striga attack. With this, maize productivity is projected to increase by at least 10% in the study areas and the technologies to be generated from this project will complement Striga research outputs being generated on other economically important cereals in the country.

## ENHANCING UGANDA'S AGRICULTURAL RESEARCH CAPACITY

### NaCRRI gets new research infrastructure



Agricultural innovations that include research products and/or knowledge can in practice only be generated by institutions that are endowed with product-oriented human resource who have at their disposal appropriate research infrastructure. NaCRRI is steadily emerging as a centre of excellence for agricultural research in the Great Lakes region. The Institute is now set to commission three new state-of-the-art research facilities; and office block for the Cassava Regional Centre of Excellence, the Centre for Nutritional Biochemistry and Physiology, and the Plant Germplasm Conservation Laboratory. All these units are equipped with technologies and appropriate human resource to ensure that they are fully functional.



In Uganda, NaCRRI is the Cassava Regional Center of Excellence, one of the four Regional Centers of Excellence (RCoEs) formed under the East African Agricultural Productivity Project (EAAPP). EAAPP is a World Bank funded regional project contributing to enhanced agricultural productivity in Uganda, Kenya, Tanzania and Ethiopia. This project focuses on four commodities, with regional centers built for specific commodity: Uganda (cassava), Kenya (dairy), Tanzania (rice) and Ethiopia (wheat). The CRCoE coordinates cassava research, training and development in Eastern Africa. The opening of the multi-storey office block will therefore provide ample working space for the Center's scientists, administration, students, and visiting cassava experts.

The Centre for Nutritional Biochemistry and Physiology will facilitate research on NaCRRI mandated crops. It is a specialized facility for nutrition profiling, value addition, physiological phenotyping, analytical services and capacity building. Key products currently under development include: biodegradable plastics and packaging material, bio-ethanol production and production of glucose syrup. All these products are being generated from cassava starch.

The newly established Plant Germplasm Conservation Laboratory will be used for conservation of plant genetic resources for present and future generations. Thus, the Unit is a center for acquiring, characterizing, maintaining, evaluating, documenting, and distributing genetic crop resources of agronomic and/or economic value. To-date, approximately 300 Ugandan cassava germplasm have been collected and established in vitro for conservation.



## Human resource development

During FY 2014/2015, NaCRRI's pool of scientific research manpower was expanded with some of its staff receiving PhDs in various disciplines. Their achievements are relevant in increasing the profile of NaCRRI as a center of research excellence. We congratulate the following:



**Benard Yada**
PhD, Plant Breeding and Genetics, North Carolina State University, (USA): Genetic Analysis of Agronomic Traits and Resistance to Sweet potato Weevil and Sweet Potato Virus Disease in a Bi-parental Sweet potato Population.



**Charles Lwanga Kasozi**
PhD, Plant breeding; University of Kwazulu Natal, (South Africa) Genetics for weevil resistance in maize



**Ephraim Nuwamanya**
PhD, Plant Sciences, Makerere University, (Uganda): Biochemical and phenotypic responses to hydro-thermal stress in Uganda's cassava varieties



**Ogwok Emmanuel**
PhD, Molecular and Cell biology; University of Witswaterand, (South Africa): Cassava Brown Streak Viruses: interactions in cassava and transgenic control.



**Geoffrey Onaga**
PhD, Plant Pathology; Göttingen University, (Germany): Transcriptome analysis of rice and blast pathogen



**Milton Otema Anyanga**
PhD, Entomology and Chemical Ecology; University of Greenwich, (UK): Phytochemical Mediated Resistance in Sweet potato to sweet potato weevils



## NaCRRI hosts new research units

NaCRRI is steadily consolidating its position as a go-to crop resources research facility in the region, reinforcing its stature as a Centre of Excellence for agricultural research in the Great Lakes region and beyond. Our national research mandate continues to grow, with two newly established research units being housed at NaCRRI. These are: The National Invasive Species Coordination Unit (NISCU) and the Uganda Biosciences Research and Training Centre (UBRTC).

The NISC Unit is an inter-ministerial unit that coordinates and champions a collective, effective and sustainable management and control of invasive alien species in the country. It became operational in August 2015 following a Government directive and NARO ratification. NISCU is specially set to create awareness on the negative impacts and early warning of invasive alien species, coordinate all efforts in management on invasions on biological diversity, ecosystem functioning, as well as coordinate scientific control innovations through cutting edge research.

UBRTC on the other hand purposes to be a leading biosciences center using the latest knowledge and cutting-edge technologies to improve livelihoods. It will undertake innovative Biosciences research, training and services provision for products or technologies development. UBRTC was established on the backdrop that biosciences innovations offer great potential for enabling national competitiveness in a rapidly growing global bio-economy by contributing to the production of sufficient and quality food as well as non-food value products– all in congruence with national development aspirations as articulated in Uganda's 'Vision 2040'.

Uganda has hitherto lagged behind in mobilizing biosciences technologies and innovations to address key national challenges. As a corollary, agriculture – the dominant sector of Uganda's economy remains largely subsistence and rudimentary in nature, characterized by perennially low yields that are a small fraction of global averages. Moreover, there has been limited capacity to exploit the abundant natural resource base. This center is seen to be a timely intervention and will serve not just Uganda, but countries in the region as well.





## Awards and recognition

NaCRRI scientists have been, and will continue, to develop research solutions that are relevant beyond Ugandan boarders. It's because of these contributions that both the institution and individuals receive accolades from the scientific community. Herein, we highlight a few of these honors that were received during 2015. Dr. Godfrey Asea, NaCRRI's Director was one of the two winners of the 2015 International Alumni Award from the College of Food, Agricultural and Environmental Sciences at Ohio State University. He was chosen for his great contribution to agricultural research in Uganda and the University. He was honored in March 2016 at the Ohio State Union.

The NaCRRI cassava research team was also recognized for its contribution to cassava research work; this accolade was from the United Kingdom. This was when the Royal Anniversary Trust awarded a Queen's Anniversary Award for Further and Higher Education to the University of Greenwich's work on cassava. The NaCRRI team has closely worked with the University of Greenwich to address key bottlenecks in cassava productivity in Uganda.

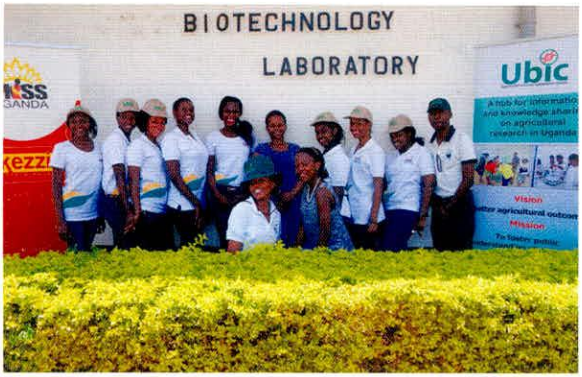


Maize research work by Pathologist Julius Pyton Sserumaga was in November 2015 awarded a certificate of out-standing project. The project entitled "Development and dissemination of Aflatoxin resistant maize varieties for Improved Food Security in Uganda" is funded by the Korean Government and it recently released maize hybrids with low aflatoxin accumulation. This work emerged as the most outstanding among 14 African member countries of the Korea Africa Food and Agriculture Cooperative Initiative (KAFACI).



Two graduate students affiliated to NaCRRI (Julius Baguma and Ismail Kayondo) were recognized as the best poster presenters during the 2015 biennial National Agriculture Bio-science conference in Kampala. Baguma's poster focused on "Exploring potentials of wide crossing and parthenogenesis in the generation of doubled haploids in cassava" while Kayondo's poster focused on; "Association mapping for cassava mosaic resistance".

## TECHNOLOGY PROMOTION: CONNECTING AGRICULTURAL RESEARCH TO SOCIETY




### Building capacity for modern biosciences communication

Modern agricultural biotechnology is one of the most complex and controversial technologies of our time, and yet probably one of the most possibly beneficial to humans, animals, and the environment. Agricultural researchers in Uganda are exploring biotechnology to control some devastating crops diseases, make plants more resilient to climate change effects like drought, and also improve nutrient levels in some staples.

UBIC therefore sought to increase the communication and public engagements skills of select groups of people who are key to creating awareness on biotechnology and whose daily work involves interaction with the topic; whether inquiry, need-to-communicate, or research. In June, UBIC trained twenty six (26) researchers from the National Agricultural Research Organization (NARO), currently working on biotechnology. These honed their speaking, writing, and message development skills to be able to talk about their work to both scientific and non-scientific audiences. A Biotech Communication skills training was also held for thirty (30) Extension Service Providers from all over Uganda, whose work involves interacting with farmers to provide new knowledge on agronomy and other agriculture issues.

Awareness and education sessions on biotechnology for agriculture were also conducted for journalists of key media houses in the country. This training came on the heels of increasing calls from journalists in Uganda, to learn about biotechnology and get updates on the progress that Uganda is making thus far.

### Talking agricultural biotechnology to the public

UBIC and its partners are cognizant of the potential benefits of modern agricultural biotechnology, such as resistance to certain diseases and hardening crops to climate change effects. More so, biotechnology cannot be discussed minus issues of bio-safety to ensure public safeguards against misuse of the technology. Therefore, in 2015, several public engagements were held to increase public awareness of modern agricultural biotechnology and bio-safety.

About 200 local leaders of Mukono District were hosted- led by Hon. Betty Nambooze (Mukono Municipality Woman Member of Parliament), to a sensitization session on modern farming and biotech. Similarly, UBIC, together with the Science Foundation for Livelihoods held thirteen (13) awareness creation sessions in eight districts of Uganda. Participants sought answers to common concerns about biotechnology and even got a chance to understand the relevance of the technology and its regulation in Uganda.

Furthermore, UBIC and the Uganda Media Center organized a three-hour dialogue with youth of the National Resistance Movement Ideology Club, who sought knowledge and awareness on modern agricultural biotechnology in light of the global controversies. These platforms were used to debug myths about biotech, increase knowledge for replicability of the awareness messages, plus increase debate for better choice and access to the technology.

All these outreach and education sessions greatly contributed to increasing the level of awareness of Ugandans about modern biotechnology, its regulation, and relevance to Uganda, so as to help them to make or to influence their leaders to make informed decisions.

Finally, in collaboration with local partners, UBIC supplemented these efforts with 21 radio and TV features, 24 newspaper articles that reach over 15 million Ugandans, and production of 19 different IEC materials with 12,200 copies distributed. Although some public concerns remain, we are confident that there is increased understanding and appreciation of modern biotechnology and biosafety by a substantial section of the targeted groups including policy makers and product end-users. In 2016, UBIC plans to conduct more up-country outreach and education sessions and well as host many more public dialogues on modern agricultural biotechnology.

### Farmer sensitization and outreach peaks



Farmer demonstrations turned out to be the biggest farmer outreach interventions of the year, by NaCRRI. For all commodities, we held over 300 farmer field demonstrations in different districts. The demonstrations brought farmers closer to the technologies for training in good agronomic practices, inputs and track general performance of technologies. These also highly supported commodity public evaluation processes.



Several sensitization and farmer outreach programs were conducted during the period under review. A total of 842 students visited the Institute to learn about the research work we undertake. These were in addition to over 200 farmers from different farmer groups. To create more awareness, the Institute participated in 15 exhibitions with key ones including; the Annual Source of the Nile agricultural Show at Jinja and the World Food Day in 2014 and 2015. During these, farmers came into contact with our novel research products and technologies. Through all these interventions, we interacted with a total of 1,500 farmers and stakeholders from across the country.

## Increasing media and online presence



NaCRRI received plausible media coverage and online presence during the year under review. Media was constantly engaged in activities which culminated into a clout of media presence. Efforts were targeted at reaching a plethora of audiences through multiple media and other approaches such as radio, television, newspapers as well as online platforms. We received 14 newspaper stories, 7 radio stories and 5 Television stories. With a number of stories in the media, Our Online presence continued to grow with over 375 followers on Facebook and 300 on twitter. In addition to this, upgrading the Institute website was initiated to enhance information dissemination and access.

## UBIC popularizes National Biotech Essay Contest



Uganda is committed to increasing young people's involvement in modern science and agriculture to realize national aspirations. Pursuant to this, the Uganda Biosciences Information Center is making efforts to increase secondary school and tertiary students in modern agricultural biosciences, through among others,

the National Biotechnology Essay Writing Contest. The contest entered its third year in 2015, witnessing over 50 per cent increase in submission from secondary schools, with close to 200 submissions from 40 secondary schools and tertiary institutions from all regions of the country. There was a marked improvement in quality of essays and increased interest in discussing agriculture biotechnology among students. The essay contest gives students an opportunity to research on, learn, and write competitive essays on various topics. The theme for 2015 was, Biotechnology: Addressing Climate Change Challenges; a timely theme considering reported deaths from famine and drought-induced starvation especially in parts of Northern Uganda. Winners received varied prizes including laptop computers, and a one-week internship for the top six students, to be done in 2016. UBIC also produced a compendium of the best essays from the first contest held in 2013 to 2015, for use as reference material for intending participants in future contests.

## STRENGTHENING SEED SYSTEM MECHANISMS



Functional seed systems make it easier and faster for farmers and other end users of products of agriculture research to access and utilize them. NaCRRI, in the last year invested efforts to developing functional seed systems for various crops under our mandate.

### Rice Seed

By the end of 2015, the Promotion of Rice Development (PRiDe) team at NaCRRI had trained more than 37,000 rice farmers across Uganda. This has culminated into an increase of rice production of 36,000 tons and national rice cultivation acreage by 10,300 hectares. The beneficiary farmers are an asset for further increase in rice production and productivity, improve quality and competitiveness of local rice. Farmers were especially trained in aspects of land preparation and crop management through to post-harvest techniques with varieties including; NERICA 1, NERICA 4, NERICA 6, NERICA 10 and WITA 9.

### Maize and Beans



During this year, 5 tons of maize foundation seed for released drought-tolerant hybrid varieties was produced. And to further consolidate private seed production, we also signed sub-license agreements with eight (8) seed companies and these have been provided with seed of the released varieties for multiplication. In addition, quality declared bean seed produced by farmer groups paid off with the production of over 487MT. The seeds of 14 new and old bean varieties currently under promotion.



## African Indigenous Vegetables Seed System

In a quest to increase production, consumption and utilisation of African indigenous vegetables, the Horticulture Program has trained a total of 163 Households in the country. These included farmers from Basooka Kwavula at Namuyumba, Nkokonjeru seed farmers group, Kamengo, Masaka and the two schools; Gayaza High School and Iceme Secondary. These farmers were equipped with skills in the production of quality seed and consumption of Bugga, Nakati, Jyobyo, African egg-plant, pumpkin, malakwang and jute marrow.

## Cassava Seed System

An improved cassava seed system can improve production of high quality and virus free planting materials especially with smallholder farmers. To increase timely access to disease free planting materials, a total of 45 cassava seed entrepreneurs were trained in seed business by the end of 2015. 120 acres of basic seed and 445 acres of certified seed fields have been established. Further, 2,428 acres of quality declared planting material were planted. These efforts culminated into 65 million cuttings which were distributed to farmers. By the end of the year, these farmers were able to sell 94,000 bags of stems; generating over Shs. 2 billion. To operationalize quality assurance of cassava planting material production & distribution, 40 crop inspectors and field officers were also trained on quality seed production.



## Sweetpotato Seed System

NaCRRI through the First Track Project has launched an intensive dissemination drive to enhance access and adoption of improved sweetpotato varieties through school-going children. This campaign in the financial year 2014/2015 was piloted in 12 primary schools located in Wakiso, Mukono and Kamuli districts. 1,200 pupils from St. Andrew Bulele, St. Kizito Ngombere, Nakalanda and Bugolombe Primary Schools were availed with vines to carry to their parents for multiplication.



On maturity, the parents are expected to reimburse twice the number of vines they received to be distributed to other farmers. 50 schools are expected to participate in this campaign. By the end of the project, a total of 3,600 children will be engaged in this drive to disseminate varieties including; New Dimbuka, NASPOT 12, NASPOT 11 and NASPOT 8. The children involved hail from farming households and are believed to be powerful change agents in transferring information to their parents.

# Staff Promotions and departures

## Staff Promotions and Departures

| | |
|---|---|
| Dr. Godfrey Asea | **Previous Position:** Program Leader, Cereals<br>**Current Position:** Director NaCRRI |
| Dr. Yona Baguma | **Previous Position:** Programme Leader, Mentoring and Head, Biosciences<br>**Current Position:** Deputy Director General, Research Coordination |
| Dr. Michael Ugen | **Previous Position:** Program Leader, Legumes<br>**Current Position:** Director, NaSARRI |
| Dr. James A. Ogwang | **Previous Position:** Director NaCRRI<br>**Current Position:** National Coordinator, NISCU |
| Dr. Patrick Wetala | **Previous Position:** Agronomist and Palm Oil Research<br>**Current Position:** Retired |
| Dr. Andrew Kalyebi | **Previous Position:** Entomologist, Horticulture<br>**Current Position:** Whitefly Ecologist, MARI-Tanzania |
| Dr. Barbra Zawedde | **Previous Position:** Coordinator, Uganda Biosciences Information Center<br>**Current Position:** Coordinator, Uganda Biosciences Research and Training Center |
| Dr. Stanley Nkalubo | **Current Position:** Ag. Program Leader, Legumes |
| Dr. Michael Otim | **Current Position:** Ag. Program Leader, Cereals |

## New Staff in 2015

| Name | Position |
|---|---|
| Dr. Kangire Africano | Pathologist, Horticulture Program |
| Ms. Winniefred Nanteza | Development Communication Officer, NaCRRI |
| John Martin Mwebaze | Pathologist -Oil Palm |
| Andiku Charles | Physiologist -Oil Palm |
| Alex Asiimwe | Agronomist - Oil Palm |
| Ann Pamella Nantongo | Development Communication Officer -Legumes |
| Harriet Abar | Nutritionist, Legumes |
| Florence Nakkazi | Social Economist, Legumes |
| Sam Wamani | Research Assistant, Root crops |
| Patrick Ocitti | Research Assistant, Root crops |
| Doreen Chelangat | Research Assistant, Root crops |
| Ketra Oketcho | Research Assistant, Root crops |
| Liliian Samanya | Research Assistant, Root crops |
| Joanne Adero | Research Assistant, Root crops |
| Oscar Eyoo | Research Assistant, Root crops |
| Teddy Oparok | Research Assistant, Root crops |
| Samuel Olaboro | Research Assistant, Root crops |
| Paul Musana | Research Assistant, Root crops |
| Everline Odrumuru | Admin Assistant, Root crops |
| Eyokia Maurine | Technician, Root crops |
| Josephine Namirimu | Technician, Root crops |
| Regina Aboyo | Technician, Root crops |
| Asiimwe Jennifer | Technician, Root crops |

# Advisory Committee 2015



Dr. Gad Gumisiriza



Mr. Nelson Masereka



Ms. Beatrice Byarugaba



Dr. Godfrey Asea



Dr. James Ssemwanga

# Management Team 2015



**Dr. Titus Alicai**
Programme Leader,
Rootcrops



**Dr. Michael Otim**
Ag. Programme Leader,
Cereals



**Dr. Stanley Nkalubo**
Ag. Programme Leader,
Legumes



**Dr. Sophy Musana**
Ag. Programme Leader,
Horticulture



**Dr. Barbara .Z. Mugwanya**
Coordinator, UBRTC



**Dr. James. A Ogwang**
National Coordinator,
NISCU

# Unit Heads 2015



**Ms. Cecilia Abaseret**
Senior Internal Auditor



**Mr. Ali Kaboggoza**
Senior Administrative Officer



**Ms. Catherine Mirembe**
Procurement Officer



**Ms. Winnie Nanteza**
Development Communication Officer



**Mr. Ramathane Wakholi**
Finance Officer



Ms. Rachael Mukisa
**ICT Officer**

# Journal articles in 2015

## ADVISORY COMMITTEE 2015

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# Collaborators in 2014 -2015

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|---|
| CG centers |
| Advanced Laboratories - BECA, LC Genomics |
| ASARECA - Association for Strengthening Agricultural Research in Eastern and Central Africa |
| Universities - Makerere Univ, Gulu Univ, Kyambogo Univ, Cornell University (USA), University of Bonne (Germany) , North Carolina State University(USA), Ohio State University (USA), University of Greenwich, University of Free State, South Africa |
| Private Sector |
| NGOs, CBOs |
| Farmers |
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- Centre for International Potato Research
- International Centre for Tropical Agriculture
- Africa Rice
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- Alliance for Green Revolution in Africa
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- Kirk House Trust
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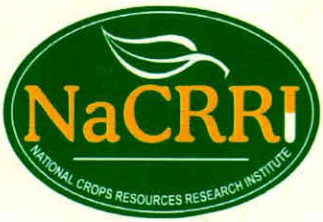


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