



LOCAL EXPERTS' VIEWS

About Biotechnology & Biosafety



A Booklet Profiling Local Experts' views about Biotechnology and Biosafety

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Preface



Kenya is currently facing dire challenges of rapid population increase coupled with climate change which has occasioned the advent of new pests and diseases, shrinking water resources, as well as desertification. It is thus evident that agricultural practices currently used in the country cannot ensure food security. Vision 2030, Kenya's blueprint for social and economic development agenda, identifies science and technology as a vital component that will propel the country to a prosperous, food and nutritionally secure nation. In this regard, Kenya has made great strides towards creating an enabling environment for the adoption and utilization of science and technology, and in this context, agricultural products developed through biotechnology.

Kenya was the first country to sign the Cartagena Protocol in 2000 and this initiative was closely followed by the enactment of a Biosafety Act in 2009. Since then Kenya has progressively put in place institutional and human capacities that are allowing the development of relevant agricultural biotechnology crops that are poised to make great impact in the economic development of the country. This booklet summarizes the regulatory, research and training capacities existing in the country based on face-to-face interviews with key scientists, and executives in national and international research and training institutions. It demonstrates that the country has the capacity to adopt and utilize agricultural biotechnology crop products developed locally and internationally.

1. The KALRO Biotechnology Centre

The Biotechnology Centre was established in 1999 as a unit under KALRO headquarters with the mandate of all biotechnology research activities in KALRO. The Centre has a modern biotechnology biosafety level two green house and modern laboratories. The Centre carries out research in various fields including: development of tissue culture protocols for vegetatively propagated crops and industrial crops; use of marker assisted breeding in development of disease

resistant maize lines. They are also developing disease and insect resistant transgenic varieties of cassava, maize, sweetpotato and biofortified transgenic cassava and sorghum. Livestock research is an important component of the Centre and diagnostic kits and recombinant vaccines of important livestock diseases are being developed.

The Centre provides leadership to all KALRO scientists involved in GM

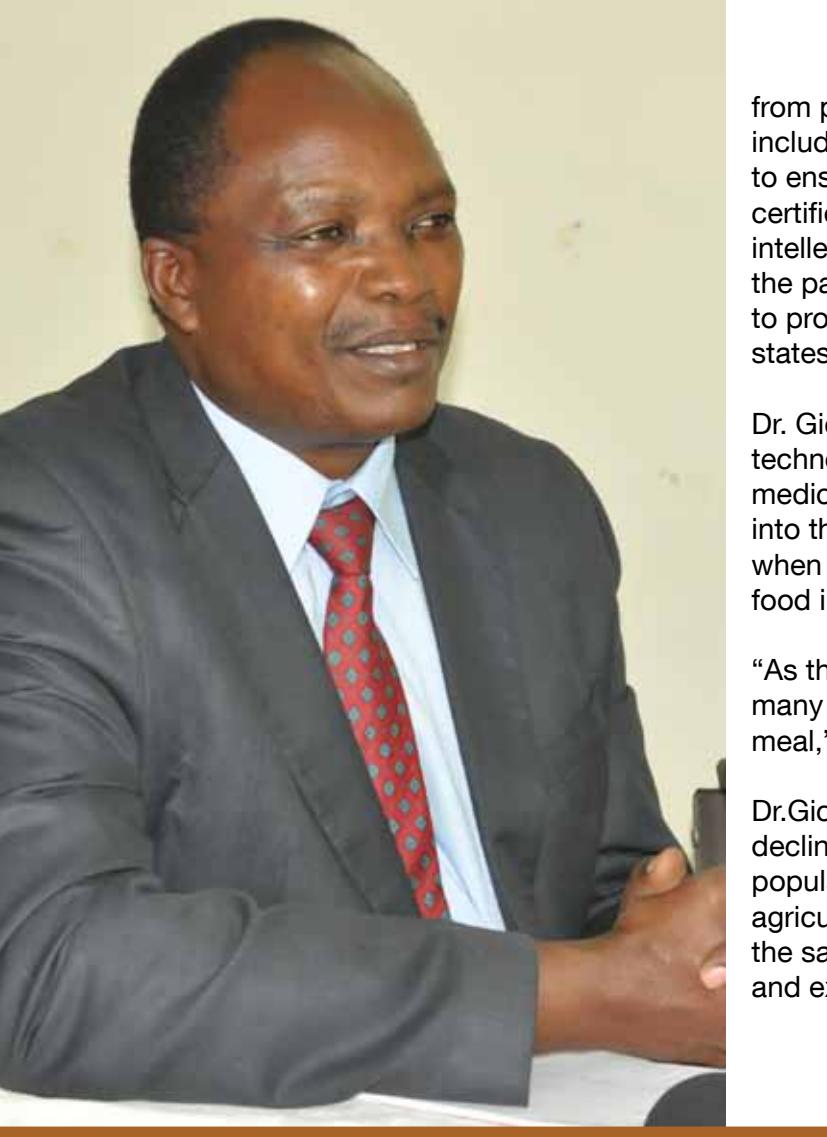
research to ensure compliance with biosafety regulations, maintenance of high standards of bioethics, intellectual property issues and awareness creation for biotechnology research and development activities in KALRO. In addition to conducting research the Centre actively participates in development of biotechnology and biosafety policies in Kenya and the region.

1.1 Interview with Dr. Simon Gichuki Former Head of KALRO Biotechnology Centre

"The KALRO Biotechnology Center has been carrying out research on genetically modified plants since the year 2000, and there are currently four on-going trials on GM crops that we anticipate when completed will contribute in ensuring food security in our country," notes Dr. Gichuki. "We are also quite well equipped for this kind of work. The Centre alone boasts of about 30 scientists with 10 of them being PhD holders and very well equipped laboratories too," he adds.

KALRO, he points out is a public institution that develops technologies, for the public good. The institute therefore goes into partnership with like-minded institutions





Expert's biography

Dr. Simon T. Gichuki is a senior scientist in charge of the KALRO Biotechnology Centre, Kabete. He is involved in biotechnology research on plant diseases and pests, drought tolerance, bio-fortification and diversity studies. He has

from public and the private sector. These include universities and seed companies to ensure farmers access internationally certified products. "We negotiate upfront on intellectual property rights or royalties with the partners we engage in our activities to protect farmers from exploitation," he states.

Dr. Gichuki finds it quite ironical that GMO technology is popular in the world of medicine where drugs are directly absorbed into the body yet people raise concerns when it's applied by scientists to address food insecurity.

"As this endless debate continues, there are many Kenyans who cannot afford a decent meal," he quips.

Dr. Gichuki observes that with the ever-declining land sizes alongside a growing population, people have to adopt smart agricultural practices as opposed to using the same old technologies over the years, and expecting different results.

"We must be ready to adopt emerging technologies to fix challenges facing today's farmer," Dr. Gichuki says.

He cites the recent Maize Lethal Necrosis (MLN) disease that wiped out farmers' maize plantations in the Rift Valley and western Kenya as a case in point where modern technology can come in handy in ensuring challenges to agriculture are dealt with.

In conclusion, Dr. Gichuki notes that as a public research institute, KALRO would never develop an unsafe agricultural product for use by Kenyans. "Commercialized GM products have been consumed for years and no single case of adverse effects to human health has been reported by scientists in any part of the world," he says. "The regulation of GM crops and foods is quite thorough and safety is the main focus of this regulatory process" he adds. Dr. Gichuki is committed to support small scale rural farmers attain food sufficiency.

worked on a number of crops including, maize, cassava, sweet potato, cashew nuts and aloe vera. Dr. Gichuki holds a Ph.D. in Genetics and Plant molecular breeding, from the University of Agricultural sciences, Vienna (Austria), and an MSc. in Agronomy

from Oklahoma State University (U.S.A). He is an active participant in Biotechnology and Biosafety policy development in Kenya and the region.

1.2 The Bt Cotton Project

Systematic failures in the cotton value chain, including pests and diseases are largely attributed as factors that led to the collapse of the once vibrant cotton sector in Kenya. From producing 70,000 bales of cotton in 1985, the country currently produces less than 20,000 bales of cotton. It is also estimated that as a result of the collapse of the sector, the country has lost more than 600,000 job opportunities. Revamping the sector would require farmers to access the best cotton seed varieties that aren't prone to attacks by pests and diseases as well as addressing other

challenges along the cotton value chain.

The Kenya Agricultural and Livestock Research Organization (KALRO) embarked on intensified research to develop improved cotton varieties for cultivation by Kenyan cotton farmers. The Institute therefore initiated research on Genetically Modified (GM) cotton in 2000, with the goal of coming up with cotton varieties that are resistant to pests and diseases. The project also aimed at reducing cotton production

1.3 Interview with Dr. Charles Waturu Principal Investigator, Bt Cotton Project

"Bt Cotton offers hope to revive Kenya's cotton sector," notes Dr. Charles Waturu, the Principal Investigator of the Bt Cotton Project. "Most cotton farmers in Kenya quit cultivating the crop due to the ever increasing production costs occasioned by pest infestation."

Application of pesticides to cotton as a strategy for managing pests has been confirmed to be expensive besides exposing the farmer to health risks due to too much exposure to pesticides. As a result, issues of costs and toxicity to farmers saw scientists seek a sustainable alternative. The GM technology incorporates resistance to the pests,

costs, thereby increasing farmers' returns while conserving the environment. The African bollworm is the most destructive pest for cotton and can cause up to 100% yield loss if unchecked. Bt cotton is, however, resistant to the pest therefore guaranteeing the farmer reduced pesticide use, hence lowering the production costs substantially.



thereby protecting farmers' health and boosting their income from the farms. KALRO has been undertaking research on Bt cotton since the year 2000.

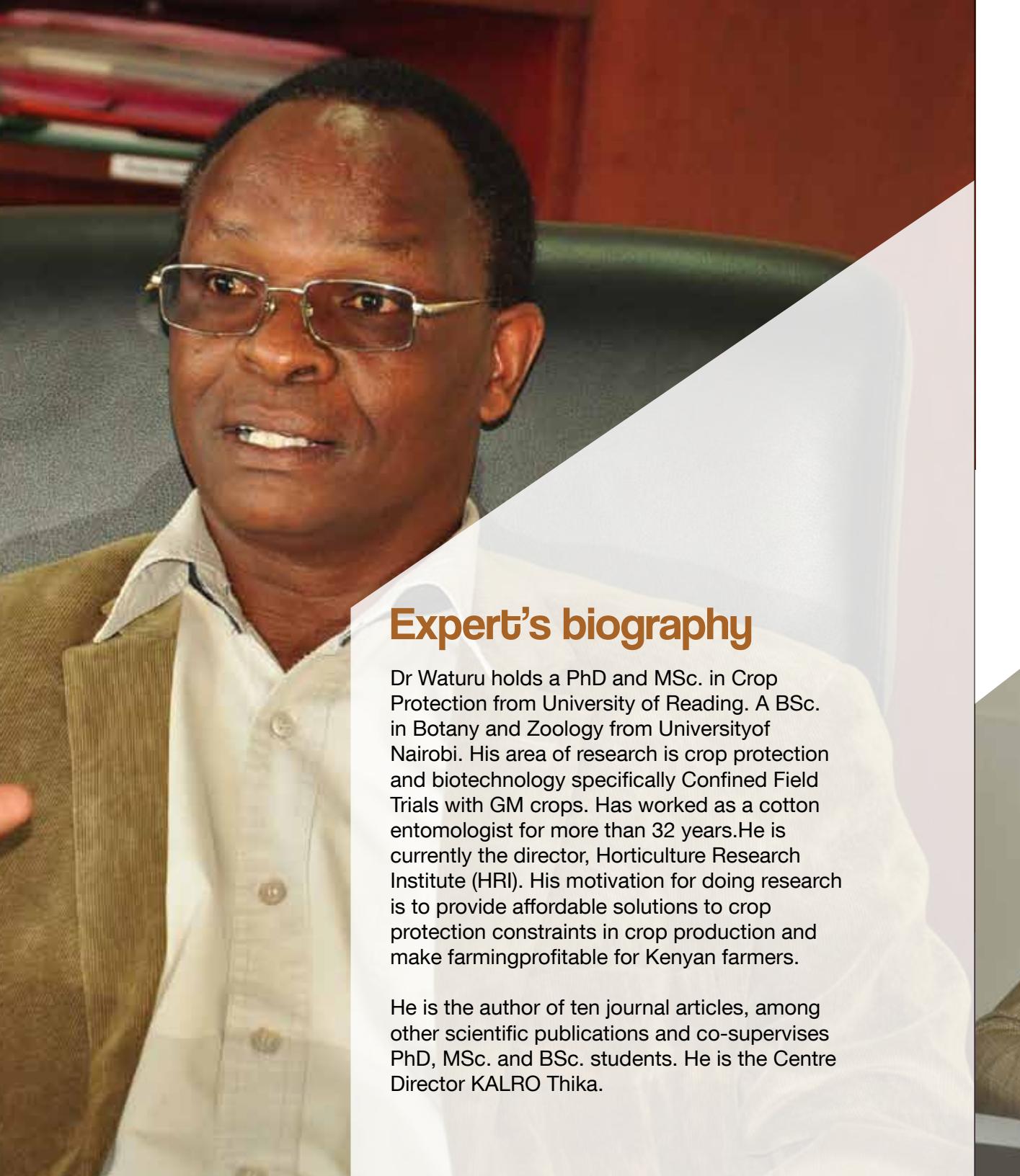
The Bt cotton varieties tested by KALRO were Bolgard I and Bolgard II. "We have now completed our research and are ready to offer our farmers the Bolgard II cotton variety which we have confirmed to be resistant to cotton pests," notes Dr. Waturu.

The existing GM import ban is, however a stumbling block standing between farmers and this new improved cotton variety. Dr. Waturu asserts that if the GM import ban in Kenya is lifted, the country would have GM

cotton being cultivated by farmers in two years' time pending regulatory approval by the National Biosafety Authority (NBA). The expert further notes that Kenya is not pioneering with the GM technology, adding that those in doubt of what the technology guarantees only need to look at those countries where the GM products are in plenty and tell Kenyans any negative experiences linked to these products in those countries.

"Smaller economies than Kenya, for example Burkina Faso, have adopted the technology and there is no reason why critics of the technology should argue that we need to wait and see how the technology is adopted by other countries. Why should we be the laggards?" he poses.

Cotton is drought tolerant and would thrive well in arid and the semi-arid regions (ASALs) of the country.



Expert's biography

Dr Waturu holds a PhD and MSc. in Crop Protection from University of Reading. A BSc. in Botany and Zoology from University of Nairobi. His area of research is crop protection and biotechnology specifically Confined Field Trials with GM crops. Has worked as a cotton entomologist for more than 32 years. He is currently the director, Horticulture Research Institute (HRI). His motivation for doing research is to provide affordable solutions to crop protection constraints in crop production and make farming profitable for Kenyan farmers.

He is the author of ten journal articles, among other scientific publications and co-supervises PhD, MSc. and BSc. students. He is the Centre Director KALRO Thika.

1.4 Virus Resistant Cassava for Africa (VIRCA) Project

Virus Resistant Cassava for Africa (VIRCA) is a collaborative project with the Donald Danforth Plant Science Center, the Kenya Agricultural Research Institute (KALRO), Uganda's National Agricultural Research Organization (NARO) and the Science Foundation for Livelihoods and Development (SCIFODE).

The project is developing improved cassava varieties, which are resistant to the two common cassava diseases-mosaic disease (CMD) and Cassava Brown Streak Disease (CBSD). The work is important because

CMD alone is estimated to cause about \$ 6-25 million in losses in Africa; while CBSD is reported to cause total losses of cassava harvest, leaving families and communities without food or income.

The project's mission is to enhance the livelihoods of smallholder farmers in East Africa by delivering farmer preferred cassava varieties that are genetically enhanced to resist serious virus diseases.



1.5 Interview with Dr. Douglas Miano, Senior Research Scientist.

"For over several years now, farmers have been grappling with the cassava mosaic disease and the cassava brown streak disease, which have translated to high economic losses prompting some farmers to stop cultivation of the crop altogether." Says Dr. Douglas Miano, the lead Virologist of the VIRCA project in Kenya. Dr. Miano is a man with a mission in science to give Kenyan cassava farmers a chance to earn income and contribute to food security in the country.

The scientist who has worked with the Kenya Agricultural Research Institute (KALRO) as a researcher reveals that



management of diseases starts with identifying causes of the diseases. He adds that besides the use of clean planting materials to tackle cassava diseases, genetic engineering is more appropriate to protect crops from the disease causing pathogens.

"In simple terms, the technology we are using to develop the improved cassava varieties under this project can be compared to how immunization works. It is all about how to make a plant realize there is a foreigner and be able to fight the foreign entity successfully." He explains.

Dr. Miano states that the project is only focused on improving the targeted traits within the cassava plant to ensure that it can resist infection by CBSD and CMD. When questioned about his motivation in carrying out research work with improved crops Dr. Miano says "I always ask myself, what contribution will I give to human kind? Planes navigate through the skies even when the clouds are thick. The airplane has been made by efforts of different people. I

also think of what I can do to help someone not die of hunger".

He adds that contrary to popular belief that scientists have no time for God, he is a God-fearing man who participates in church functions and a loving family man who strives to be with his family whenever there is an opportunity. "I am a scientist and also a Christian. I create time for my work and for the family without forgetting God," he says with a chuckle.

Expert's biography

Dr. Miano holds a Ph.D in Plant Virology from Louisiana State University, USA, MSc. in Plant Pathology and BSc. in Agriculture both from the University of Nairobi (UoN), Kenya. He is a Senior Lecturer at the Department of Plant Science and Crop Protection, Faculty of Agriculture, University of Nairobi. Before joining UoN, Dr. Miano worked as a Senior Research Officer at the Kenya Agricultural Research Institute (KARI) Biotechnology Center. He was awarded the KARI Scientist of the Year in 2010-11.



2. The Kenya Plant Health Inspectorate (KEPHIS)

The Kenya Plant Health Inspectorate (KEPHIS) is the government parastatal whose responsibility is to assure the quality of agricultural inputs and produce to prevent adverse impact on the economy, the environment and human health.

The mandate of KEPHIS is to provide a science based regulatory service by assuring the quality of agricultural inputs

and produce to promote food security and sustainable development. The agency implements this mandate for agricultural biotechnology in conjunction with the National Biosafety Authority, which is the lead regulatory agency for Genetically Modified Organisms (GMOs) among other agencies.

The institution has a state of art molecular laboratory with modern equipment dedicated for GMO analysis, as well as other well-equipped laboratories for pathological and diagnostic work.



2.1 Interview with Mr. Abed Kagundu Head, Biosafety and Phytosanitary Services

The Kenya Plant Health Inspectorate (KEPHIS) plays a significant role in the regulation of genetically modified products in Kenya. The institution is involved in biosafety both as a member of the NBA Board and as one of the eight regulatory agencies working in consultation with the National Biosafety Authority to implement the Biosafety Act.

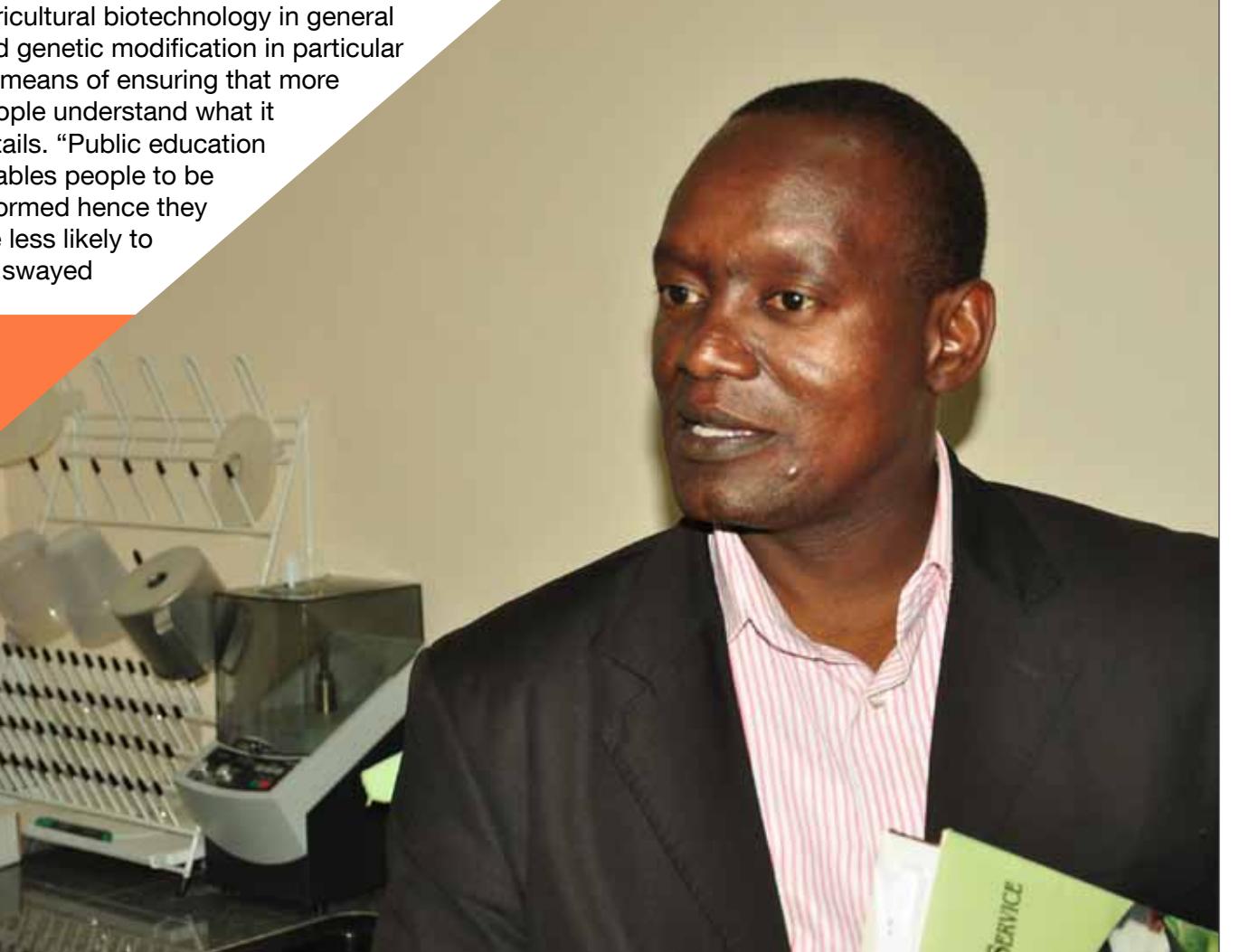
According to Mr. Kagundu, Kenya's regulatory agencies are very capable of effectively regulating biotechnology/ genetic modification to ensure safety for humans and the environment. "KEPHIS for example has the necessary human capacity and world class laboratories to do the requisite testing for GMOs," notes Mr. Kagundu. In addition to the state of the art lab, we also

have surveillance offices with competent staff at all border points in the country to ensure effective biosafety regulation." He adds.

Mr. Kagundu notes that myths and misconceptions are the main reasons behind the numerous concerns raised regarding GMOs. He therefore recommends increased public awareness about agricultural biotechnology in general and genetic modification in particular as means of ensuring that more people understand what it entails. "Public education enables people to be informed hence they are less likely to be swayed

by mis-information. In science, we do not promote populist ideas but results based on proven ideals," he explains.

In conclusion, Mr. Kagundu observes that though Kenya has a biotechnology policy, implementation must be prioritized to realize the set objectives.



Expert's biography

Abed is a Programme Officer, regulatory affairs at AATF. Before joining AATF he was acting General Manager for Phytosanitary services at KEPHIS where he worked for eleven years.

3. Kenya Bureau of Standards (KEBS)

The Kenya Bureau of Standards (KEBS) is a National Standards Body with an overall mandate to promote standardization in industry and trade through standards development, conformity assessment, testing and metrology. It aims at providing standards based solutions that deliver quality and confidence to the consumers.

The state corporation which was established in 1974 by the Standards Act, is one of the eight government agencies that work alongside the National Biosafety Authority (NBA) to implement the Biosafety Act (2009). With regards to products of genetically modified organisms, the role of KEBS is to develop standards for

specifications and codes of practice as well as to inspect and monitor for all GMO products for conformity to the standards. All the standards developed by KEBS have to be complementary to the Biosafety Act 2009.

3.1 Interview with Mrs. Margaret Aleke Manager, Food and Agriculture Standards, Kenya Bureau of Standards

The process of standards development according to Mrs. Margaret Aleke is influenced by the changing technology, consumer preferences and safety requirements among others. "KEBS facilitates the process of standards development to ensure that the country has the right measures in place to guarantee quality," she says.

In an interview, Mrs. Aleke informs that Standards for the Genetically Modified Organisms (GMOs) and derived products have been developed as a deliberate effort to enhance surveillance scope. "Though the National Biosafety Authority (NBA) is the lead regulatory agency for genetically modified organisms, standards help

ascertain that any approved GMO product meets the internationally benchmarked quality standards," Mrs. Aleke explains.

"So far, we have domesticated three Codex standard guidelines for conduct of food safety assessment and five standards from International Organization for Standardization (ISO) for detection and quantification of genetically modified organisms and derived products. Our first point of reference in development of standards is an international standard because it has international



acceptance”
Mrs.
Aleke says.

The manager adds that though Kenya is on the path to commercialization of GM crops, there is need to take note that the GMO development process is more rigorous compared to the conventional breeding process. It involves mandatory integration of risk assessment steps to provide food safety assurance.

“Safety of a food should be the first criteria in determining its fitness for consumption. However good a food may be in terms of yields and safety for the environment, food safety should never be compromised,” she asserts. Mrs. Aleke insists that there must be uniform ways of determining what is safe for the market from what is not. The use of uniform guidelines and test methods ensure that only safe GMO foods, approved by National Biosafety Authority are marketed. Without such guidance, consumer’s health would be at risk.

“The adoption of a particular standard involves consultations and consensus building among stakeholder representatives who stand to benefit from the products. In the case of GMO standards, it includes,

research institutions, academia, industry, the Ministry of Agriculture; regulatory agencies; the National Biosafety Authority (NBA); trade associations; and a consumer association, who represent the public.

However, she notes that sometimes there are misconceptions about the mandate of various regulatory agencies. “The agencies complement each other to ensure that all aspects of quality control are covered. Each regulator focuses on specific aspects in the quality system to ensure that given products meet certain set quality parameters,” she says.

For instance, she points out that inspection officers from KEBS can alert NBA if they have reasons to believe that, a GMO food product, entering the country has not been approved by NBA for use in the country. The corporation also verifies information about imports in countries of origin to ensure that the products entering the Kenya market meet requirements specified in the Kenya standards. The status of the foods, particularly those which are known to have genetically modified counterparts, must be declared as required by specific standards for commodities and labeling of GMO food and feed. Import consignments are required to have a certificate of conformity to Kenya standards.

“Only import consignments that meet standards are allowed to access the Kenya market”, she says.

Mrs. Aleke notes that KEBS conducts regular surveillance patrols in the market; industry and border points to ensure that Kenyans are treated to quality products that pose no health risks. In a bid to bring services closer to the people, six (6) regional offices and fourteen (14) entry posts are in place. Asked what motivates her, Mrs. Aleke points out that she is happiest when quality and safety are upheld because this ensures consumers are protected and get value for their money.

Expert's biography

Mrs. Margaret Aleke holds a BSc in Food Science and Technology, a BSc in Applied Human Nutrition from the University of Nairobi. She has a postgraduate certificate in biosafety in plant biotechnology from Ghent University, Belgium. She has worked with Kenya Bureau of Standards for 29 years: 25 years in standards development and 4 years in quality assurance and inspection. Currently, she manages the development of food and agriculture standards. She has a wide knowledge of standards development at the East African Community (EAC), Codex Alimentarius Commission (CAC) and International Organization for standardization (ISO).

4. The National Biosafety Authority (NBA)

The National Biosafety Authority (NBA) is the national competent authority with the overall mandate to exercise general supervision and control over the transfer, handling and use of genetically modified organisms and consults with eight other regulatory agencies. Some of the roles of the Authority include receiving, reviewing and making approval or rejection decisions on applications to introduce biotechnology

products for research or commercial purposes into the country based on risk assessment.



4.1 Interview with Prof. Dorrington Ogoyi Director Technical Services, National Biosafety Authority

“The comprehensive application processes that Genetically Modified Organisms (GMOs) go through are not meant to frustrate researchers or importers but, to ensure safety,” notes Prof. Dorrington Ogoyi.

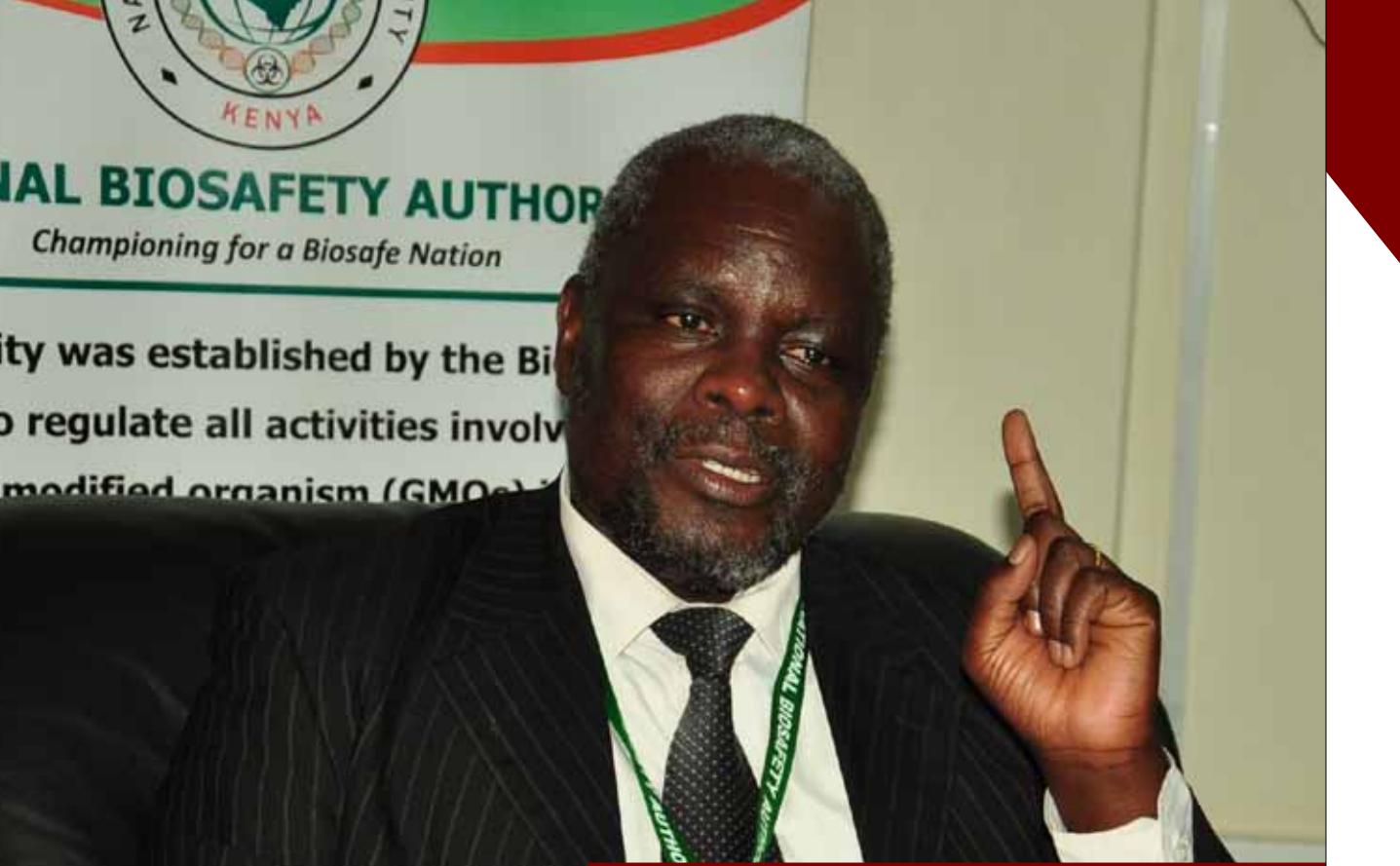
“NBA just implements internationally acknowledged best practices in its risk assessment of GM foods before releasing them into the country,” he adds.

Prof. Ogoyi enlightens that NBA has a team of competent personnel within the authority and some external experts, who review the applications to check on conformity to the established international regulations.

"We have 43 staff that oversees the regulation of biotechnology in the country besides the external professionals that we usually seek expert opinion from, to ensure total compliance," he said. Since establishment in 2010, the authority according to him, has developed clear guidelines on how risk assessment should be done. "The process of how applications for GM crops and foods are reviewed is in place and is based on sound science and internationally recognized standards," notes Prof Ogoyi. "As a regulator, NBA is a neutral referee in the review of GMO applications. We are not promoters of the technology but we support responsible use to ensure only safe applications of GMO are in the market. We stand in between promoters and consumers of the technology," said Prof Ogoyi.

He explains that in the development of various regulations and guidelines, the stakeholders are widely consulted and the final document is generally developed after taking into account various opinions expressed by the stakeholders. "It is for this reason that any concerns from the stakeholders would be taken seriously in the review of our documents" explains Prof. Ogoyi. On whether the country has capacity to regulate GMOs, Prof. Ogoyi unequivocally points out that all the eight regulatory agencies in Kenya have what it takes to effectively regulate GMOs.

"We are equal to the task and the stringent measures in place speak volumes about how safety is our priority," Prof Ogoyi says, exuding confidence.



Expert's biography

Prof Ogoyi is a PhD holder from the University of Nairobi. Prior to his appointment. As Director of Technical Services at the National Biosafety Authority, Prof. Ogoyi was an Associate at the University of Nairobi department of He is also an Associate Professor at the Technical University of Kenya. He is the National Focal Point for the Cartagena Protocol on Biosafety for Kenya.

He further explains that besides the trained workforce and the technical experts within the agencies, NBA also has well-equipped, state-of-the art laboratories, which ensure various kinds of tests on GMOs, can be done.

5. Genetically Modified for Drought Tolerance (GEMADOT)

Maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. Worldwide production of maize is 980 million tons; Africa produces less than 10 % of this global total and is estimated to import 30 % of the required maize from countries outside the continent. This is attributed to crop failure due

to unreliable rainfall patterns pervasive in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. Worldwide production of maize is 980 million tons; Africa produces less than 10 % of this global total and is estimated to import 30 % of the required maize from countries outside the continent. This is attributed to crop failure due

Africa. Kenya is one of the main focus countries of the project. The research work is led by the department of biochemistry and biotechnology at Kenyatta University in partnership with: Mikocheni Agricultural Research Institute (MARI) in Tanzania, the Ethiopia Institute of Agriculture Research (EIAR) and the Sudan Agricultural Research Co-operation (SARC). The project is currently at the green house testing stage.

5.1 Interview with Dr. Steven Runo Senior Lecturer, Department of Biochemistry and Biotechnology at Kenyatta University

Dr. Stephen Runo the Principal Investigator of the GEMADOT project predicts that yield could potentially be doubled or tripled from its current low levels of about 0.5 to 1 metric ton of grain per ha, particularly through strong positive yield synergies between improved crop varieties, fertilizer and other management techniques. He points out that capturing even a modest portion of these potential gains, including cultivating drought tolerant crops would generate major impacts in reducing food insecurity and increasing incomes in these impoverished areas.



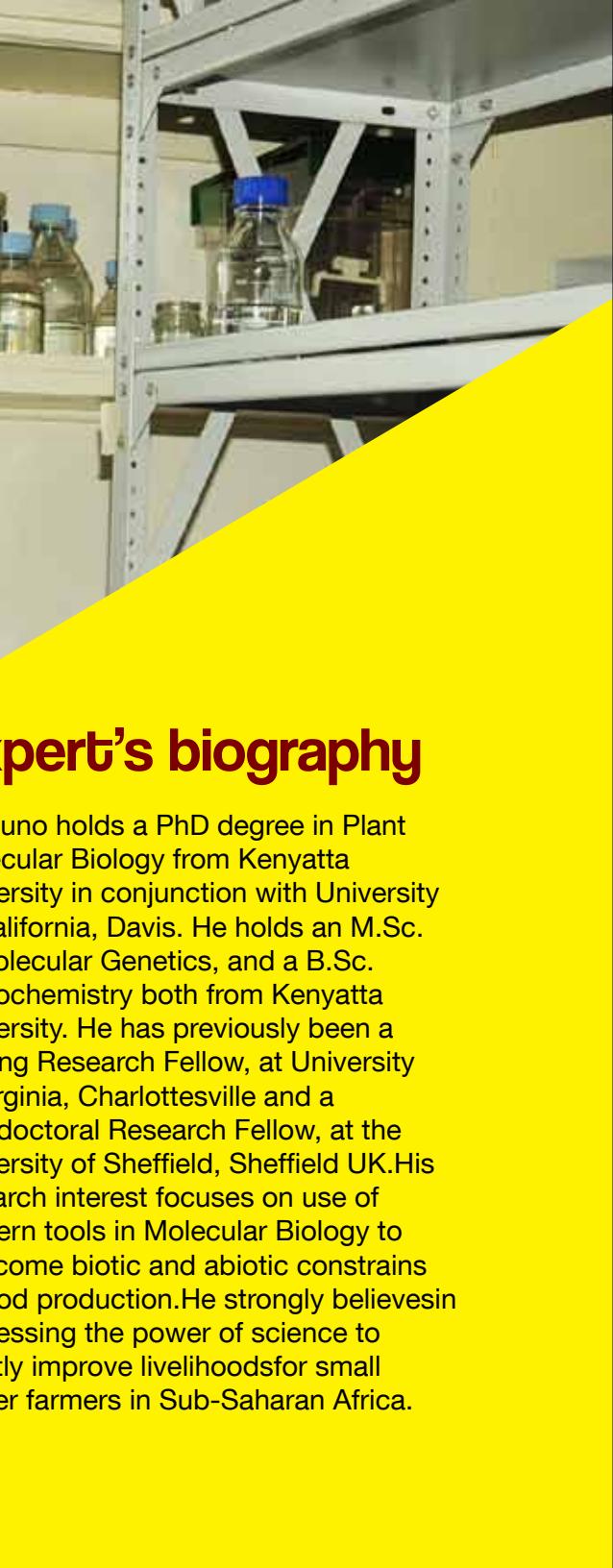


By applying modern biotechnology techniques, Dr. Runo and his research team has figured out a way of genetically improving maize crops to ensure that they are able to give optimum yields in drought conditions. Dr. Runo advises that, for Kenya to significantly improve its agricultural production, the country must integrate modern agricultural technologies like biotechnology into the system. "We need to shift to science based agricultural system for us to adequately respond to present realities like climate change and population increase," he notes.

Considering the apprehension with which GM crops (and products in general) are regarded with, Dr. Runo believes pro-active knowledge sharing efforts by scientists will

help clarify certain public misconceptions about genetically modified products.

"With the right information about the value of biotechnology, opposing views would be neutralized therefore allowing Kenya (and by extension Africa) to unlock its agricultural potential and stop over relying on relief aid," he says. Dr. Runo also proposes a review of the secondary schools curriculum to ensure that students are conversant with topics like biotechnology and genetic modification earlier on in their academic lives. "The basics of genetic engineering can be well taught at high school level. That is the easiest way to start passing this vital information rather than waiting to change people's minds, when they are adults," he points out in conclusion.



6. Jomo Kenyatta University of Agriculture and Technology (JKUAT)

JKUAT Research, Production and Extension (RPE) Division is one of the three Divisions in the University. The Division was set up when JKUAT, then JKUCAT became a constituent College of Kenyatta University in 1987.

The division under the leadership of the office of the Deputy Vice Chancellor (RPE) coordinates the following activities: Research including fundraising and dissemination, production and income generating activities, extension including

shows and exhibitions, linkages with local and international organizations and community collaboration. The Division's mandate is performed by various directorates, departments, institutes and Centres.

The Institute for Biotechnology Research (IBR) is an example of these institutes through which major technical advancements in the Division have been realized. Some of the technologies include tissue culture of banana, Aloe Vera,

Jatropha and rose plantlets that are free of diseases and have high yields, organic farming practices which include the development of vermiculture compost and its benefits. The Division is also in charge of oyster and button mushroom production. It is also involved in bio-prospecting and characterization of microbes with industrial potential.



6.1 Interview with Prof. Esther Kahangi

Prof. Esther M. Kahangi, is the Head of Research, Production and Extension (RPE) Division at the Jomo Kenyatta University of Agriculture and Technology (JKUAT).

Prof. Esther Kahangi stands tall as one of the pioneers of tissue cultured bananas in Kenya. The introduction of tissue cultured bananas forever changed the lives of banana farmers in different parts of Kenya by ensuring they could access high yielding and disease free bananas thereby putting the farmers back to profitable farming. Prof Kahangi developed a keen interest in tissue-cultured bananas in 1988 following a stint in Japan where she learnt about cell and tissue culture.

In an interview, she explains how the deplorable state of banana farming in Kenya motivated her to seek a solution. "In the 1990s bananas were getting extinct due to pests and diseases. Nematodes were the most worrying pests as they threatened banana productivity and left farmers counting losses," she recalls. She narrates how as a young scientist motivated by the challenge of finding a solution, she took the initiative to establish a commercial laboratory and to carry out extension services to convince farmers that the bananas were worth investing in.

"I initially started in small laboratories provided by Japan International Cooperation Agency (JICA), although I could not produce enough suckers to meet the demand. I therefore wrote proposals to establish a commercial laboratory to produce enough planting materials for the farming community," she explains. Her proposals were successful and she received funding to start a laboratory at the University. Other partners eventually came on-board and played a crucial role in the dissemination of the technology. She observes that the adoption of the technology was good and it ensured that many farmers' could comfortably earn income from bananas. "Another impact of the introduction of tissue-cultured banana was that it ensured that Kenya was able to produce adequate banana internally

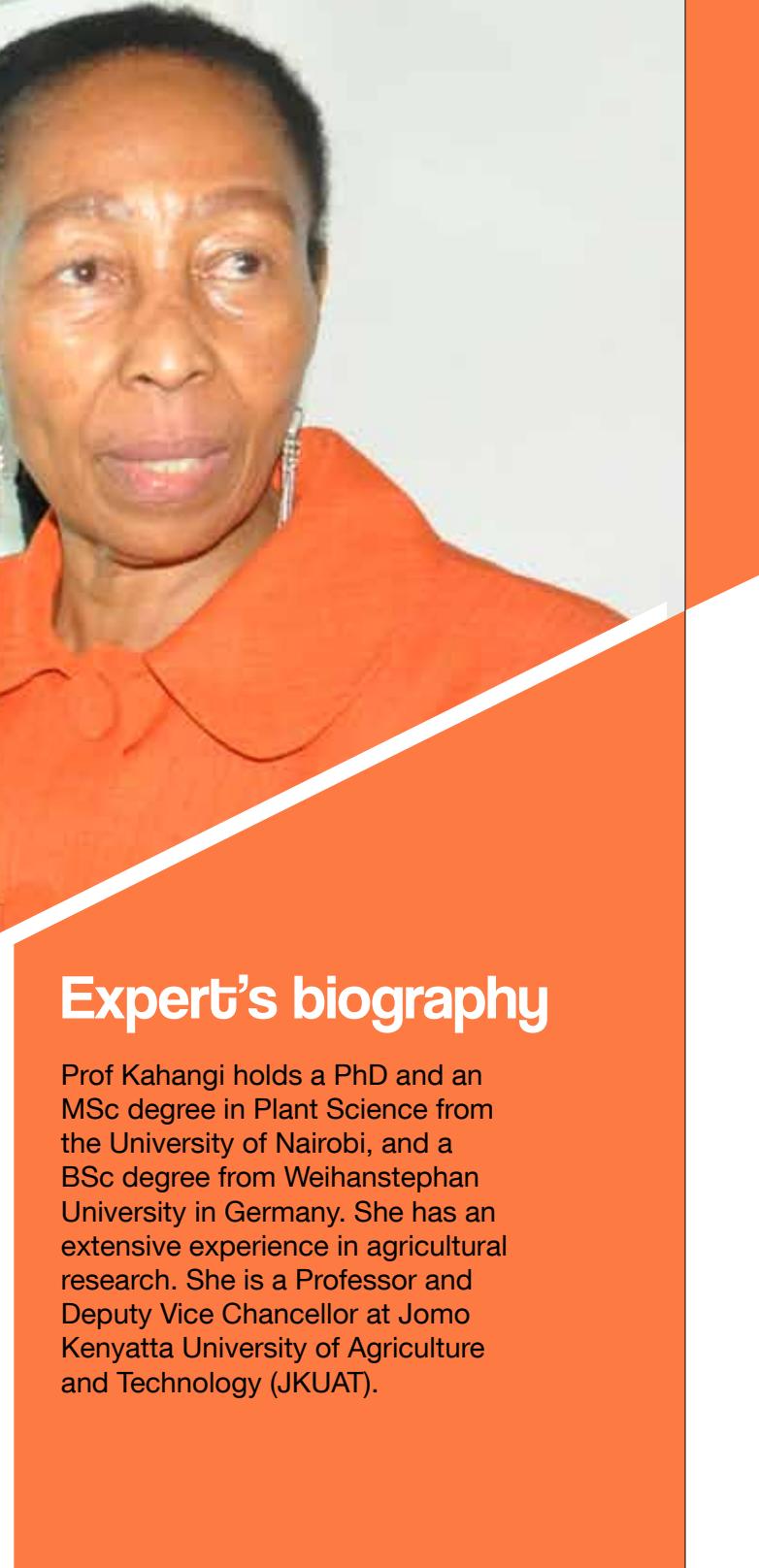
thereby putting an end to importation of this fruit from neighbouring countries like Uganda," she notes.

Prof Kahangi notes that the successful adoption of tissue-cultured banana in Kenya indicates why the country should give new agricultural technologies a chance to prove their worth.



Expert's biography

Prof Kahangi holds a PhD and an MSc degree in Plant Science from the University of Nairobi, and a BSc degree from Weihenstephan University in Germany. She has an extensive experience in agricultural research. She is a Professor and Deputy Vice Chancellor at Jomo Kenyatta University of Agriculture and Technology (JKUAT).



6.2 Interview with Dr. Ciira Kiiyukia

Senior Lecturer, JKUAT-College of Health Sciences, Public Health Department

Dr. Ciira Kiiyukia, a food safety expert and lecturer at Jomo Kenyatta University of Agriculture and Technology (JKUAT) downplays fears that GM foods pose health risks to human beings. GM foods, he says are safe for human consumption. The fact that his scientific specialty makes it possible to follow the entire food process from seed to the plate gives him confidence on the matter of GM food safety. "Any GM food released for human consumption goes through rigorous risk assessment tests that include allergenicity and toxicity tests amongst others to ascertain safety," he states. Sensitive matters like food safety should not be politicized if leaders are committed to saving this country from perennial food shortages.

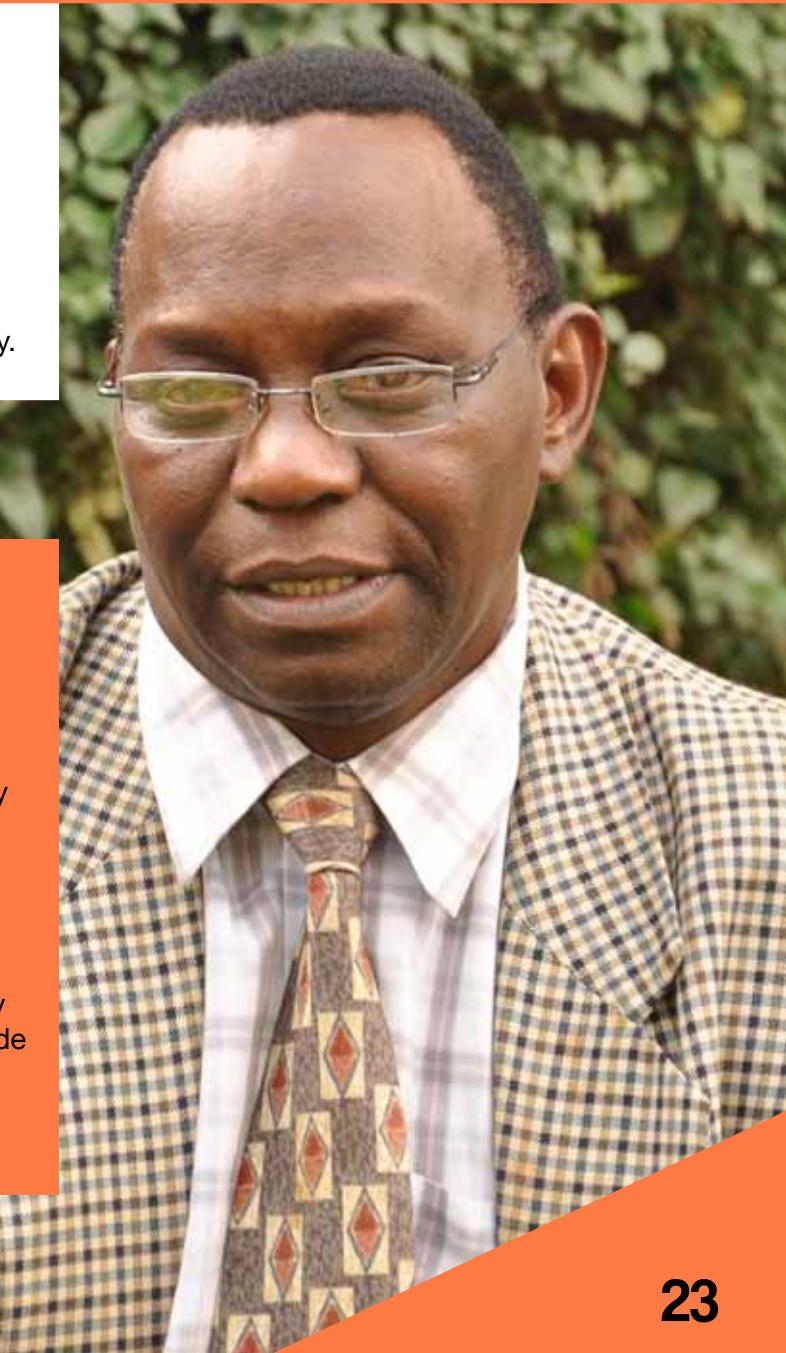
The Government should consult Kenyan experts like me, and others, regarding the question of food safety. This way they are less likely to come up with misinformed policy directives about issues like GMO food safety," notes Dr. Kiiyukia. "Why is it that GM technology is widely used in medicine and nobody has ever raised a

finger or rejected medication because they are GM? It is therefore all about politics as opposed to safety concerns, when it comes to GM food," Dr Kiiyukia says.

Dr. Kiiyukia notes that compared to Kenya, countries where GM foods are consumed have a higher life expectancy.

Expert's biography

Prof. Kiiyukia holds a PhD, and MSc. degree in Microbiology, and a Postgraduate Certificate in Food Sanitation and Hygiene, all from Hiroshima University, Japan. He has a BSc. from the University of Nairobi in Biochemistry and Botany. He is currently an associate professor at the Mount Kenya University, Medical School in Thika. At the time of this interview he was working as a senior lecturer at (JKUAT) – College of Health Sciences (COHES) Food Science and Technology Department. His research interest include food safety and security, environmental health, occupational health and safety, medical and food microbiology.



7 Centre for Biotechnology and Bioinformatics (CEBIB)

University of Nairobi's Centre for Biotechnology and Bioinformatics (CEBIB) was founded as a virtual research centre to train postgraduate students at MSc and PhD level in biosciences (Biotechnology & Bioinformatics). The program aims to develop capacity and manpower for the development of Biotechnology.

The program is serviced by academic staff, senior scientists from the University of Nairobi's faculties and schools including; School of Biological Sciences (SBS), School of Computing and Informatics (SCI), School of Mathematics (SOM), Department of Biochemistry and Department of Physics all from the College of Biological Sciences (CBPS) as well as those from the College of Agriculture and Veterinary Sciences (CAVS) and School of Pharmacy.

The goal of the biotechnology outreach programme is to create an enabling environment for biotechnology research and development in Kenya through improved knowledge and awareness in biotechnology and biosafety among stakeholders. Overall the goal is to increase the number of people to whom significant knowledge or skills have been imparted through formal or informal means. It does this by improving knowledge and awareness in biotechnology and biosafety among biotechnology stakeholders.

7.1 Interview with – Prof. James Ochanda, Director Centre for Biotechnology and Bioinformatics (CEBIB)

"We focus on developing highly reliable manpower at masters and PhD levels. Students who are well versed with the place of biotechnology as an important tool in production of quality crops to boost food security in Africa," Prof. Ochanda explains about CEBIB.

The director explains that the University made the strategic decision to start the Center as a means of addressing the growing shortage of experts within Kenya in health, agriculture and industrial development.



"Biotechnology has emerged globally as a key area of scientific development in Kenya and across the world. We therefore had to come up with a programme that will develop the human resources the country needs to advance in this area of science," he notes. Prof. Ochanda is quick to point out that CEBIB is the only Center in Eastern and Central Africa that trains masters and PhD level students on Biotechnology and Bio-informatics. The fact that the Centre is based in Nairobi, Kenya he notes, puts the Kenya at a great advantage in terms of building the requisite human capacity needed to practice biotechnology in Agriculture, health, industrial development and environmental management.

Prof Ochanda explains that the admission to the program is however not only limited to Kenyan students only. More and more students from across the eastern Africa region are also enrolled into the program. The Professor, who was also involved as part of the team that drafted Kenya's Biosafety Act (2009), says that he gets disappointed whenever people allude that Kenya doesn't have the requisite capacity to deploy biotechnology.

"There is enough capacity to oversee the regulatory processes for GM products. Personally, I have trained hundreds of scientists who have the requisite skills to carry out research and testing of GM products," Prof Ochanda says. "Other Universities like Kenyatta University and Jomo Kenyatta University of Agriculture and Technology have equally been

churning graduates who are specialists in this field." He adds. Besides having highly sophisticated testing equipment in universities and other independent research institutions, Prof. Ochanda also observes that: "We have government owned institutions like Kenya Agricultural Research Institute (KALRO), the Kenya Plant Health Inspectorate Service (KEPHIS) and, the Kenya Bureau of Standards (KEBS) who also have highly skilled staff and world class facilities for safe deployment of biotechnology."

In his opinion, the obsession by certain groups of stakeholders in Kenya with imagined negative effects of GM crops is misguided. He instead urges for full focus on the benefits for farmers and the country at large if we were to adopt biotech/GM crops. "Application of insecticides and pesticides is not good for our farmers, neither is it for the environment. This is why biotechnology comes in as a better alternative, because usage of herbicides and pesticides will be significantly reduced," Prof. Ochanda asserts.

Prof. Ochanda further explains crops like Genetically Modified (GM) cotton in Kenya would brighten up the faces of farmers whose hopes of ever cultivating the cash crop had been dashed due to diseases and pests. "If GM crops were to be introduced to farmers in Kenya, 80 per cent would adopt them. Farmers assess the impact of crops in terms of how profitable they are," he says in conclusion.



Expert's biography

Prof. Ochanda holds a PhD from Hokkaido University in Biochemistry and a BSc. degree in Biochemistry and Zoology from the University of Nairobi.

8. The African Agricultural Technology Foundation (AATF)

The African Agricultural Technology Foundation (AATF) was set up in the year 2003 after two years of consultations between a wide range of stakeholders from Africa, North America and Europe.

AATF main objective is to avert food insecurity and poverty by facilitating the adoption of appropriate technologies that can boost agricultural production to farmers and increase their income levels.

8.1 Dr. Denis Kyetere

AATF Executive Director, Dr Denis Kyetere view about the programme

AATF executive director, Dr Denis Kyetere says that the foundation focuses on empowering small holder farmer.

"AATF strength is anchored in public-private partnerships to enhance access and delivery of appropriate technologies that guarantee improved agricultural productivity" AATF Executive Director, Dr Denis Kyetere

The director points out that such partnerships bring together the requisite

The structure and operations of this foundation, draws upon the best practices and resources from both the public and private sectors. Moreover, this technological foundation assists small holder farmers to acquire technologies from technology owners through royalty-free licenses or agreements.

AATF establishes partnerships with existing institutions to adapt agricultural technology for use by farmers in Africa.



expertise, and appropriate technologies that farmers are yearning for to increase yields.

Dr Kyetere further says that these technologies differ depending on the priority needs of targeted farmers. He faults those who claim that partnering with technology developers from the private sector puts African countries at a disadvantage in terms of intellectual property rights.

Technology developed products are affordable to consumers

The director says that technology developed products are affordable to farmers while reacting to queries about the added costs accrued from royalty

Dr. Kyetere hints that the organization has also started working with seed companies in supplying quality seeds that are not available in Africa. He assures that companies deliver seeds to farmers at affordable costs.

AATF director says that countries need to view agriculture as a business to take appropriate measures to support the development of better technologies that can guarantee value for the farmers' investments.

Agriculture plays a crucial role in development in Africa

The expert affirms that AATF has developed a variety of technologies for farmers to get income and improve their living standards in Africa. According to Dr. Kyetere, Genetic Engineering is one of the technologies well suited to solve some of the problems that Africa face.

"The African continent has witnessed notable improvements in Agriculture, Science and Technology, Innovative ideas have been recognized as playing a crucial role in the development of Africa". The director says.

The director says having analyzed problems facing People, and identified the safe solutions like Genetic Modification, adding that GMO technology should not be wished away in guise that it is not appropriate for Africa.

The director further asserts that Genetic Modification has advantages in solving challenges facing product development in the continent observing that genetically modified crops are increasing as countries invest in products that can transform their people's financial fortunes.

OFAB plays a pivotal role in promoting Agri-Biotechnology

Dr Kyetere says that Institutions like the Open Forum on Agricultural Biotechnology in Africa (OFAB) have played a critical role in the adoption of Agri-biotechnology in Africa.

The Director acknowledges that partners create a platform for various stakeholders to share their experiences and explore

sustainable ways to improve Africa's food security

He further says that the organization currently operates in 13 out of 48 countries that they intend to reach with their programmes. However, he points out logistical and financial challenges as impending to this course

Expert's biography

Denis Kyetere is a geneticist/plant breeder with a PhD from The Ohio State University, and an MSc from the University of Wales, Aberystwyth College. He previously served as Director General of Uganda's NARO and Chairman of the board for ASARECA and FARA. His desire is for Africa to achieve economic and food security.

9. The Biosciences Eastern and Central Africa-International Livestock Research Institute (BecA-ILRI) Hub

The Biosciences eastern and central Africa-International Livestock Research Institute (BecA-ILRI) Hub is a shared agricultural research and biosciences platform located at and managed by ILRI in Nairobi, Kenya.

The BecA-ILRI Hub's mission is to improve agricultural productivity in sub-Saharan Africa by providing access to world class laboratories for African and international scientists conducting research on African agricultural challenges.



The Hub, which serves 18 countries of eastern and central Africa, is a co-creation of ILRI and the African Union/ New Partnership for Africa's Development (AU/NEPAD). It was established as part of the African Biosciences Initiative to harness biological applications in the health, agriculture, environment and mining sectors and supports Africa's agricultural development as articulated in regional and continental agendas, including the Comprehensive Africa Agriculture

Development Programme (CAADP) and the recently developed Science Agenda for Agriculture in Africa (dubbed 'S3A') led by the Forum for Agricultural Research in Africa (FARA).

All research projects implemented at the BecA-ILRI Hub are directed towards delivering products to help improve food and nutritional security in Africa.

9.1 Interview with Dr. Appolinaire Djikeng Director, BecA-ILRI Hub

Dr. Djikeng begins by acknowledging Africa's notable improvements in agriculture, science and technology. Innovations are increasingly being recognized as playing a crucial role in the development of the continent.

Accessing world-class scientific research facilities and training is often cited as one of the main challenges to research utilization in Africa. To address this challenge, the African Union through its NEPAD program sought to address this challenge in 2007 by championing the establishment of a world-class research facility on the continent and this marked the formation of the BecA-ILRI Hub.

Dr. Appolinaire Djikeng who currently leads the Hub, says that to make informed decisions, Africa's governments should make it a practice to integrate new knowledge emerging from institutions such as the Hub in the development agenda.

The director advises the use of evidenced-based knowledge in the use of biotechnology and other kinds of new scientific technologies, which he says offer great opportunities to improve crop and animal productivity on the continent, thereby significantly reducing poverty, hunger and malnutrition.

"The facility was officially opened by His Excellency President Mwai Kibaki in the year 2010. The facility has been privileged to host a number of scientists from different parts of the continent," affirms Dr. Djikeng.

The director says that Kenya is privileged to be the host for such a major research facility with an Africa-wide mandate. The scientist further acknowledges the support of the Kenyan Government, which he says has enabled the institution to grow over time.

"With government support, we have managed to run our programmes well as we interact with individuals and research institutions at all levels. Dr. Appolinaire Djikeng underscores the importance of African countries investing in more of such facilities. This, in his opinion, will support sustainable research that responds to the continent's agricultural needs.



Expert's biography

Dr. Appolinaire Djikeng holds a PhD in Molecular Biology from Brunel University, London, UK; MSC Biology and BSC Hons from University of Yaounde I, Cameroon. He is the Director at the Biosciences eastern and central Africa-International Livestock Research Institute (BecA-ILRI) Hub since December 2012. Previously he worked in various positions in academia and not-for-profit research institutions in Europe and America. Dr Djikeng has over 20 years' experience in structural genomics, functional genomics and metagenomics with applications to human health, environmental health and agricultural development. He is driven by the passion for capacity building, and believes that African scientists are able to create solutions for agricultural development challenges faced in the continent.

10. The Improved Maize for African Soils (IMAS) Project



The Improved Maize for African Soils (IMAS) is a partnership project between CIMMYT, the Kenya Agricultural and Livestock Research Organisation (KALRO), the Agricultural Research Council in South Africa and Pioneer Hybrid from the USA. The project is seeking to develop maize varieties that are better at capturing the small amount of fertilizer that African farmers can afford.

The project, started in 2010 with funding from the Bill and Melinda Gates Foundation and USAID, the project envisages improving nitrogen use efficiency in maize

in Southern and Eastern Africa where maize is a staple diet for millions of people.

Through the project, maize varieties have been identified in Kenya, Zimbabwe and South Africa, which will be genetically modified (GM) to produce high yielding maize seed varieties that will guarantee better yields using fertilizer quantities that the majority of the farmers can afford.

The transgenic maize seed varieties developed under the project will be tested under Confined Field Trials (CFT) as from 2016 in Kenya and South Africa.

Apart from the challenges of drought, weeds, and pests, African maize farmers are also faced with the problems of degraded nutrient-starved soils and their inability to purchase enough nitrogen fertilizer. As a result, the maize yields of smallholder farmers in sub-Saharan Africa are only a fraction of those in the developed world. On average, such farmers apply only 9 kgs of fertilizer per ha of cropland. Of that small amount, the crop captures often less than half; the rest is leached deep into the soil beyond the reach of the crop's roots.



10.1 Interview with Dr. Biswanath Das Principal Investigator, IMAS Project

Principal investigator, IMAS project Dr. Biswanath Das says that the project is using genetic engineering to develop varieties of maize that respond better to between 11-20 Kgs of fertilizer per-hectare. This is in consideration of the estimated fertilizer quantity that average farmers in Africa can afford. "Most African farmers can afford only one-tenth the amount of fertilizer recommended for their crops. This is one of the biggest problems they face", says Dr. Das.

"We anticipate that the tests for nitrogen use efficiency in the GM maize varieties will continue up to 2018, after which, the varieties will be ready for release to the market subject to approval by the relevant regulatory agencies." Says Dr. Biswanath.

Dr. Biswanath observes that since the seed sector is still growing in most of the African countries, the project team will involve the private seed companies, which will assist in bulk production and distribution of seeds at affordable costs to farmers during the commercialization process.

The IMAS expert challenges governments to make investments in emerging technologies on behalf of their people asserting that in the long run, they stand to benefit immensely.

The investigator says that the initial cost of developing technologies is expensive, but long-term impact is enormous and thus worth the investment. "Studies carried out in some of the developed countries report that each dollar

spent on agricultural research returns about \$10 worth of benefits to the economy" says Dr. Biswanath

On the question of technological innovations in tackling climate change adversities, Dr. Biswanath says that developing them and improving on the performance of the existing ones is the best intervention to the erratic weather patterns, which has threatened crop production.

He concludes by citing GM technology as one of these innovations. "GM crops are not a panacea to perennial.

Expert's biography

Dr. Biswanath is a hold PhD holder in Plant Pathology from Imperial College London and has been working at CIMMYT (International Maize and Wheat Improvement Centre) as a research scientist for 7 years. He was initially based at CIMMYT-HQ in Mexico but is now based in Nairobi since 2011. His research area of interest is developing new varieties of maize that are tolerant to environmental and biotic stresses prevalent in sub-Saharan Africa. Having grown up on a farm in Zambia he is acutely aware of the challenges that farmers in Africa encounter despite their hard work, patience and resilience. He is driven by the need to contribute to the betterment of small holder livelihoods in Africa.

11. The Aflasafe Project

Aflatoxin is a poison produced by a pervasive fungus that infects various crops (maize, groundnuts, cashew nuts and wheat) in the fields and stores making food and feed unsafe. Aflatoxin contamination is a major constraint to improving the health and well-being of African people.

The contamination causes significant social and economic cost relating to impaired health and productivity of people and animals, food spoilage, and inability to market agricultural products internationally. The rural poor in Africa is chronically exposed to unsafe levels of aflatoxins. This is mainly because the food is usually produced, stored, prepared and marketed by farm families without much awareness of the risks of aflatoxin.

Owing to the serious food safety risks and human exposure to aflatoxins, the International Institute for Tropical Agriculture (IITA) launched a project dubbed the Aflasafe Project.

This project aims at enabling the commercialization of the biocontrol product Aflasafe™. This is an indigenous biological control product, which contains a mixture of four toxigenic strains originating from Nigeria on sorghum grain as a carrier.

Adoption of this biocontrol technology will address a serious food safety issue, and benefits will accrue to the entire value chain—small producers, their families who eat their own production, food and feed processors, and food consumers.

This project, is expected to reduce aflatoxin contamination by more than 70% in maize and groundnut, increase crop value by at least 5%, in the target countries especially among groups with increased vulnerability to diseases, particularly women and children.

Once this technology is successfully tested and commercialized, it will be replicated beyond Nigeria and Kenya where biocontrol work is currently ongoing. Lessons learned from this project will guide similar biocontrol activities that are underway in other SSA countries.

11.1 Interview with Dr. Charity Mutegi Kenya Country Coordinator, Aflasafe Project

Dr. Charity Mutegi says biotechnology is one of the tools among others which can effectively tackle food insecurity. She, however, decries the pervasive misinformation currently prevailing in Kenya and other parts of Africa as part of the main reason for delayed agricultural biotechnology adoption in Africa. “Our soils are getting heavily degraded,

agriculture is largely rain fed and climate change is here with us affecting crop production. I wish that the voices of the food experts were as loud as those of the antagonists in this debate,” Dr. Mutegi says.

The coordinator further explores options to boost food production in Africa and says it is not possible for the governments to feed

its population by relying only on traditional food production techniques alone.

The Aflasafe expert says that the time is ripe for countries like Kenya to start growing GM crops, adding that Kenya has the required infrastructure to conduct research and regulate the technology thereby guaranteeing Kenyans safe food, feed and fiber.

“Kenya has to look at alternative ways to improve food security just like South Africa, Sudan and Burkina Faso have done on the continent,” Dr. Mutegi says.

Kenya has competent regulatory agencies to monitor GMO foods

The scientist observes that Kenya has one of the most stringent regulatory agencies on the continent and the public should have confidence in their own institutions in evaluating GMO foods which she says are proven to be good for human consumption.

She further says that as a country we are fixated with allegations that GMO foods cause cancer, adding that it is not true since that hasn't been proven scientifically. “We refuse to deal with the aflatoxins in the maize flour and ground nuts although it is a scientific fact that aflatoxins cause cancer”, she quips.

Probed as to her team's future action, especially in light of the international recognition that she was accorded on account of the project, Dr. Mutegi expresses her optimism at achieving the project's objectives. She points out that there is a great agricultural potential in the sub-Saharan Africa region if only agricultural technology innovations were adopted.



Expert's biography

Charity Mutegi holds a PhD in Food Security from the University of KwaZulu Natal, SA,. She currently works for the International Institute of Tropical Agriculture (IITA) and serves as the East Africa Coordinator for Aflasafe. Her research interests are in the area of food safety, and has spent over a decade researching on aflatoxin management. She is inspired by ensuring food safety, critical to attaining food security in the African continent. In 2013, she received international recognition for her achievements in aflatoxin management in Kenya, earning her the 2013 Norman Borlaug Award for Field Research and Application.

12. Africa Bio-fortified Sorghum Project (ABS)

Each year, over 3.5-million children under the age of five die of malnutrition, which affects one out of every three people on earth. One of the simplest ways to improve nutrition is to fortify staple foods like wheat, maize or sorghum with a “nutrient premix” that includes nutrients such as vitamin A, zinc or folic acid. The Africa Bio-fortified Sorghum (ABS) Project is one such ongoing initiatives working to tackle malnutrition in the continent through biofortification.



12.1 Interview with Dr. Florence Wambugu

According Dr. Florence Wambugu, the CEO of Africa Harvest Biotechnology Foundation (Africa Harvest), the organization leading implementation of the ABS project, sorghum is a universal crop with numerous health benefits and is widely consumed in virtually all homes in Africa.

“It boosts our immune system and has been found to be a great diet for people living with HIV/Aids besides other illnesses,” Dr. Wambugu explains. “However, agricultural biotechnology offers us an opportunity to make this crop better nutritionally. And that is exactly what we are doing in the ABS project,” she adds.



According to Dr. Wambugu, agri-biotechnology, more so genetic modification is good for Kenya’s agriculture because it promises alternative food and better nutrition for millions of people threatened by malnutrition and hunger in Africa.

Genetically Modified (GM) crops, she says are not harmful to human health as critics of the technology would like Kenyans to believe.

“Countries are ignoring a technology that is moving the world ahead. Farmers use 60 % more on pesticides than they would use if they were cultivating GM crops. Adopting a wait and see attitude due to the divided opinions over the safety of GM food is a misplaced idea,” she says.

She advises that countries in Africa must appreciate the value of scientific evidence before discrediting emerging technologies. In Kenya, she observes that a lot has been done to build the requisite capacity to effectively carry out research and development on GM crops as well as to regulate them.

She cites The National Biosafety Authority, as the lead regulatory agency for GM products, with other institutions like Kenya Plant Health Inspectorate Service (KEPHIS), Kenya Bureau of Standards (KEBS), National Environment Management Authority (NEMA) among others assisting in this regulatory duty.

“Applying science and technology in our agriculture and in other sectors is the only sure way for the country to achieve Vision 2030,” notes Dr. Wambugu.

She also opines that it is important for all ministries with a role to play with regards to new technologies such as genetic modification to work more closely to ensure unilateral decisions and controversial policy decrees like the ban on GMO imports do not reverse the gains the country has made.

Expert's biography

Dr. Wambugu holds a Ph.D. in Virology, Biotechnology from the University of Bath, England an M.Sc. in Pathology from North Dakota State University a B.Sc. in Botany from the University of Nairobi. Dr. Wambugu is the recipient of a host of awards including IITA’s (International Institute of Tropical Agriculture, Nigeria) Award, 1981; KALRO’s 1989 Crop Science Award for outstanding scientist of the year; International Potato Center’s (CIP) Regional Research Award/ Grant, 1989; Farmers Support Award, Pyrethrum Marketing Board of Kenya, 1990; recognised as an exemplary PhD candidate, Virology Division of Horticultural Research International in England and KALRO, 1991; Monsanto Company Outstanding Performance Award, 1992; World Bank Global Development Network Award in 2000 for successful introduction of the tissue-culture banana in Kenya; and Woman of the Year Award by the American Biographical Institute, 2002–03.



13. The Bacterial Wilt Resistant Banana Project

The banana bacterial wilt (BXW) disease endangers the livelihood of millions of farmers in East and Central Africa. The disease is very destructive and can wipe out an entire banana plantation.

The disease has caused over USD 2 billion losses over a decade in the Great Lakes region of East Africa. If unchecked, the disease will have drastic effects on food security. There are currently no banana varieties that are resistant to the disease. Conventional breeding has not worked well to contain the disease hence biotechnology provides an alternative technique to control the disease.

The International Institute of Tropical Agriculture (IITA) negotiated a royalty-free license from the patent holder Academia Sinica, Taiwan, through the African Agricultural Technology Foundation (AATF) for access to the gene for production of bananas resistant to BXW in sub-Saharan Africa.

Genetic transformation of bananas that are resistant to bacterial wilt has now been successfully completed at IITA in collaboration with the National Agricultural Research Organization (NARO) in Uganda. Five banana varieties in both Kenya and Uganda have been transformed and evaluated in the screen house. Promising lines were identified and confined field trials are expected to take place in Uganda and Kenya.

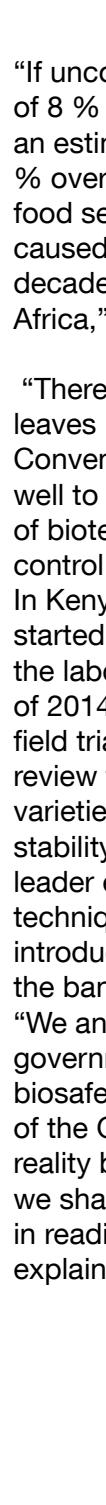


13.1 Interview with Dr. Leena Tripathi Principal Investigator, Bacterial Wilt Resistant Banana Project

"Biotechnology offers an alternative approach for boosting crop production. When crops developed through conventional methods are not working to the farmers' satisfaction, they have a choice. Scientists have to think outside the box," says Dr. Tripathi who is currently leading the project seeking to develop a bacterial wilt banana variety.

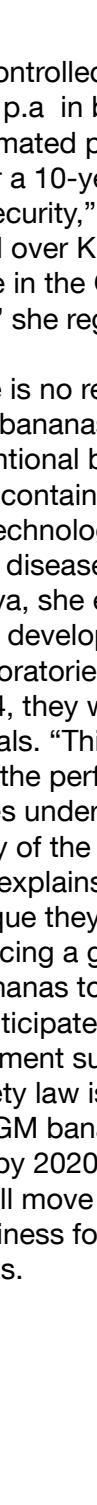
Dr. Tripathi cites BXW disease as a real threat to banana production not only in Kenya, but the entire East Africa region. "The economic losses are quite high as the disease spreads so fast and wipes off bananas very fast." She adds.

Dr. Tripathi explains that BXW disease was first reported about 40 years ago in Ethiopia on Enset, a close crop relative of banana. She observes that the disease has spread overtime across the region, affecting banana farms in Burundi, Democratic Republic of Congo, Kenya, Rwanda and Tanzania.



"If uncontrolled, BXW could spread at a rate of 8 % p.a. in banana plantations, causing an estimated production loss of about 53 % over a 10-year period threatening food security," she warns. The disease has caused over KES 2 billion losses over a decade in the Great Lakes region of East Africa," she regrets.

"There is no resistant germplasm and this leaves bananas susceptible to the disease. Conventional breeding has not worked well to contain the disease hence the use of biotechnology is an alternative way to control disease," Dr. Tripathi points out. In Kenya, she explains, the project team started developing transgenic plants in the laboratories in 2011 and by the end of 2014, they were conducting confined field trials. "This will help the project to review the performance of the new banana varieties under field conditions to ascertain stability of the resistance." The project leader explains that the biotechnology technique they have adopted entails introducing a gene from sweet pepper to the bananas to achieve disease resistance. "We anticipate that with appropriate government support given that the biosafety law is in place, commercialization of the GM bananas in Kenya will be a reality by 2020 because after the field trials, we shall move to multi-locational trials in readiness for commercialization," she explains.



Expert's biography

Dr. Tripathi holds a PhD in Plant Molecular Biology from National Botanical Research Institute, Lucknow, India and MSc. in Molecular Biology & Biotechnology from G. B. Pant University of Agriculture and Technology, Pantnagar, India. She is currently heading the Plant Transformation team at International Institute of Tropical Agriculture (IITA), Nairobi. Her primary research focuses on genetic improvement of banana, plantain, cassava, enset and yam for disease and pest resistance to enhance production, which will lead to food security, income, and wellbeing of resource-poor people in sub-Saharan Africa. She was recognized as one of the 'Top Scientist at IITA' in 2005 and received Board of Trustees Annual Excellence Award (2013) for "Outstanding Scientist".

She is recipient of several awards and scholarships. IITA recognized her contributions to research as one of the 'Top Scientist at IITA' in 2005. She is member of many scientific societies, and editor and reviewer for several books and International Journals. Her research has been featured in more than 150 national and international media outlets including Nature News, Discovery News, Nature Biotech., CNN-Earth's Frontiers, Guardian, The Standard, SciDev Net, Crop Biotech update, Science Times Magazine, Science News, and American Scientist.



14. The Water Efficient Maize for Africa (WEMA) Project

The Water Efficient Maize for Africa (WEMA) is a public-private partnership project to develop drought-tolerant and insect-protected maize varieties using conventional breeding, marker-assisted breeding, and biotechnology. The project, started in 2008, involves 10 organisations that include; African Agricultural Technology Foundation (AATF), National Agricultural Research Systems; Kenya Agricultural Research Institute (KALRO), Instituto de

Investigação Agrária de Moçambique (IIAM), Agricultural Research Council (ARC) of South Africa, Commission of Science and Technology (COSTECH) of Tanzania, National Agricultural Research Organisation (NARO) of Uganda, the International Maize and Wheat Improvement Center (CIMMYT), and Monsanto company, with each bringing strategic expertise and strength.



14.1 Interview with Dr. Sylvester Oikeh Project Manager, Water Efficient Maize for Africa (WEMA)

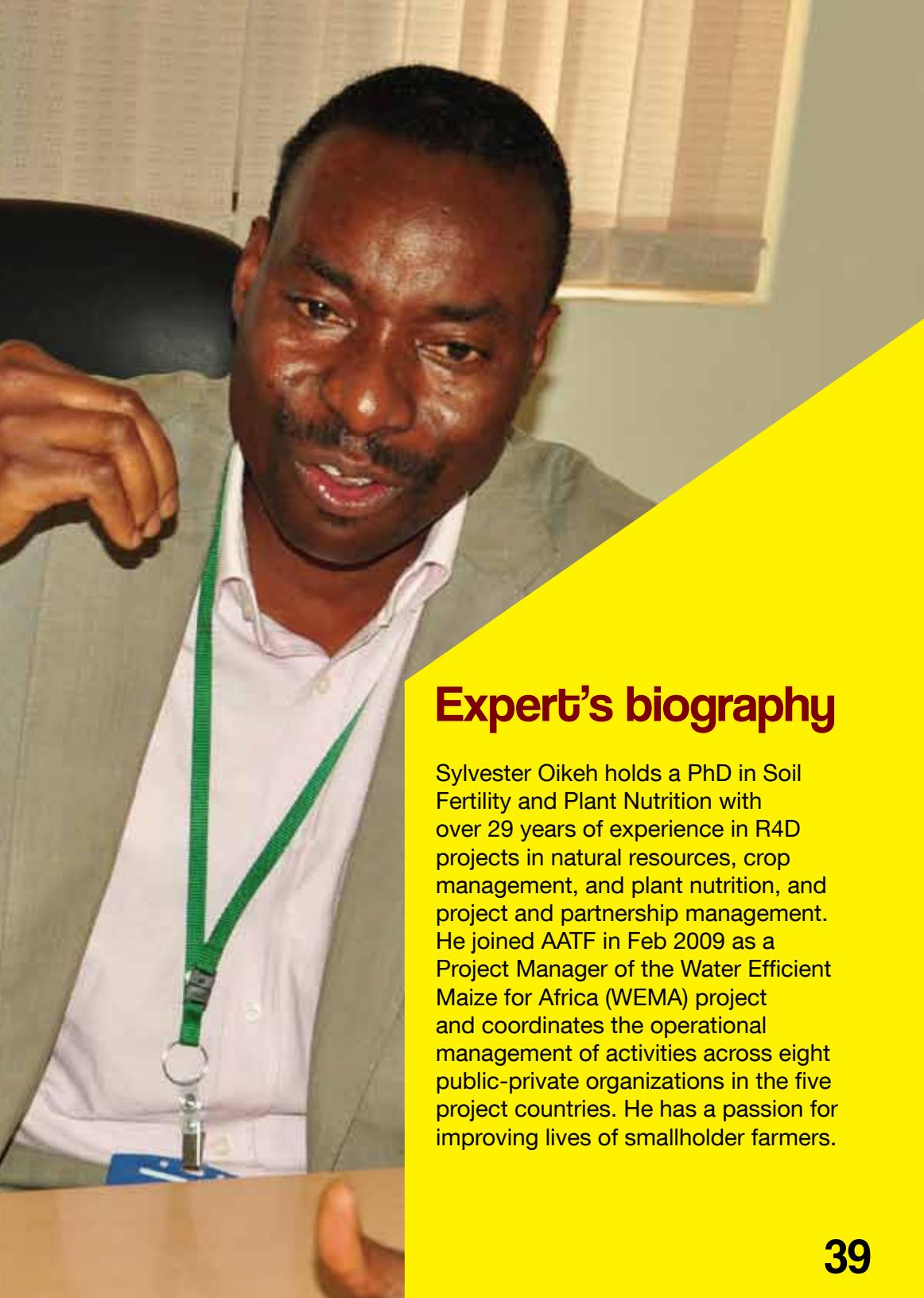
For Dr. Oikeh, a farmers' choice - whether or not to plant biotech crops is paramount. "If farmers are satisfied with biotech crops for instance, they will adopt them but, if they don't find any advantages from them, they will definitely ignore them," he states in response to concerns by anti-GM groups that biotech crops will not improve the farmer's outputs.

Dr. Oikeh notes that agriculture in Kenya, as in many other sub-Saharan Africa countries, experiences various challenges. One of the main challenges is drought and other effects of climate change including increase in insect pests menace.

"WEMA started as a project focused on developing drought-tolerant maize varieties. However in the course of the project we realized that yields were being compromised by insect-pest infestation. We have now moved to the next level where insect-pest protection is being incorporated in the drought tolerant maize", explains Dr. Oikeh. The research team is therefore now testing the efficacy of this technology in confined field trials (CFTs) in Kenya and Uganda. "The improved seeds will be available in the market at about the same cost as the other seeds because there will be no royalty fee charged for use of the drought-tolerant and insect-protection technologies," he said.

Additionally the team has developed a non-GMO drought-tolerant WEMA maize hybrid WE1101 which was released to farmers in October 2013 in Kenya being sold by six seed companies under the trade name, Drought TEGOTM. "We are encouraging seed companies to distribute the seeds to farmers by giving them a license and providing them with information on the attributes of this new hybrid," he adds.

He observes that by October 2013, there were 72 tons of hybrid WE1101 seed being sold to farmers by licensed seed companies in Kenya. "We expect the demand to go up next season given that farmers would have had a feeling of the quality of the seeds," he adds expressing his optimism on the adoption of the technology. Asked what motivates him to carry out research on drought tolerant maize, Dr. Oikeh asserts that his driving force is the need to improve people's lives through his work. "One in three people in Africa will benefit from any research on maize; this means that through this work on WEMA, I will touch so many lives!"



Expert's biography

Sylvester Oikeh holds a PhD in Soil Fertility and Plant Nutrition with over 29 years of experience in R&D projects in natural resources, crop management, and plant nutrition, and project and partnership management. He joined AATF in Feb 2009 as a Project Manager of the Water Efficient Maize for Africa (WEMA) project and coordinates the operational management of activities across eight public-private organizations in the five project countries. He has a passion for improving lives of smallholder farmers.

15. Tree Biotechnology Program Trust



The Tree Biotechnology Program Trust is a public-private venture to promote afforestation programmes in Kenya through biotechnology. The program, which was initiated in 1991, is being implemented through a partnership between the government, the Kenya Forest Service and the Kenya Forest Research Institute (KEFRI) among other partners.

The main aim of the project is to improve the living standards of rural families in Kenya, by enhancing forestry production

through integration of improved and proven clonal and tissue culture forestry biotechnologies into the traditional propagation systems. This is achieved through propagation of hybrids, clones and seedlings of Eucalyptus species for distribution to rural communities to increase productivity and alleviate wood products' shortages. The project's initial strategy was to build capacity for clonal propagation and tissue culture in order to eventually incorporate other desirable and indigenous species such as *Prunus*

Africana, *Melia volkensii*, *Jatropha* and *Acacia melanoxylon*. This technology transfer model has proven successful and been replicated in Tanzania and Uganda.

The program, which is currently self-sustaining was initially funded by Gatsby Charitable Foundation in the (UK). It has immensely benefitted from local and international partnerships including interactions with tree breeders in making strides that have enriched service delivery.

15.1 Interview with Mr. Benson Kanyi Program Director, Tree Biotechnology Program Trust

Mr. Kanyi observes that the country has for long concentrated on planting trees purely for conservation purposes, yet, it has the potential to achieve the 10 per cent forest cover as envisaged in the constitution by promoting commercial forests.

"In this program, we use the vegetative methods to speed up the breeding process. Naturally, forest propagation is through seeds but this process takes long. This has become a barrier to access of seeds and thus a limitation to afforestation programmes," notes Mr. Kanyi. "With vegetative propagation it only takes 2 years from breeding to deployment of benefits compared to at least five years when seeds are used," He adds.

"We bring tree hybrids produced from long term breeding in South Africa and test them in Kenya to assess their suitability. Thereafter, we multiply them using the clonal multiplication technology for growers in the country," he explained. The organization has nurseries for clonal multiplication that were started in 2001 whose capacity is 3 million clone hybrids per year.

"So far, we have produced some 28 million Eucalyptus hybrid clones and distributed within and outside Kenya," said Mr. Kanyi.

Eucalyptus is the entry point but the technology can be used on other tree species. "We shall extend to other tree species and give small and medium growers an opportunity to access quality tree germplasm," he adds. Mr. Kanyi explains that the TBPT program is currently at the commercialization stage where they are able to supply sustainably, quality germplasm for commercial benefit, to farmers. "We are at the beginning of commercial forestry. We can supply to any grower keen to plant for commercialization," he says. "We need to change our perception of planting trees as merely a conservation activity, but rather a commercial one. There is a lot of money to be made from forest farming," he concludes.



Expert's biography

Benson Kanyi holds an MSc in Entomology from London University, Imperial; a BSc in Forestry from the University of Nairobi and a Diploma of Imperial College. He recently defended his PhD thesis in entrepreneurship at Kenyatta University. He is currently the Programme Director Tree Biotechnology Programme Trust, Kenya. His interest in

entrepreneurial commercial forestry can be traced back to his childhood days growing up on the slopes of Mt. Kenya where his father was a wood trader. He is motivated by the opportunity to exploit the potential of numbers of smallholder farmers, available arable land and technologies to improve livelihoods of the rural populace.

16. Genetics Technologies International Ltd (GTIL)

Genetics Technologies International Ltd (GTIL) is a private company involved in propagation of disease and pest free planting materials through tissue culture and Aeroponics technologies. The company, which was established in 1997, has a production capacity of over 20 million plantlets per year.

It has a tissue culture laboratory that is used to develop high quality planting materials that are supplied to the farming community in Kenya thereby enhancing sustainable Agriculture and economic growth in the country and beyond.

The company works with farmer groups and institutions which purchase seedlings and raise them in their localities. This reduces the cost of transport thereby making the plants available and affordable to most farmers.

16.1 Interview with Mr. Suresh Patel Director, Genetics Technologies International Ltd (GTIL)

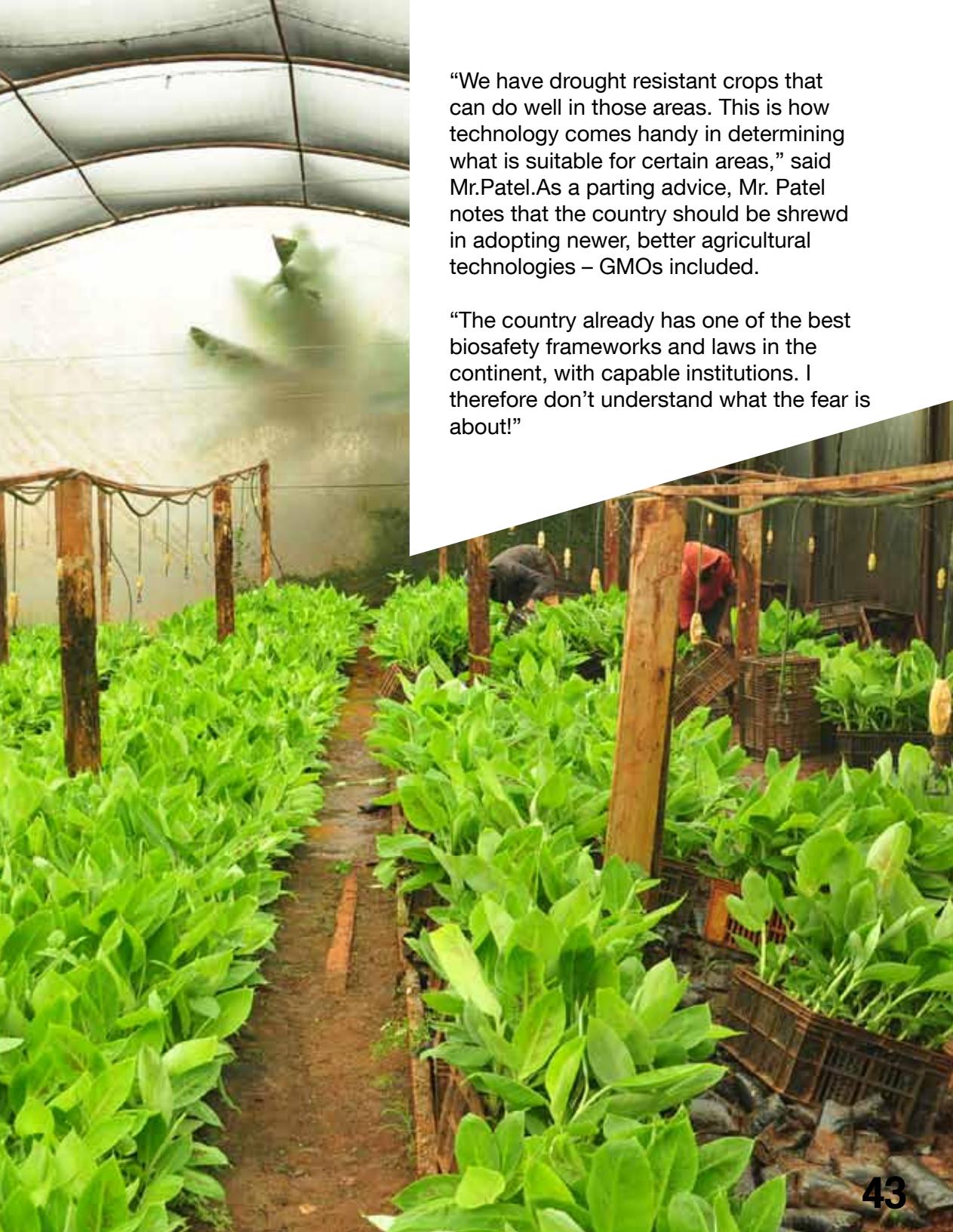
Mr.Patel in interview discloses that the laboratory produces planting materials for various food crops including dessert and cooking bananas, plantains, sweet potato, irish potato, and cassava. It also produces seedlings of flower crops such as roses, orchids, lilies, eustoma, gladiolus, and statice . “The lab also produces tree species for fuel wood, furniture, poles, pulp, and bio-fuel and these include eucalyptus, acacia, grevillea, teak, cypress and jatropha among others,” he explains

“The market is there if you invest in the right product as opposed to planting maize each year even when the yields keep on declining, over the years. Diversification is the way out because in the event one of the crops fails, you stand to earn from the rest,” Mr.Patel quips with optimism.“We



also produce plantlets for medicinal plants like Aloe Vera, Neem, Artemesia annua and Prunus Africana besides investing in Bamboo and ornamental shrubs,” he adds. Beyond Kenya, the company supplies planting materials to Tanzania, Ethiopia, Malawi, Mozambique, Rwanda, Uganda, Ghana, Somalia and South Sudan.

The laboratory liaises with the Kenya Plant Health Inspectorate Service (KEPHIS) and other certified laboratories in the UK and South Africa to uphold quality standards. “People are reluctant to try new farming methods and new crops for fear of incurring losses. They should view agriculture as a business where a real entrepreneur is a risk taker,” advises Mr. Patel. He says that besides supporting research, the government should target areas that perform poorly in terms of food production like the Arid and Semi-Arid regions (ASALs) and help the area residents cultivate crops that can thrive in those areas.



“We have drought resistant crops that can do well in those areas. This is how technology comes handy in determining what is suitable for certain areas,” said Mr.Patel. As a parting advice, Mr. Patel notes that the country should be shrewd in adopting newer, better agricultural technologies – GMOs included.

“The country already has one of the best biosafety frameworks and laws in the continent, with capable institutions. I therefore don’t understand what the fear is about!”



ISAAA AfriCenter
ILRI Campus, Old Naivasha Road,
P.O.Box 70-00605,
Uthiru, Nairobi, Kenya.
Tel: +254 20 4223618,
Fax: +254 20 4223634
Email: africenter@isaaa.org
Website: www.africenter.isaaa.org