Ubic
Uganda Biosciences Information Center

SECOND ANNUAL BIOTECHNOLOGY ESSAY WRITING CONTEST

AWARDS BOOKLET | 2nd October 2014



Winners at the First Annual Biotechnology Essay Writing Contest pose with some of the evaluators and biotech officials

THE REPUBLIC OF UGANDA
MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY & FISHERIES

NARO

NaCRRI
NATIONAL CROPS RESOURCES RESEARCH INSTITUTE

UNCST

THE REPUBLIC OF UGANDA
MINISTRY OF EDUCATION



ABOUT UBIC

Uganda Biosciences Information Center (UBIC) is an information hub that develops, produces, and disseminates information on modern biosciences and biotechnology advances in agricultural research in Uganda so as to facilitate informed decision making about biotechnology application and regulation. Established in 2011, our mandate comes from the National Agricultural Research Organisation (NARO)- the overall coordinating body of agricultural research in Uganda. UBIC is hosted at the National Crops Resources Research Institute (NaCRRI) at Namulonge in Wakiso district.

Vision

Better agricultural outcomes

Mission

To foster public understanding of agricultural research for informed decision making

Goal

To become a one-stop centre for information and knowledge-sharing on agricultural biosciences research in Uganda

Current specific objectives

- To help increase public understanding of agricultural biotechnology and the existing regulatory system in Uganda so that people can make informed decisions about the technology
- To strengthen biotechnology training in the formal education system of Uganda
- To facilitate knowledge sharing and partnerships among biotech communication partners locally and internationally

Key audiences

- Youth and their educators
- Faith-based /cultural leaders
- Journalists and media practitioners
- Farmers' associates
- Scientists

Message from Coordinator, UGANDA BIOSCIENCES INFORMATION CENTER (UBIC)



It is with great pleasure that I welcome you all to the 2nd Annual Biotechnology Essay Writing Contest, 2014 under the theme: Biotechnology and the environment. The participation of students, input from educators, and support from learning institutions in this exciting capacity building activity is indeed testament to the increasing appreciation of modern biotechnology in advancing agriculture in Uganda. I welcome our colleagues from Cafe Scientifique, who have mobilised students from ten schools to participate in this event.

UBIC's vision is to contribute to better agricultural outcomes in Uganda. We believe that agricultural research is vital for this realization and so we promote information and knowledge sharing of the advances in agricultural research. Through this Essay Writing Contest, UBIC seeks to interest young scientists to join the research teams using advanced techniques for improving agriculture. Through this second contest, we hoped to encourage students to explore ideas on application of biotechnology in everyday life and its likely impacts on the environment. I am therefore thrilled by high participation.

In second contest, we received a total of 177 submissions from 18 secondary schools and 8 tertiary institutions. There was a marked increase in the quantity and quality of submissions, and I thank all the teachers/lecturers who aided the students to prepare their essays. The prizes for the winning essays include laptops, text books on modern biotechnology and a one-week internship at a research institute where they will experience hand-on training and interact with the experts. I believe that this will be the start of their journey to becoming some of the best scientists and innovators in Uganda and the world.

The UBIC team is grateful for the competent and reliable evaluators for committing to guide these budding scientists. We appreciate the commendable leadership of the National Agricultural Research Organisation (NARO) and the National Crops Resources Research Institute (NaCRRI). We thank all our partners who have helped to prepare this event. The UBIC team at NaCRRI: Gilbert Gumisiriza, Nassib Mugwanya, and Anita Tibasaaga; thank you for your commitment and hard work.

Finally, I wish to call upon all stakeholders here present, to increase their involvement in fostering public understanding of modern biotechnology, its application and regulation, because it shows immense potential for mitigating some of challenges in our agricultural sector. I hope that this essay contest is just a start for long-term partnership between the Ministry of Agriculture, Animal Industry and Fisheries and the Ministry of Education and Sports to foster future agricultural scientists and innovators for Uganda.

I thank you.

Barbara Mugwanya Zawedde, PhD



Message from Ministry of Agriculture, Animal Industry and Fisheries



The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) recognises modern biotechnology as an important tool for developing novel and/or improved products to achieve sustainable agricultural and nutrition productivity, competitiveness, economic growth, food security, environment quality, and poverty reduction in Uganda. At MAAIF, we believe that the deployment of modern biotechnology tools will not only elevate agriculture research in Uganda; but also help to address challenges faced by farmers, which problems conventional and traditional agriculture processes have failed to mitigate. Biotechnology is one of the priority areas in the Government's Plan for the Modernization of Agriculture and therefore it deserves rightful attention.

MAAIF is therefore pleased to promote the engagement of Ugandan youth in agriculture, particularly in development of technology for agricultural productivity. The Ministry applauds the gesture by Uganda Biosciences Information Center (UBIC), to groom youths into scientists and biotechnology experts who will support technology advancements and research in agriculture. We hope that through this Essay Writing Contest, UBIC and its partners can ably interest Ugandan youths to increase their engagement in agricultural sciences, including: molecular biology, biochemistry, and bioinformatics. In this way, we shall develop a critical mass of skilled scientists who can enhance Uganda's ability to innovate, integrate, and promote modern technology for agriculture productivity.

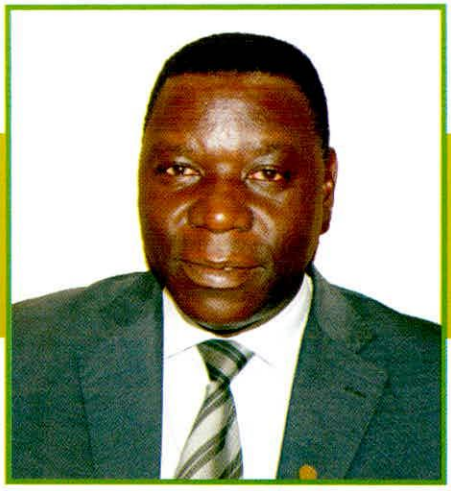
To the students who have participated in the Contest, MAAIF congratulates you for taking part and for choosing to seek knowledge and understanding of modern biotechnology to help improve Uganda's agriculture. The Ministry calls upon you to become emissaries to your fellow youth and encourage them to support national development through agriculture. Suffice to note that this sector employs close to 80% of Uganda's labour force but youth engagement in agriculture is declining amidst rising youth unemployment. However, although the services and industrial sectors are growing at considerably faster rates, they have not created enough jobs for the burgeoning youthful labour force. This state of affairs poses food security, could worsen unemployment, exacerbate underemployment and, complicate government's efforts to drive economic growth through agriculture.

Finally, MAAIF commends the National Agricultural Research Organisation (NARO) for its visionary leadership in championing agricultural research in Uganda and for supporting youth engagement in agriculture. We commit to furthering our working relationship with UBIC, NARO, and many other partners in this sector.

Prof. Zerubabel Nyiira
Minister of State for Agriculture

Message from Ministry of Education and Sports





Mr. Robinson Nsumba-Lyazi
Commissioner for private secondary schools and institutions

The Ministry of Education and Sports (MoES) in Uganda is pleased to support the work of the Uganda Biosciences Information Center (UBIC), particularly in grooming young scientists to engage in relevant research for development in the country's agriculture sector.

One of the four priorities of Uganda's National Development Plan (201-2015) is the promotion of science and technology, and in furtherance of this, the Government of Uganda, through MoES is committed to promote this plan through several initiatives including the Education Sector Strategic Investment Plan (2007-2015).

These plans aim at improving quality and provision of equitable access to science education and technical skills development in Uganda, plus knowledge creation and application.

The Ministry is also promoting biotechnology training in the formal sector through the National Curriculum Development Center (NCDC), which is responsible for developing relevant and impactful course material for secondary and primary schools, as well as carrying out capacity building for teachers and educators. I was therefore thrilled to learn that NCDC and UBIC are working together to contribute to this mandate, and that UBIC has even donated some reference teaching and learning materials to the Curriculum Development Centre. The Ministry applauds this partnership and calls upon all other development agencies to come together to support and develop a cluster of competent and well-rounded scientists that can drive Uganda's development agenda.

Finally, MoES recognises the leadership of the National Agricultural Research Organisation (NARO), the guidance of the Ministry of Agriculture, Animal Industry and Fisheries, and the stewardship of the National Crops Resources Research Institute (NaCRRI). We congratulate the students who participated in this essay contest and encourage them to continue searching for knowledge and seizing opportunities such as this, for grooming into competent professionals.



Message from Evaluation Committee

The evaluation committee is impressed with the overall improvement in the scope of discussion in essays submitted. We observed that overall the grammar was very good and submissions from the tertiary institutions had better literature citation. We congratulated UBIC in the increased participation in the second contest.

However, there was still inadequate connectivity linking the topic and discussion especially the environmental aspect. Some essays are still not written in essay-format; it is obvious that some participators used only one reference; there was inaccurate content without supporting evidence; and plagiarism especially in the secondary schools category was evident.

We recommend that there is need to increase the publicity to tertiary institutions, and encouraging the more teachers and lecturers to pass the message to the students and collaborate in the essay writing.

Essay Evaluation Committee

Category A: Secondary schools



Mr. Robinson Nsumba-Lyazi
Robinson is the Commissioner for private secondary schools and institutions in the Ministry of Education and Sports. A renowned scientist, he is a member of the Uganda National Council for Science and Technology. He has a Master of Education degree in Mathematics.



Ms. Betty Kituyi
Betty has been the National Coordinator of Cafe Scientifique, Uganda since its establishment in 2009. Her work involves liaising with various stakeholders to address contentious issues in science and linking students to experts in science and technology so as to enhance their interest, critical thinking, and leadership skills for science advancement.



Mr. James Sendikaddiwa
For many decades, James has worked as a teacher of Agriculture, researcher, and a curriculum developer. He has taught Agriculture in several schools including: Aggrey Memorial S.S., Makerere College School, and Wampeewo Ntakke Secondary School. James has Med and MSc in Crop Science.



Ms. Loi Namugenyi
Loi is a Science Officer in charge of Science and Technology Information Management Services at the Uganda National Council for Science and Technology. A second-time evaluator in this contest, she is also the European Union Focal point for ICT development in Uganda and is a member of the International Programme Committee of IST-Africa.

Essay Evaluation Committee

Category B: Post-secondary education institutions





Dr. Joseph Oonyu

Joseph is an Associate Professor in the Department of Science, Technical, and Vocational Education in the College of education and External Studies, Makerere University. He is also the President of the National Association of Science Teachers of Uganda (NAST-U).



Dr. Richard Echodu

Richard is the Dean of the Faculty of Science and Head of Bioscience Research laboratories at Gulu University. He is also a molecular biologist with interest in using genetics and genomics tools to help understand plant, animal, and human make-up.



Dr. Barbara Zawedde

Barbara is the Coordinator of Uganda Biosciences Information Center (UBIC), based at NaCRRI in Namulonge. She is an environmental safety specialist, with keen interest in promoting sustainable use of biological diversity to address agricultural challenges. Barbara is also passionate about interesting the youth to learn, use, and promote modern agricultural sciences.



Ms. Deborah Kasule

Deborah is a Senior Science Officer in charge of Science and Technology Outreach and Information Management Unit at Uganda National Council for Science and Technology (UNCST). Deborah is keen on promoting and popularising science teaching and learning in schools in Uganda. She has an MSc in Environment and Natural Resources.



Participating institutions and essay submissions

Secondary schools

Name of institution	No. of females	No. of males	Total
Apostles of Jesus Minor Seminary, Kabale	00	25	25
Bishop Cipriano Kihangire S.S	04	08	12
Gayaza High School	06	00	06
Hope Senior School	00	05	05
Kawanda Secondary School	00	01	01
Kyambogo College	01	00	01
Lira Town College	02	06	08
Mary Hill High School, Mbarara	04	00	04
Naalya S.S., Bweyogerere	10	40	50
Ndejje Senior Secondary School	02	00	02
Our Lady of Africa S.S., Mukono	02	02	04
Our Lady of Good Counsel, Gayaza	00	03	03
Sacred Heart S.S., Mushanga, Bushenyi	01	00	01
St. Henry's College Kitovu, Masaka	00	01	01
St. Mary's College Rushoroza	00	02	02
St. Paul S.S. Kabale, Bukinda	01	02	03
Total number of submissions	**33**	**95**	**128**

Post-secondary education institutions

Name of institution	No. of females	No. of males	Total
Bishop Stuart University	00	01	01
Bukalasa Agricultural Institute	00	02	02
Gulu University	00	01	01
Kyambogo University	01	14	15
Kyera Agricultural Training College	00	01	01
Makerere University	03	19	22
Mbarara University of Sci. & Technology	00	01	01
Uganda Christian University	03	02	05
Total number of submissions	**07**	**41**	**48**



TOPIC: APPLICATION OF AGRICULTURAL BIOTECHNOLOGY AND ITS IMPLICATIONS FOR THE ENVIRONMENT

NAME: **KASIITA PATRICK- S.6**
APOSTLES OF JESUS MINOR SEMINARY BUKINDA, KABALE

Agricultural biotechnology encompasses a range of modern plant breeding techniques. Scientists use agricultural biotechnology to understand and modify the genetic make-up of organisms for use in agriculture technologies including genetic modification (GM), genomics and bioinformatics, marker-assisted selection, micro propagation, tissue culture, cloning, artificial insemination, embryo transfer particularly in the crop sector. These technologies have been applied in different ways which are discussed below:

Firstly, agriculture biotechnology has been applied in the manufacture of vaccines. Oral vaccines have been in the works of many years as a possible solution to the spread of diseases in undeveloped countries. Take an example in Uganda where costs are prohibitive to wide spread of vaccination. GM crops usually fruits or vegetables can be designed to carry antigenic proteins from infectious pathogens that will trigger an immune response when ingested.

Less than 20% of the earth is arable land but some crops have been genetically altered to make them more tolerant of conditions like salinity, cold and drought. The discovery of genes in plants responsible for sodium uptake has led to development of knock-out plants able to grow in high salt environments. Corn and rapeseed plants, able to thrive under drought conditions are being grown in some USA fields.

Agricultural biotechnologies advances allow for specific changes to be made quickly on a molecular level. Methods like marker-assisted selection improve the efficiency of plant and animal breeding, without the controversy normally associated with GMOs. Another non-GMO biotechnology method (embryo rescue technique) was used to produce new rice for Africa that grows in less wet areas through an interspecific cross of Asian rice (Oryza sativa) and African rice (Oryza glabarrima).

Genetic modification (GM) in plants which is achieved by adding a specific gene or genes to a plant, or by knocking out a gene with RNAi, to produce a desirable phenotype. This method has been applied in breeding of pesticide-resistant crops. The most famous example of this is the round-up ready technology. This was first introduced in 1998 as GM soya beans. Round-up Ready plants are unaffected by the herbicide glyphosate thus are savings in time and costs associated with conventional tillage to reduce weeds or multiple applications of different types of herbicides to selectively eliminate specific species of weeds. Insect resistant crops have also been introduced through agricultural biotechnology. For years, Bacillus thuringiesis Bt, which produces a protein toxic to certain insects was used to dust crops to control the European corn borer. To eliminate the need of dusting, scientists developed transgenic crops expressing Bt protein. Bt protein is non-toxic to humans and most beneficial insects. This makes it easier for farmers to avoid costly and harmful pesticide sprays.

Some groups oppose the use of GM crops because they believe those crops pose unacceptable risk to the environment. However, many people who have helped develop GM crops believe these crops may provide a solution to some important problems including the following;

Biotech crops contribute to reducing the environmental impact of productive agriculture thereby increasing global food security without increased land clearances. More to that, biotechnology application of pest and disease resistant, drought and stress tolerant crops offer additional opportunities to increase global food security while further reducing the environmental footprint of agriculture. The world's population is currently 7 billion and projections are that it will reach 9 billion by 2050. It is estimated that the world needs at least 70% more food by 2050.



KASIITA PATRICK Essay Continued

Habitat destruction is the biggest single threat to treat biodiversity. Higher yields mean farmers can produce increasing amounts of food without increasing arable land and this has a major impact on protecting wild life habitats.

Herbicide tolerant crops are great enablers of zero-tillage, a substantial agricultural contributor to sustainable agriculture. Zero-tillage means sowing seeds directly into the field without first ploughing to remove weeds. By leaving the soil undisturbed, more moisture is retained, which is good for water conservation.

Nevertheless, agricultural biotechnology is consider to be disruptive to the environment. The environmental issues associated with GM crops are perhaps more effective as elaborated below. One of the issues is the herbicide resistant crops possibly becoming weeds in following years. This is an environmental and agronomic issue associated with GM crops is their resistant to broad-spectrum herbicide is one that kills a large number of weed species. Round up is an example of a broad spectrum herbicide.

The concern is that the seeds left behind after the harvest of these crops may sprout and become weeds the following year. Some are concerned for example, that if a farmer uses roundup-ready corn one year, and then roundup soybeans the next year, the roundup herbicide will not control residual corn that is roundup ready. As more crops are developed that are resistant to the same herbicide, this will become more problematic.

Another concern with development of herbicide tolerant, viral-resistant or insect resistant GM plants is that they will breed with wild relatives resulting into super weeds that are more competitive. More competitive weeds are more difficult to control and may make weed management more complicated, expensive and perhaps chemically intensive. Such resistance should be developed in plants that do not have weedy relatives so genes inserted in these plants have a negligible chance of escaping when GM plants breed with weedy relatives. The effect that a GM crop may have on weed populations needs to be studied and considered before it receives agreement approval for commercial production.

Lastly, the media have given much attention to the potential impact of GM crops on non-target organisms, which include all organisms except for the pest that is being controlled. These include mammals, fish, birds, reptiles and other insects. An ideal pest control tactic would control the targeted pest but protect the other organisms from harm but this does not exist. An example of a highly specific pesticide is spod-x, a best single species and is nontoxic even to its close relatives. Examples of non-target organisms to be targeted in GM crops studies include lady beetles, lace wings and other insect predators, honey bees and other insect pollinators and other aesthetically pleasing insects.

Though by its nature, agriculture biotechnology may be disruptive to the environment, much work and research is taking place to limit and decrease the environmental footprint it leaves. GM crops are very controversial but promising.

Top five finalists in Category A

1. Kasiita Patrick- Bukinda Seminary (Collaborating teacher: Alex Byamugisha).
2. Asiimwe Emmanuel- Bishop Cypriano Kihangire S.S. (Collaborating teacher: Paul Nantinda)
3. Mugabi Patsy Nalukenge- Gayaza High Sch (Collaborating teacher: Brian Kibirige)
4. Akello Barbara- Bishop Cypriano Kihangire S.S. (Collaborating teacher: Paul Nantinda).
5. Batte Martin Zinabala- Naalya S.S. Bweyogerere (Collaborating teacher: Henry Amalai).

Best essay in Category B:
Post-secondary education institutions



TOPIC: DISCUSS THE ENVIRONMENTAL SAFETY ISSUES ASSOCIATED WITH THE USE OF MODERN AGRICULTURAL BIOTECHNOLOGIES

NAME: SINGURA OWEN
BACHELOR OF SCIENCE TECHNOLOGY –BIOLOGY, YEAR 1, KYAMBOGO UNIVERSITY

Biotechnology can be defined as the use of living systems and organisms to develop or make use full products or any technological application that uses biological systems, living organisms or their derivatives to make or modify products or processes for specific use (UN Convention on biological diversity).

Agricultural biotechnology sometimes called green biotechnology is a collection of techniques used to improve crops, animals and microorganisms. Debates over biotechnology are part of a long history of social discourse over new products or technologies. Many times, new technologies are greeted with skepticism, outright opposition, often dominated with slander, myths, misinformation and innuendo. Often the claims are based less on science but politics of the time. While advocates of biotechnology have tried to rely on the need for scientific accuracy, critics employ theoretical methods that are designed to invoke public fear and cast doubt on the motives of the scientists. For instance, in addition to claims about the negative impacts of such crops to the environment, there are wild claims that associate genetically modified (GM) crops with maladies such as brain cancer and impotence as well as behavioral changes. Consequently conspiracies over impact of GM crops is becoming increasingly complex, intense, and at times emotional. The commonly talked about types of risks posed by GM crops are food and environmental safety associated.

A major environmental safety concern associated with GM crops is their potential to create new weeds throughout crossing with wild relatives. Leakage of genes from GM plants like herbicide resistant crops (e.g. 'roundup ready' soybean) to the wild or semi-domesticated relatives can lead to creation of 'super weeds'. There is also a potential for herbicide resistant varieties to become serious weeds in other crops. This may result into an increased amount of herbicides applied per hectare of land. However, current research shows that hybridization between GM crops and their compatible relatives does not have serious environmental consequences because studies are conducted before producing the GM crops.

Another environmental safety concern is that, the planting of GM crops in 'centers of species biodiversity' could result in losses of genetic diversity. The most often expressed concern relates to sexual hybridization between the GM crop and its relative, and the levels of biodiversity will be reduced from that interaction. In addition, some researchers proved that plant tissue culture loosens the organizational constraints of tissues and allows plant cells to grow in an unorganized manner. Apparently this removal of organizational coherence results in genomic instability which often leads to chromosomal aberrations (Karp and Maddock, 1984) and mutations (Evans and Sharp, 1983) thus causing loss of certain genetic diversity.

Some activists speculate that in the worst case the natural population or land races might go extinct. However, in reality most crop ancestors are dispersed over a wide geographical range and their numbers are large, so the likelihood of their species extinction is minimal. Also in many cases, it is difficult to find single centers of crop diversity for example crops like wheat, sorghum, pearl millet, peas, maize and lima beans have multiple centres of crop diversity. Some crops do not have distinct centers of diversity for example sorghum, pearl millet and bottle gourd. Some researchers have shown that hybridization between crops and wild species could actually result in higher levels of genetic diversity in the wild relatives as the genes of the wild species and the crop are blended together. Many new taxon have evolved by losing many alleles to form hybrid population which are likely to carry high levels of diversity for many generations.



Concerns have been raised that genetically engineered traits could be transferred to other organisms via horizontal gene transfer and there by threaten environmental safety. Horizontal gene transfer is defined as the stable transfer of genetic material from one organism to another without reproduction or human intervention. This phenomenon is considered a significant source of genome variation. This issue has received a considerable attention from numerous expert panels held under the auspices of various national and international regulatory systems such as National Agricultural Research Organisation (NARO), World Health Organization, Food and Agriculture Organisation (FAO), Organization for Economic Cooperation and Development (OECD), European Food Safety Authority (EFSA), and United States Department of Agriculture (USDA). Based on scientific evidence, they report that horizontal gene transfer from GM plants to other organisms is, at most, an extremely rare phenomena and to date no environmental harm has been reported from it.

Effects on non-target organisms are also a concern in environmental risk assessment. Non-target organisms include pollinators, non-target herbivores, soil organisms and species which contribute to local beneficial biodiversity. The effects of GM crops to non-target organisms can be direct or indirect: direct effects are due to toxicity through ingestion by the non-target organism of a toxin produced by GM crops. For example other insects feeding on Bt (Bacillus Thuriengiesis protein gene extract) crops. Indirect effects occur through the food chain that is it involves organisms not directly consuming the GM crop but feeding on other insects associated with the GM crop. On the other hand results from the extensive evaluation of Bt crops from a number of studies summarized by OECD (2007) in a consensus document on 'safety information on GM plants expressing Bt derived insect control protein' revealed that a few non-target organisms are negatively impacted by exposure to Bt proteins. For example tests on Bt maize showed that poultry was not affected by feeding on it, soil microbial organisms in Bt maize fields were not negatively affected, as well as honey bee (Apis millifera) larvae and adults fed on pollen containing the Bt proteins.

As a result of the above concerns and controversies, commercially available crops made by using modern agricultural biotechnology have been subjected to more testing and regulations than any other agricultural product.

However modern agricultural biotechnology has offered remedy to environmental safety threats in the following ways:

Phytoremediation (the use of green plants and their related microorganisms to remove pollutants from the environment and render them harmless). For example genes encoding a nitro-reductase from a bacterium were inserted in tobacco and shown faster removal of TNT (Tri nitro toluene) and Di-nitroglycerin (due to explosives) residues from the soil and enhanced crop resistance to the toxins. Similar research has been done on several crops (e.g. sorghum and wheat) in order to get crops that can grow on marginal lands of high acidic soils hence increasing plant population.

It should be noted that the higher yields obtained from some GM crops could actually reduce the conversion of rich forests into farm lands and there by protect biodiversity. Also the specificity of certain GM proteins such as Bt has reduced the use of harsher pesticides that are more toxic to more organisms. In fact, earth worms, bees and beetles have been found more abundant in Bt cotton fields than in conventional sprayed fields (Marvier et al, 2007).

In conclusion modern agricultural biotechnology has increased the amount of food safety and environmental safety studies carried out on new agricultural crops. Secondly, as it was said by H.E. Y.K. Museveni, "Uganda needs improved crops that can resist pests and diseases, and perform well in varying environments'.

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Top five finalists in Category B

1. Singura Owen, BSc. Technology-Biology-Kyambogo University (Collaborating Lecturer: Olal Sammy)
2. Tuhirirwe Mackenzie, Information Technology- Mbarara University
3. Sharon Letia - UCU, (Collaborating teacher: Diana Kimono)
4. Edema Hillary, Gulu University
5. Kembabazi Gloria, UCU (Collaborating teacher: Dr. Elizabeth Kizito)



NOTES



MAY 2014

AGRICULTURAL BIOTECHNOLOGY RESEARCH & DEVELOPMENT CAPACITY IN UGANDA

Biotech/ GM crops under R&D in Uganda

SWEET POTATO
(Virus resistance; Weevil resistance)

MAIZE
(Drought tolerance; Insect resistance)

CASSAVA
(Virus resistance CBSV & CMV)

RICE
(Nitrogen Use Efficeincy/Water Use Efficiency and Salt Tolerance)

BANANA
(Bacterial wilt resistance; Nutrition enhancement; Nematode resistance)

Biotech Infrastructure

15 RESEARCH INSTITUTIONS actively involved in biotech R&D

4 GENOMICS LABORATORIES

2 PLANT TRANSFORMATION LABORATORIES

7 TISSUE CULTURE FACILITIES

10 CONFINED FIELD TESTING SITES

Biotech Human Resource Capacity

145
Ugandan Scientists
actively involved in biotech R&D



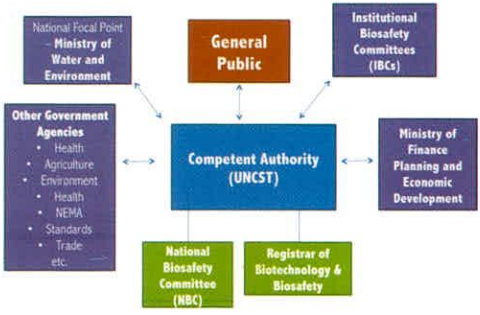
25 PhDs

50 MSc

70 BSc Degrees

Proposed Institutional Biosafety Framework

National Biotechnology and Biosafety Bill (2012)



Production of this infograph has been done through a collaboration between the Uganda Biosciences Information Center (UBIC), ISAAA AfriCenter and Uganda Biotechnology and Biosafety Consortium (UBBC). UBIC is a NARO-led information hub that shares information on agricultural research in Uganda.

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