ASARECA
Transforming Agriculture for Improved Livelihoods

ASARECA WORK ON AGRO-BIOTECHNOLOGY FOR FOOD AND NUTRITION SECURITY IN EASTERN AND CENTRAL AFRICA

Status paper

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A. Background

1. Studies show that the Sub-Saharan Africa region will experience the largest growth in demand for food in the next decades (about 155% between 2015 and 2050), compared to average global increase of 40%. This growing demand for food is driven by growing incomes and population growth with most of the incremental demand expected to come from urban areas where the retail value of urban food markets is expected to increase by 400% between 2010 and 2030. There will be increased demand for both fresh and processed foods. However, the demand for processed foods will increase relatively faster, presenting an opportunity for linking primary agriculture (farming) with the food industry and unlocking the contribution of agriculture to industrialization. Based on the foregoing, the contribution of the sector to growth, attainment of food and nutrition security and increased prosperity for the people is still lagging behind expectations. To increase the contribution of agriculture to the overall goal of national and regional economic growth, wealth creation, food security and poverty alleviation, the sector must be transformed from a purely subsistence state to sustainably commercial and profitable business enterprises. Agro-biotechnology has the potential of bridging the gap between the increasing demand for and supply of food in Sub-Saharan Africa. In crop production, use of biotechnology and more specifically genetically engineered crops can contribute to:
   - Increasing crop productivity, and thus contributing to global food, feed, fiber and fuel security, with benefits for producers, consumers and society at large;
   - Conserving biodiversity, as a land-saving technology capable of higher productivity on the current 1.5 billion hectares of arable land, and thereby precluding deforestation and protecting biodiversity in forests and other in-situ biodiversity sanctuaries;
   - Reducing the environmental footprint of agriculture by contributing to more efficient use of external inputs, thereby contributing to a safer environment and more sustainable agriculture systems;
   - Mitigating climate change and reducing greenhouse gases by using biotech applications for ‘speeding the breeding’ in crop improvement programmes to develop well adapted germplasm for changing climatic conditions and optimize the sequestering of CO_2;
   - Increasing stability of productivity and production to lessen suffering during famines due to biotic and abiotic stresses, particularly drought which is the major constraint to increased productivity on the 1.5 billion hectares of arable land in the world;
   - The improvement of economic, health and social benefits, food, feed and fiber security and the alleviation of abject poverty and malnutrition for the rural population dependent on agriculture in developing countries;
   - The cost-effective production of renewable resource-based biofuels, which will reduce dependency on fossil fuels, and, therefore, contribute to a cleaner and safer environment with lower levels of greenhouse gases that will mitigate global warming; and as a result, provide significant and important multiple and mutual benefits to producers, consumers and global society.

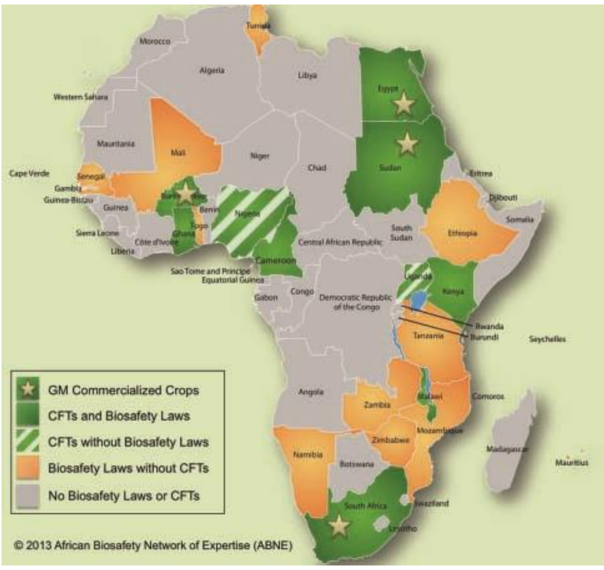
   In animal production, applications of biotechnology can be used in improved livestock reproduction, breed selection and breeding; enhancing animal health; enhanced feeding and nutrition; and growth and production.

2. The major concern about biotechnology in Africa focuses on safety, ethical and trade-related issues. Against this background, it is notable that all countries in Sub-Saharan African are Parties to the Convention on Biological Diversity (CBD, 1992). The CBD recognized that technology includes biotechnology (Article 16) and foresaw the need to exploit the potential benefits of modern biotechnology. At the same time, it stressed the need to safeguard against potential risks to biological diversity and takes into account risks to human health. The Cartagena Protocol on biosafety was developed as a supplementary agreement to the Convention on Biological Diversity (CBD) to address these concerns but despite all the efforts made, the major concerns about biotechnology in Africa have remained focused on its safety, ethical and trade-related issues.

   Inspite of the fact that a majority of Sub-Saharan African countries have embraced the Cartagena Protocol, they are yet to set up fully functional National Biosafety Frameworks (NBFs) as set out in Article 2 of the Protocol which requires countries to establish a functional NBFs to safely harness the benefits of biotechnology. These key components include:
   - A policy on biosafety, which is often part of a broader national policy on biotechnology;
   - A regulatory regime for biosafety, which usually consists of a law or an act in combination with

implementing regulations;
- A system to handle notifications or requests for authorizations for certain activities, such as field trial releases of GMOs in the environment. The system typically provides for public participation and risk assessment and public participation;
- A system for monitoring and enforcement and
- A system for public information, i.e. a system to inform stakeholders about the development and implementation of the NBF.

Many countries in Africa find themselves faced with the daunting task of establishing these components and consequently, only four countries in Africa; Burkina Faso, Sudan, South Africa and Egypt have so far permitted commercialization of biotechnology products.



Key Highlights
- Dark Green – countries with fully functional biosafety frameworks
- Yellow – countries with interim biosafety frameworks
- Brown – countries where work on biotechnology is in progress
- Light Brown – countries without National Biosafety Frameworks

3. The African Union in its efforts to strengthen legal and regulatory systems on emerging technologies in Africa at both continental, regional and national level has established the High Level Panel on Emerging Technologies (APET) to engage AU member states and RECs to promote a culture that allows responsible regulation of emerging technologies without imposing an undue burden on adoption. In addition, NEPAD Agency and AUC will work closely with the appointed High Level Panel to assist AU Member States and RECs to effectively assess the ethical and safety requirements and standards of emerging technologies by providing expert knowledge, advice and recommendations. APET has recently identified and endorsed the new advances in biotechnology as key in fast tracking Africa's development and transformation process. Gene technologies such as gene editing were indeed singled out as holding great prospects in the areas of food production, medicine and animal improvement. In the wake of this pronouncement, emerging genetic technologies such as genome editing are attracting a lot attention as they enable faster, easier, cheaper and more precise changes to DNA. Given their precision, affordability and potential, Africa stands to benefit most provided that member countries are mobilize and assisted to efficiently introduce the technology, regulate it and communicate their potential benefits and risks.

4. During the Africa Food Security Leadership Dialogue (AFSLD) convened/coordinated by the World Bank, the Food and Agriculture Organization of the UN (FAO), the African Development Bank (AfDB), and the International Fund for Agricultural Development (IFAD) in Kigali in August 2019, the senior officials and leaders of key organizations supporting major security programs in Africa signed a Communiqué, which among other things appreciates the role of science in sustaining Africa food and nutrition security. On the other hand, development partners have developed strategies that include, among other disciplines biotechnology. For example, in its new strategy – *Global Food Security Strategy: East Africa Regional Plan, 2019-2024*, USAID seeks to support the development of science-based biosafety systems that enable responsible access and utilization of biotechnology.

5. Based on the foregoing, ASARECA through its Agro-biodiversity and Biotechnology Programme has

since 2008 implemented over **15** biotechnology-focused projects in Eastern and Central Africa (ECA). Notable among these projects are shown in **Table 1** below:

Table 1. Summary of notable agro-biotechnology work in ASARECA(2008-2018)

	Project title	Objective	Target countries	Amount (US$)	Funding source
1	Genetic engineering of maize for drought tolerance in ECA (2008-2013)	To develop and avail drought tolerant maize genotypes adapted to the sub-region	Kenya, Tanzania, Ethiopia, Sudan	4,350,980	MDTF
2	Fighting striga: resistance genes deployed to boost sorghum productivity (2009-2011)	To utilize modern biotechnology tools to locate quantitative trait loci (QTL) for Striga resistance to breed market demanded striga resistant varieties	Kenya, Eritrea, Sudan, Tanzania, Uganda.	436,091	MDTF
3	Enhancing sorghum adaptability to climate change, striga resistance & drought tolerance traits pyramiding through biotechnological approaches (2011-2013)	To develop resistant crop cultivars using molecular biological tools, marker assisted selection and transformation	Kenya, Eritrea, Sudan, Tanzania, Uganda	536,480	MDTF
4	Evaluation of striga resistant farmer preferred sorghum varieties in ECA (2011)	To evaluate available Striga resistant lines and promote their dissemination in the semi-arid areas the ECA	Kenya, Eritrea, Sudan, Tanzania, Uganda.	210,059	USAID
5	Applying tissue culture to improve access to cassava and sweet potato clean planting materials for framers in ECA (2008-2011)	To enhance productivity and utilization of tissue culture applications for multiplication of cassava and sweet potato germplasm	Burundi, DR Congo, Kenya, Ethiopia, Madagascar, Tanzania, Rwanda, Uganda.	366,061	MDTF
6	Conservation for sustainable availability of cassava and sweet potato germplasm through biotechnology applications (2008-2011)	To enhance utilization of conservation technologies for cassava and sweet potato	Burundi, DR Congo, Kenya, Ethiopia, Madagascar, Tanzania, Rwanda, Uganda.	515,570	USAID
7	Improving food security and livelihoods in ECA through improved community-based low-cost tissue culture innovations (2011-2013)	To establish low cost cassava, potatoes, banana and sweet potato tissue culture innovation platforms and mobilizing the private sector to operate them	Burundi, DR Congo, Kenya, Ethiopia, Madagascar, Tanzania, Rwanda, Uganda, Sudan, Eritrea	1,000,000	MDTF
8	Transfer of banana tissue culture technologies to small scale farmers in ECA	To produce and make available quality, pest and disease free banana germplasm using biotechnology tools	Uganda	46,200	MDTF
9	Establishment of a genetic transformational platform for cassava in ECA (2008-2011)	To enhance utilization of cassava transformation technologies in the ECA	Kenya, Tanzania, Uganda	309,229	USAID
10	Diagnostic and control tools and strategies for *Taenia solium cysticercosis*	To develop and evaluate diagnostic test for *Taenia. solium* in pigs and strengthen the national capacity for its surveillance in ECA	Burundi, DR Congo, Kenya, Ethiopia, Eritrea and Uganda.	521,859	MDTF
11	Integrated Management of Maize Lethal Necrosis Disease in Eastern Africa	To develop MLN resistant varieties through biotechnology (introgression of resistance into adapted germplasm)	CIMMYT (Lead Partner), Uganda, Kenya, Rwanda, Burundi and South Sudan	3,985,128	MDTF
12	Regional Approach to Biotechnology and Biosafety Policy in Eastern and Southern Africa (RABESA) project:	To generate and analyze technical information required to inform COMESA and ASARECA countries on regional biotechnology and	All COMESA countries	255,376	USAID

	Project title	Objective	Target countries	Amount (US$)	Funding source
		biosafety policy choices and options			
13	Improving Conservation, Productivity And Market Access Of Nutritionally Rich And Underutilized Agro biodiversity For Food Security In Semi Arid Areas Of Kenya (2010-2012)	To develop underutilized crop species from semi-arid areas to increase availability and accessibility to nutritious foods	Kenya	40,000	IDRC
14	Integrating Agro-Biodiversity with Conservation To Improve Livelihoods (2009-2011)	To enhance utilization of best-bet land use practices through development of methodologies for agro biodiversity conservation in Savannah Eco-Systems	Kenya and Tanzania	510,891	MDTF
15	Building Sustainable Rural Livelihoods Through Integrated Agro-Biodiversity Conservation In Savannah Eco-Systems (2011-2013)	To enhance utilization of agro-biodiversity and development of best bet practices/ innovations in the ECA savannah ecosystems	Kenya, Tanzania, Uganda	265, 259	MDTF
				13,349,183	

B. Approach/method

6. All the projects were implemented in nearly all the ASARECA countries by a regional team of scientists closely coordinated by the ASARECA Secretariat subject matter specialists. Regional coordination of joint/collective action was important because most member countries except Kenya, Uganda and to some extent Tanzania, lacked the requisite infrastructure, institutional and human capacities to undertake biotechnology research. The delivery of the regional biotechnology initiatives required leveraging on facilities in fairly advanced institutions, regional resource mobilization, strong coordination, collaboration and continuous monitoring, evaluation and learning.

7. As a result of effective coordination, the 15 projects highlighted in **Table 1** above posted important achievements including:

- The development of the first-ever genetically modified drought tolerant maize lines using farmer-preferred varieties sourced from four member countries;
- Development, release and dissemination of striga resistant varieties adapted to ECA agro-ecologies;
- Development and transfer of low cost tissue culture clean planting materials for cassava, potato, banana;
- Development of a penside diagnostic test kit for *Taenia. solium* in pigs;
- Building of human and infrastructural capacity to undertake biotechnology research in member countries.
- Advancing the process of the Regional Approach to Biotechnology and Biosafety Policy in Eastern and Southern Africa (RABESA) to the development of the COMESA Biosafety policy on commercial planting of GMOs, trade in GM products and access to emergency food aid with GM content. This was approved in the 5thJoint COMESA Meeting of Ministers of Agriculture, Environment and Natural Resources on 16-20 September 2013 in Addis Ababa, Ethiopia.

C. Highlights of past ASARECA work in Biotechnology.

8. Below are details of select five projects that demonstrate achievements of regionally convened and coordinated Agro-biotechnology projects undertaken by ASARECA:

Box 1: Genetic Engineering of Maize for Drought Tolerance in Eastern and Central Africa Project

Introduction

ASARECA implemented the ***Genetic Engineering of Maize for Drought Tolerance in Eastern and Central Africa***project from 2008 to 2013. The Objective of the project was to develop and avail drought tolerant maize genotypes adapted to region. This was done using genetic engineering approaches including gene up-regulation, under-regulation (silencing) and drought inducible expression of candidate genes. The Multi-donor Trust Fund (MDTF) supported this project to the tune of US$ 4,350,980. The project was slated to last four years (2008-2011), but an extension was granted up to 2013.

Justification of the project
At the onset, it had been established that maize is the most widely cultivated cereal covering over 147 million hectares in the world (maize outlook report). It is the third most important food crop for humans after wheat and rice and is a staple food crop in East and Central Africa that is grown on more than 5.5million hectares mostly by small and medium scale farmers. Maize provides well over 50% dietary calories with a per capita consumption of about 100kg/year. However, maize productivity has been declining over years due to a number of biotic and abiotic factors. Drought is the single most important abiotic stress responsible for reduced maize productivity in arid and semi-arid areas, leading to up to 70% crop loss. These, coupled with lack of suitable varieties that perform well under insufficient and erratic distribution of rainfall significantly reduce productivity of maize, with grain yield of 1.3tons/ha, compared to the potential of over 10tons/ha. Conventional breeding methods aimed at breeding varieties resistant to drought fell below expectations.

The project set out to introgress drought resistance genes through genetic transformation into farmer preferred varieties sourced from Sudan, Kenya, Tanzania and Ethiopia. To enhance capacity in genetic maize research, ASARECA offered opportunities to scientists from the National Agricultural Research Institutes; Mikocheni Agricultural Research Institute (MARI), Tanzania; Ethiopia Institute of Agriculture Research (EIAR), Ethiopia; Sudan Agricultural Research Co-operation (ARC), Sudan; together with Biotechnology students at Kenyatta University to undertake PhD studies of genetic engineering of maize. The students constituted part of the core of the research team. Fifty-seven (57) ECA maize varieties including 15 open pollinated varieties (OPVs) and 42 inbred lines adapted to ECA were tested to establish their transformability and regenerability. Transformation efficiency of up to 46.7% was achieved.

Achievements
- A total of nine (9) tropical maize genotypes were successfully transformed with drought conferring genes in 2010. They include two Ethiopian lines, three Kenyan lines, two Sudanese lines and two Tanzanian lines. They were transformed with amiRNA1 gene, amiRNA3 gene, NHX1, PMI genes, XvPrx2 gene and CBF1 gene.
- The maize transformed maize lines were advanced and evaluated in the screen house at Kenyatta University and bulked in preparation for drought stress experiments and field trials.

Potential areas for further interventions
Due to operational interruptions at ASARECA Secretariat, some of the previously planned interventions were not accomplished. ASARECA was due to commence follow up initiatives to ensure the technologies were transferred to national systems for confined field trials. Some of the next steps included: Carrying out an impact assessment of the GMO before campaigning for confined field trials; coordinating preparation of member countries for multi-location trials including mobilizing resources form the development of physical infrastructure and human resources for Biotechnology adoption.

Box 2: The three successive Striga projects (Total value US$ 1,182,630)

Introduction
From 2008 to 2013, ASARECA implemented three successor projects, which brought together a team of scientists from the National Agricultural Research Systems including: Agricultural Research Corporation of Sudan (ARC); the National Agricultural Research Institute of Eritrea; the Rwanda Agricultural Board; the University of Nairobi; and the International Centre for Agricultural Research in Arid and Semi Arid Tropics (ICRISAT) to implement this initiatives, popularly referred as the Striga projects: The **three** projects were: (i) Fighting striga: resistance genes deployed to boost sorghum productivity project (US$436,091); (ii) Enhancing sorghum adaptability to climate change, striga resistance, and drought tolerance traits pyramiding through biotechnological approaches project(USD$536,480); and (iii) the evaluation of striga resistant farmer preferred sorghum varieties project (USD$210,059).

The objective of the first project (2009-2011) was to develop Striga resistant marker selected sorghum lines into the Striga prone cropping systems of Eastern and Central Africa to enhance sorghum productivity, while the objective of the second project (2011-2013) was to take gains in the first project by developing resistant crop cultivars using molecular biological tools, marker assisted selection and transformation. The third project (US$210,059) was a one-year bridging initiative (2011) meant evaluate available Striga resistant lines to open the way for their dissemination in the region. The three projects were supported by the Multi-donor Trust Fund Financed mainly by the European Union, USAID and managed by the World Bank.

Justification of the projects
Justification of the project: Sorghum is ranked second after maize as the most important cereal staple crop in the ASARECA region. However, its production has over the years been constrained by Striga, a parasitic weed, which causes yield losses as high as 100%. At the onset of the project in 2009, over 17,000 ha of sorghum had been infested by the weed, leading to yield losses of up to 2.3 million metric tons annually. Against this background, ASARECA led

the efforts to develop Striga-resistant sorghum lines using a marker assisted selection, which is reputed for its precision and effectiveness inbreeding for Striga resistance. The technology involved backcrossing using a donor Striga-resistant sorghum line N13 and three farmer preferred sorghum cultivars—Tabat, Wad Ahmed and AG-8—that were susceptible to Striga. The third project was built on the need to develop farmer preferred Striga resistant verities. It brought in the additional element of systematically evaluating the already availed Striga resistant technologies for integration into farming systems.

Achievements

- A total of 51 lines of striga-resistant sorghum varieties were generated using molecular marker breeding technology. Out of these, four lines code named ASARS1, ASARS2, ASARS3, ASARS4, were in 2012 released by the Government of Sudan.
- Thirty-six lines were put under advanced evaluation in at least six countries including Eritrea, Kenya, Rwanda, Tanzania, Uganda and Sudan for agronomic performance and striga resistance with the aim of releasing them for commercial use. In Uganda, the 36 lines were successfully put under adaptation trials at National Semi Arid Research Institute (NaSARRI) for striga resistance, farmer acceptance and colour and bulking to increase seed.
- Through the project support for technical capacity building in marker-assisted breeding for striga resistance, one PhD student and two (MSc) students from Sudan and Kenya respectively have been funded. They use facilities at ILRI-BecA in Nairobi and ICRISAT headquarters in India for DNA extraction and genotyping of the BC3 progenies.
- The project facilitated the training of 14 scientists and technicians from National Agricultural Research Institutes and universities from Eritrea, Kenya, Tanzania, Uganda and Sudan in application of molecular markers in diversity studies and marker assisted breeding at BecA.
- To scale out the new varieties, a GIS map of the study sites was generated for promoting Striga-resistant and drought-tolerant sorghum varieties in the region.

Potential areas for further interventions

Due to operational interruptions at ASARECA Secretariat, some of the previously planned interventions were not accomplished. ASARECA has not been able to follow up on the diffusion of the achievements of this research, which promised good results.

Box 3: Applying tissue culture to improve access to cassava and sweet potato clean planting materials for farmers in the ECA region

Background

ASARECA implemented this project from 2008 to 2011. The objectives of the project were; To make available clean cassava and sweet potato tissue culture materials to national breeding programmes and other users for rapid multiplication; Strengthen NARS capacity to apply tissue culture in cassava and sweet potato improvement programmes and to disseminate information on cassava and sweet potato tissue culture to stakeholders. The US$ 366,061 project was supported by the Multi-donor Trust Fund (MDTF) and was implemented in Burundi, DR Congo, Kenya, and Ethiopia. The Biosciences East and Central Africa Region (BecA) in Nairobi, Kenya was commissioned to develop, validate and standardize virus indexing tools and a plant material certification system.

Justification

Cassava and sweet potato are major staple crops for millions of people in the region. Despite their crucial importance, the two crops face low productivity due to pests and diseases, inadequate quality planting materials, lack of suitable varieties, inefficient multiplication and distribution systems, poor market access and the lack of conducive policy and regulatory environment. This project intends to generate appropriate cassava and sweet potato tissue culture technologies and make them available to ease multiplication of planting materials; strengthen capacity for cassava and sweet potato tissue culture and make information on the cassava and sweet potato tissue culture available to stakeholders. The project is implemented in Uganda and Kenya in partnership with other regional and international agricultural research institutions.

Achievements

- A baseline of the status of Tissue Culture (TC) applications in ECA has been conducted in Burundi, DR Congo, Ethiopia, Kenya, Madagascar, Rwanda, Tanzania and Uganda to determine the existing capacity in terms of human resources and physical infrastructure.
- All the available virus sequences for cassava and sweetpotato virus have been collected for major viruses of cassava and sweet potatoes. Over 200 sequences of virus for cassava brown streak virus (CBSV), Sweetpotato feathery mottle virus (SPFMV), Sweetpotato chlorotic stunt virus (SPCSV), Sweetpotato chlorotic fleck virus (SPCFV), and Sweetpotato mild mottle virus (SPMMV) have been collected for virus indexing.
- Using DNA sequences obtained by ECA scientists, PCR primers can now be used to test for the presence of SPFMV, SPCSV, SPCFV and SPMMV.A set of potential epitope from the virus sequences has been selected. Using the selected epitopes, a total of 12 peptides for cassava/sweet potato virus coat proteins were selected for epitope candidates, and

the synthesized peptides were injected to rabbit for polyclonal antibody production. These antibodies will be used to detect viruses in the diagnostic kits to be developed.

- A total of 22 technicians and scientists from Uganda, Kenya, Tanzania, Burundi, Ethiopia, DRC, and Rwanda were trained in the basic techniques of tissue culture, virus indexing and seed systems of the vegetatively propagated crops.

Potential areas for further interventions

ASARECA plans to scale up the achievements of this research, which have so far posted good results to countries especially those with less resourced National Agricultural Research Systems.

Box 4: Establishment of a genetic transformation platform for cassava in the ECA region

Background

This project was implemented from (2008-2011). It brought together scientists from Kenya, Tanzania and Uganda. The objective of the project was to improve farmer preferred, but highly susceptible local cassava cultivars by introducing resistance genes while retaining the superior storage root traits. The US$ 309,229 initiative was funded by USAID.

Justification

Cassava is a major food security crop in Eastern and Central Africa. However, it is constrained by pests and diseases, which are responsible for the dramatic reduction of harvest, cutting down yield to less than half the potential. Cassava mosaic disease (CMD) and cassava brown streak disease (CBSD) have over time been the most important constraints affecting cassava. With funding from USAID ASARECA coordinated efforts by researchers from the region in partnership with researchers at the Donald Danforth Plant Science Centre (DDPSC), USA and the International Institute for Tropical Agriculture (IITA) to use genetic engineering to introduce genes that confer resistance to CMD and CBSD into cassava.

Achievements

- Resources were provided to refurbish laboratories, purchase modest equipment for transformation and adapting technologies that have been developed elsewhere in preparation for confined field trials.
- In Kenyatta University, a biotechnology laboratory was been upgraded to match the regulatory requirements for biosafety (level two) and a state of the art screen house is almost complete.
- In Uganda and Tanzania new laboratories were constructed and refurbished. Laboratory technicians have been recruited and trained on genetic transformations. A number of students were attached to these laboratories to enhance their skills in biotechnology applications. Formal training for MSc qualification was provided to Ms. Mary Buttibwa of NARO, Uganda.
- Cassava molecular constructs and embryogenic cultures for cassava transformation have been developed using facilities of the National Crop Resources Research Institute (NaCRRI) and Mikocheni Agricultural Research Institute (MARI).
- Cassava landraces in Uganda, Tanzania and Kenya were screenedfor somatic embryogenesis using these platforms.
- Building on initial facilitation from this project, other donors supported a number of activities to enhance cassava transformation in the region including training of regional scientists and technicians in cassava transformation and refurbishment of transformation facilities.

Potential areas for further interventions

ASARECA plans to scale up and scale out the achievements of this research within the beneficiary countries as well as other member countries.

Box 5: Diagnostic and control tools and strategies for *Teaniasolium cysticercosis* implementation

Background

This project was implemented from 2009 and 2010. The main participating countries were:Burundi, DR Congo, Kenya, Ethiopia, Eritrea and Uganda. The main objectives of this 18 months initiative was to determine the risk factors for *Taenia solium cysticercosis/taeniosis*; developing and evaluating a pen-side diagnostic test for *T. soliumcysticercosis* in pigs and strengthening the national capacity for surveillance, prevention and control of *T. soliumcysticercosis* in pigs. The Multi-donor Trust Fund (MDTF) supported the US$ 521,859 initiative.

Justification

Pig rearing and subsequent pork consumption have increased significantly in ECA during the past decade primarily due to the lack of grazing land for ruminant livestock and the realization by farmers for a quicker and more impressive return on their investment from raising pigs. Consequently, with increased smallholder pig rearing and pork consumption, there have been reports of increasing prevalence of epilepsy in eastern and southern Africa (ESA), without a clear etiology, and the appearance and increase in cases of porcine *cysticercosis* in Humans. *Cysticercosis* is caused by a zoonotic tapeworm *Teania solium* found in pigs. Humans acquire taeniosis (tapeworm infection) when they eat raw or undercooked pork meat contaminated with cysticerci, the larval form of T. solium. When ingested, the cysticerci establishes in the intestine of humans, become adult tapeworms and shed eggs in human feces that can infect other humans in turn; and pigs by direct contact or by indirect contamination of water or food. *T. solium cysticercosis* is present throughout the region and it is increasing as an important constraint to the nutritional and economic well-being of small holder farming communities as well as a serious public health risk. Community-based studies on porcine *cysticercosis* in Tanzania indicated a prevalence of up to 18%. The prevalence of porcine *cysticercosis* found in these ECA countries ranks among the highest in the world. Optimal productivity of pigs is also hindered by infections with *cysticercosis.* This project aims at determining the risk factors for *Teania solium cysticercosis/taeniosis*; developing and evaluating a pen-side diagnostic test for *T. soliumcysticercosis* in pigs and strengthening the national capacity for surveillance, prevention and control of T. *solium cysticercosis* in pigs.

Achievements

- An epidemiological study in the five countries of Uganda, Kenya, Tanzania, D R Congo and Burundi on the impact of *Teania solium cysticercosis* in pigs and humans revealed that 23.5% of humans were positive for *Teania solium cysticercosis*. This suggests that epilepsy is caused by *T. solium cysticercosis*. In Tanzania, 30 – 50% of epilepsy cases were found to be positive for *Teania solium cysticercosis*. In Kenya, About two hundred pigs in Homa bay district have been examined for cysts of *Taenia solium* and about 10% found positive.
- Data collected on pig production and management systems and the risk factor for porcine *cysticercosis* in the selected areas has been used for clinical evaluations and testing of serum samples from pigs and humans. This has formed the basis for the acquisition of immunodiagnostic kits and vaccines for field tests.
- Using the data, national action plans have been developed for surveillance, prevention and control of *T. solium cysticercosis* in Uganda, Kenya, Tanzania, Burundi and DR Congo and a policy brief has been prepared for awareness and sensitization.
- An MSc student is being trained at Sokoine University in Tanzania to use biotechnological tools for diagnosis and control of *Teania solium cysticercosis* in pigs and humans.

Potential areas for further interventions

ASARECA plans to set up a regional monitoring system for *Teania solium cysticercosis* surveillance using the develop test kit to further advance this research and work with other stakeholders in controlling the disease.

Box 5: Regional Approach to Biotechnology and Biosafety Policy in Eastern and Southern Africa (RABESA) project:

Introduction

The Regional Approach to Biotechnology and Biosafety Policy in Eastern and Southern Africa (the RABESA initiative) is a project that was initiated and endorsed by the Common Market for Eastern and Southern Africa (COMESA) in 2003. RABESA was designed to examine the potential ramifications of GMOs on trade, food security and access to emergency food aid in the COMESA and ASARECA2 countries. The overall objective of the initiative is to generate and analyze technical information required to inform COMESA and ASARECA countries on regional biotechnology and biosafety policy choices and options.

The specific objectives were: (i) To undertake stakeholder analysis in the ASARECA/COMESA countries highlighting opportunities, challenges, views and positions related to their engagements in trade, GMOs and food security; (ii) To estimate impacts of GMO crops on farm income in the ASARECA /COMESA region; (iii) To analyze commercial risks that ASARECA/COMESA countries would face in the destination export markets both regionally and internationally, if permission to plant GMO crops was granted; (iv) To estimate the impact of precautionary GMO policies on access to emergency food aid and food security in the ASARECA/COMESA region; and (v) To identify range of regional biosafety policy options for decision-making on issues of GMOs and trade in ASARECA/ COMESA countries. ASARECA's Eastern and Central Africa Programme for Agricultural Policy Analysis (ECAPAPA) which would later become the Policy Analysis and Advocacy Programme (PAAP) in conjunction with the Program for Biosafety Systems (PBS) and the African Centre for Technology Studies (ACTS) provided technically support to COMESA in the implementation of the RABESA initiative.

The Journey of RABESA:

- Implementation of RABESA phase I commenced in 2004 and ended in 2006 with a regional workshop that brought together key stakeholders from COMESA member states. Recommendations of the regional workshop were presented at the 4th meeting of the COMESA Ministers of Agriculture held in Khartoum, Sudan, in March 2007. The Ministers endorsed recommendations reached by stakeholders. This mainly focused on three priority areas of: Commercial planting of GMOs and trade policy in GM products; Policy on access to emergency food aid with GM content; and

Policy harmonization.

- Regional Biosafety policies and guidelines addressing the three thematic areas were drafted in line with the Ministerial recommendations.
- At the request of the COMESA Ministers of Agriculture, the RABESA Initiative, which had been in progress since 2003, completed the preparation of three regional biosafety policies and guidelines in March 2010. These policies and guidelines were presented and discussed in a regional workshop held in Nairobi, Kenya, in April 2010. During the workshop, stakeholder comments and feedbacks were obtained and incorporated.
- The Third Joint Meeting of the COMESA Ministers of Agriculture, Environment and Natural Resources, in July 2010, in Lusaka, Zambia, decided that the documents be subjected to further national consultative process for wider ownership before consideration by the COMESA policy organs.
- National consultative workshops were successfully held in 15 of the 19 COMESA member countries in the last one year ending September 2011. The workshops involved key stakeholders in each country drawn from a diversity of institutions including ministries of agriculture, trade, environment, national biosafety focal points, biosafety competent authorities, farmers and farmers' representatives, seed traders, millers, media, food relief agencies, consumer groups, civil society, and politicians. The countries which participated included: Burundi, DRCongo, Djibouti, Eritrea, Ethiopia, Egypt, Kenya, Madagascar, Rwanda, Seychelles, Sudan Swaziland, Uganda, Zambia, and Zimbabwe.

Milestones of RABESA Implementation

- Formation of the COMESA Panel of Experts
- The evidence led into the development of the COMESA Biosafety policy on commercial planting of GMOs, trade in GM products and access to emergency food aid with GM content, which was approved in the 5th Joint COMESA Meeting of Ministers of Agriculture, Environment and Natural Resources, 16-20 September 2013 in Addis Ababa, Ethiopia.
- A communication strategy-to create awareness about the COMESA harmonization agenda has been developed
- A biosafety roadmap- to support countries to establish and implement functional biosafety systems developed.

Potential areas for further interventions

ASARECA plans to follow up on the road map for domestication of the COMESA Biosafety policy on commercial planting of GMOs, trade in GM products and access to emergency food aid with GM content.

D. Current policies, laws and regulations on biotechnology/GMOs in ASARECA Member countries

9. All ASARECA member countries are signatories to the Cartagena Protocol on Biosafety, a binding international agreement under the Convention on Biological Biodiversity. They are therefore bound by the provisions of the Protocol which requires countries to establish biosafety procedures for trans-boundary movement, transit, handling and use of all living modified organisms that may have adverse effects on the conservation and sustainable use of biological diversity, taking into account risks to human health (*Article 4*).

10. Pending a comprehensive study by ASARECA to determine the status of biotechnology and biosafety in the sub-region, the following table highlights the current policies, laws and regulations on biotechnology / GMO development in ASARECA Member States. This study will document the status of: (i) biotechnology and biosafety policies; (ii) biosafety laws and bills; (iii) biosafety implementing regulations; and (iv) any other legislation with clauses on biotechnology and biosafety.

Country	Regulatory Regime	Current Status
Burundi	Biosafety Bill (2006)	◎ Draft framework exists and is being subjected to the national legislative process ◎ Draft Bill covers exports of GMOs or products derived from GMOs
DRC	Biosafety Bill (2007)	◎ Has draft National Biosafety Policy ◎ Not specific to GMOs – piecemeal legislation for requirements on importation of plants and animal products and standards to be met ◎ Decision-making procedure unclear
Eritrea	Draft Biosafety Bill and Guidelines	◎ Draft Policy makes reference to adoption of a precautionary approach and mentions measures—case-by-case screening for demonstrated risks and scientific uncertainties, tighter rules for screening for GM seeds and comprehensive labeling
Ethiopia	Biosafety proclamation passed into law in 2009	◎ Highly precautionary and reference made for new law to strictly govern movement of GMOs ◎ Biosafety proclamation has provisions for regulation of import, export, transit, handling, transport & placing on the market of GMOs
Kenya	Biosafety Act (Feb,	◎ Adopted a national biotechnology development policy to guide the

Country	Regulatory Regime	Current Status
	2009)	creation and use of GMOs in 2006. ◎ Biosafety Act 2009 includes clauses on labeling GMOs, distances that must be maintained between GM and conventional crops during cultivation, and import and export of the varieties. ◎ National performance trials on Bt cotton ongoing; anticipated release in 2020.
Madagascar	Draft Biosafety Bill	◎ Reference made on a participatory decision-making mechanism in the course of use of GMOs
Republic of Congo		◎
Rwanda	Draft Biosafety Bill (2006)	◎ National Biosafety law and regulations in draft form since 2014 ◎ Aug. 2019: Rwanda Environment Management Authority drafted the Bill, the National Biosafety Framework, the Biosafety Policy, and Regulations to be forwarded to the Rwanda Law Reform Commission for review. ◎ The Bill not only takes into account the risks to human health, but also seeks to provide a regulatory framework that facilitates the safe development and application of biotechnology, research, development and release of GMOs.
South Sudan	-	◎ -
Sudan	Biological Safety Act 2010	◎ Reference made for risk assessment and management measures before environmental release of GMOs ◎ Policy covers trade in trans-boundary movement of GMOs
Tanzania	Environmental management Act CAP 191 (2004)&Biosafety regulations (2009).	◎ Domestic regulatory framework operational since 2006 ◎ The guidelines apply to movement, commercial application and use of GMOs and their products. ◎ The regulations give preliminary provisions, general principles, administration and institutional arrangements, decision-making procedures and approval mechanisms, risk assessment and management, GMO transportation, liability and redress, offenses and penalties, and general provisions (2005b).
Uganda	Interim arrangements: National Science& Technology Act CAP 209 (1990) & Genetic Engineering Regulatory Act 2018	◎ National Biotechnology and Biosafety Policy in place since 2008 ◎ September 2019: the President of the Republic of Uganda for the second time declined to sign into law the National Biotechnology and Biosafety Bill 2012. The first Bill was first rejected by the President in in 2017 and returned to Parliament. ◎ The Bill seeks to provide a regulatory framework that facilitates the safe development and application of biotechnology, research, development and release of GMOs.

E. Potential Areas of Intervention / Support

11. Evidence from past ASARECA work highlighted above provides opportunities for further regional coordination and convening of biotechnology interventions. The key areas include: (i) follow up initiatives to ensure the technologies developed in the previous interventions are transferred to the national systems; (ii) coordinating the development of physical infrastructure for biotechnology adoption; (iii) coordinating priority setting for biotechnology research; (iv) strengthening human capacity for biotechnology research in national systems; (v) continuous advocacy for regional policy harmonization including biosafety regulation; (vi) Assisting countries which don't have functional national biosafety systems to have them and (vii) supporting efforts towards development of biotechnology policies, laws and regulations in the region.

F. Appeal to development partners, member countries and institutions

12. There is renewed interest in the application of biotechnology by various actors, which has led to a proliferation of actors in this area. This has led to duplication of efforts leading to waste of resources. This calls for the need to provide a platform for effective regional coordination, convening of assorted stakeholders, advocating for regional policy harmonization, providing a clearing house for knowledge products and technologies, brokering effective partnerships within the region, as well as providing catalytic resources for enhancing intra- and inter-country benefits and spill overs of biotechnology. Based on the above background, ASARECA appeals to development partners, member countries, institutions and agencies to consider supporting biotechnology initiatives in the region. The benefits gained from biotechnology products and services from previous ASARECA work are a clear indication of what biotechnology can achieve in terms of agricultural transformation.