ASARECA
Transforming Agriculture for Improved Livelihoods

ANNUAL REPORT 2010

Technologies without borders: Sharing regional innovations for food security

The focus of ASARECA has been to increase the efficiency of agricultural research in eastern and central Africa to facilitate economic growth, food security and export competitiveness through productive and sustainable agriculture

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Technologies without borders:
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Association for Strengthening Agricultural Research
in Eastern and Central Africa (ASARECA)

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ASARECA has worked tirelessly at improving its management efficiency to enhance technological and scientific innovation at all stages of the project cycle—from design to implementation

Quality seed garden

Communication from Dr Razafinjara Lala, Chairman, Board of Directors

In the last almost two decades since the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) was established in 1993, its focus has been to increase the efficiency of agricultural research in eastern and central Africa to facilitate economic growth, food security and export competitiveness through productive and sustainable agriculture. As hunger, poverty and disease become more rampant, fanned by food scarcity and rising food prices, the role of ASARECA in seeking regional solutions to agricultural research and development challenges in eastern and central Africa also becomes more significant. Conscious of this challenge, ASARECA has worked tirelessly at improving its management efficiency to enhance technological and scientific innovation at all stages of the project cycle—from design to implementation.

To deliver on the promise to improve livelihoods, ASARECA has taken initiatives and scored achievements in the following areas:

Empowering people to work

Aware of the critical role that human beings play in realizing these goals, ASARECA undertook capacity building initiatives for institutions and individuals. Emphasis was placed on strengthening the capacity of the developing National Agricultural Research Systems (NARS), especially in Burundi, Rwanda, and Sudan. The idea was to increase efficiency through staff mentoring and change management. ASARECA secretariat staff and other partners also received training in various areas, including results-based management, integrated soil fertility management, natural resources management, integrated striga management, and gender analysis among others.

Utilization of funds

ASARECA engaged all its partners to identify and address bottlenecks to ensure efficient use of research resources. As a result, challenges in procurement, accounting and reporting, among others, were exposed and solutions jointly arrived at, leading to a marked improvement in the absorption of funds, which is expected to enhance output.

Burundi farmer appreciates improved variety

Gender mainstreaming

"Charity starts at home", so goes the old adage. ASARECA adopted the principle of equal opportunity when it came to gender mainstreaming. To kick-start the new phase of gender mainstreaming, ASARECA developed a Gender Mainstreaming Strategic Plan to guide the processes of implementation, and introduced initiatives to involve its technical staff, including the management, to build a common vision and understanding of concepts, processes and dynamic approaches on the same principal of equal opportunity. Most programme and project indicators reflect this parameter. Beyond the ASARECA projects, it has been able to add value to new projects implemented by its partners. These are the East African Agricultural Productivity Program (EAAPP) and the Sustainable Intensification of Maize-Legume cropping systems for food security in Eastern and Southern Africa (SIMLESA) programme. These are the first regional initiatives where ASARECA is responsible for technical backstopping in gender mainstreaming, monitoring and evaluation, knowledge management, upscaling and capacity development.

Kick-starting EAAPP

ASARECA facilitated meetings of EAAPP to agree on the modalities for cooperation amongst the programme countries. It also supported the Comprehensive African Agricultural Development Programme (CAADP) Resource Group in the Common Markets for Eastern and Southern Africa (COMESA) sub-region through capacity building workshops and through the SIMLESA programme.

Management information systems

The Secretariat continued its efforts to enhance management and service delivery by instituting appropriate information systems. Two modules, the Projects Management System and the Grants Management System were completed, commissioned and deployed to the Secretariat servers. This is to facilitate centralized management of project-related information as well as tracking of research grants awarded to the sub-grantees for project activities.

In conclusion, ASARECA, undoubtedly, is geared towards performance. This is a result of concerted efforts by various players in the region and elsewhere. The continued identification of human resources that are up to the task; reliable and timely guidance by development partners through joint supervisions; the keen oversight provided by the Board of Directors and patron ministers; the dependable partners in NARS; and the mutual collaboration with international agricultural research institutions have made us what we are. ASARECA is proud of each one of you!

Dr Razafinjara Lala
Director General, Centre National de Recherche Appliquee au Developpement Rural (FOFIFA), Madagascar
Chairman, Board of Directors, ASARECA

Communication from Dr Seyfu Ketema, Executive Director

The proportion of farmers who effectively controlled BXW using single-stem removal increased from about 5% to 60% in Uganda and DR Congo

ASARECA has been steadily expanding its scope of work and impact. Following the positive milestones attained in 2009, during 2010, ASARECA widened its coverage and celebrated the outcomes of its efforts.

Tackling BXW, the banana disease

The Banana Xanthomonas Wilt (BXW) disease has wreaked havoc on the crop in Ethiopia, Uganda, Tanzania, Kenya, the DR Congo, Rwanda and, more recently, in Burundi. BXW destroys the entire plant, reducing growth and the overall bunch size and weight by up to 78%. In response, ASARECA initiated three projects to address the production and marketing constraints of banana in the six countries. The projects focused on how to use existing technologies for disease management as well as developing new innovations. In 2010, progress was made in deploying existing cultural control options such as removal of male bud, destroying affected mats and disinfecting tools with fire in BXW hotspots, among others. The proportion of farmers who effectively controlled BXW using single-stem removal increased from about 5% to 60% in Uganda and DR Congo. As a result, banana yield has improved from a mere 2.5% previously, to 30% in Uganda during the reporting period.

Banana affected by BXW

Expanding benefits from sorghum

One of the challenges to the research and development of sorghum in eastern and central Africa is the wrong perception that it is a poor man's crop. Ironically, sorghum ranks as a staple crop in the region, with perhaps the highest potential to withstand harsh conditions like drought, compared to other cereals like maize, millet and rice. Aware of this, researchers from Eritrea, Kenya, Tanzania, Uganda and Sudan, supported by ASARECA, in 2009, initiated a process to change the perception regarding sorghum. As a result, in 2010, 14 new value-added products that were easy-to-cook,

tasty, economically priced and had a long shelf-life were developed. These were meant to appeal to various consumers, especially those in the urban areas.

Expanding cassava, potato benefits by harmonizing quality standards

Market failures like the lack of key institutions and frameworks to enhance efficient marketing along the value-chain and lack of standards for commercial use limit the potential of cassava and potato. In addition, value-addition technologies are still under-utilized due to a lack of clear guidelines and supportive policies on standards. To enhance the value of cassava and potato through commercialization, ASARECA, in 2006, initiated a project to develop standards for root crops in the region. Four years down the road, the East African Community General Assembly has approved 11 standards for cassava and potato.

Catalysing agricultural productivity through EAAPP

In 2009, while world food prices were skyrocketing and rendering poor families across the globe uncertain of their next meal, a programme with the potential to rekindle hope was being born. The East African Agricultural Productivity Programme (EAAPP) is a regional initiative where four countries—Ethiopia, Kenya, Tanzania and Uganda—are scaling up national research programmes into Regional Centres of Excellence (RCoE). Kenya is the centre of excellence for dairy, Uganda for cassava, Ethiopia for wheat and Tanzania for rice. RCoE will facilitate better use of scarce expertise and resources scattered across the sub-region by sharing resources, knowledge and technologies among EAAPP countries through mechanisms championed by ASARECA. ASARECA hosted two sub-regional EAAPP meetings to refine the roles and responsibilities of ASARECA and the member countries.

AIV seed study plot

African indigenous vegetables (AIV) contribute significantly to household nutrition and income. Nutrition experts say that eating these vegetables contributes to micronutrient intake

African indigenous vegetables: budding business for smallholders

African indigenous vegetables (AIV) contribute significantly to household nutrition and income. Nutrition experts say that eating these vegetables contributes to micronutrient intake. In Kenya, Uganda, Tanzania and Rwanda, most of the vegetables are produced and sold by smallholders. However, production of AIV is hampered by limited supply of quality seed. In response, in 2008, ASARECA commissioned a study to identify promising farmer-level AIV seed models that can be scaled up. Following this study, a project entitled, "Scaling up farmer-led seed enterprises for sustained productivity and livelihoods in ECA", was started in December 2009. Although barely a year old, farmer groups have started to produce seed and to market their products.

Exploiting market opportunities for value-added dairy and meat products in ECA

Food and Agricultural Organization (FAO) statistics show that ASARECA countries are net importers of dairy and meat products. This means that the domestic dairy and beef industries are not meeting

local demand for value-added dairy and meat products. Most of the milk and meat is traded in informal, traditional markets with little or no value addition. Realizing the need to position small and medium-scale producers and processors to play a significant role in bridging the demand–supply gap for value-added products, ASARECA initiated a project to enhance the performance of the livestock sector in Ethiopia, Kenya, Rwanda and Uganda.

Unleashing the full potential of Quality Protein Maize

It is estimated that about 30% of the children in Sub-Saharan Africa suffer from protein-energy malnutrition. Most households in Africa reduce or cut out proteins from their diets because protein-rich foods such as milk, meat, fish and eggs are expensive. This has led to increased incidences of malnutrition, especially among the urban and rural poor. In response, ASARECA and its partners are promoting Quality Protein Maize (QPM) technologies in DR Congo, Kenya, Tanzania and Uganda. QPM is an improved variety of maize containing twice the *Lysine* and *Tryptophan*, amino acids essential for protein synthesis in humans and animals like pigs and poultry. During 2010, substantial progress was attained in distributing QPM foundation seed and certified seed in the project countries as well as in providing information to farmers about the nutritive benefits of QPM products.

It will now be possible to identify, isolate, and clone genes for striga resistance

Pursuing the enemy: fighting cassava and potato viruses

Cassava brown streak disease is the most damaging enemy to the crop, causing up to 100% yield loss. As for the sweet potato crop, the sweet potato virus disease complex has affected its productivity. To address these two challenges, ASARECA and partners initiated a project to develop tools to detect and eliminate viruses from tissue culture materials for use by farmers. In 2010, the partner scientists were at the final stages of deriving the proteins required to produce antibodies besides ensuring the supply of good quality planting materials.

Striga, the witch weed

Racing against drought: impressive progress in genetic maize research

In 2009, ASARECA reported a number of technological breakthroughs in the search for a maize variety that could withstand drought. Researchers coordinated by ASARECA successfully introgressed drought-tolerance genes into the maize genome. Since then, the team has success-

I would like to thank and acknowledge the contribution of the Director Generals of the ten ASARECA Member National Agricultural Research Institutions for their dedication, guidance, mobilization and deployment of scientists, other professionals and national resources, which ensured the successful implementation of the ASARECA projects

fully transformed nine maize lines with drought-conferring genes. The lines are now being multiplied in preparation for confined field trials.

Healthy pigs ensure quality pork for healthy people: checking epilepsy by treating pigs

Pork consumption is increasingly becoming popular in the region. Unfortunately, there are reports of a prevalence of epilepsy, a condition caused by *Taenia solium, a* tapeworm transmitted by pigs. To tackle this problem, ASARECA and partners in Burundi, DR Congo, Kenya, Tanzania, Uganda and the International Livestock Research Institute (ILRI), initiated a project to develop, make available and promote the use of appropriate diagnostic and control tools and strategies to tackle the disease. In 2010, a vaccine to fight *Taenia solium* in pigs was developed, which is under trial. By the end of the year, 300 user-friendly diagnostic test kits were produced and were being tested on a number of pigs in the project countries.

Exciting advances in striga-resistance research

Following the generation of 50 striga-resistant sorghum lines by ASARECA-coordinated scientists from Eritrea, Kenya, Sudan and International Crop Research Institute for Semi-Arid Tropics (ICRISAT), in 2009, scientists in Sudan advanced more than 20 of the 50 lines towards stable lines in 2010. Some of these lines were due for release by the end of the year. In addition, one of the ASARECA-sponsored PhD students, Ms. Rasha Ali, from the Agricultural Research Corporation in Sudan, completed fine mapping the genes and has saturated two Quantitative Trait Loci (QTL) regions associated with striga-resistance in sorghum. It will now be possible to identify, isolate, and clone genes for striga resistance.

First batch of information and communication professionals graduate

An ASARECA project, the Regional Agricultural Information Network (RAIN), in partnership with the Regional Universities Forum for capacity building in agriculture (RUFORUM), and Egerton University in Kenya, in 2006, developed an MSc degree curriculum on Agricultural Information and Communication Management (AICM). The first of its kind in eastern and central Africa, the course was meant to enhance

the competencies of individuals and institutions to analyse issues and trends in agricultural research and development by using information and communication tools. ASARECA started implementing the AICM in 2007 and, as of December 2010, six of the eight AICM students were close to completing their studies.

ASARECA could not have achieved these outcomes were it not for the support from our partners and well-wishers. In this context, I would like to thank and acknowledge the contribution of the Director Generals of the ten ASARECA Member National Agricultural Research Institutions for their dedication, guidance, mobilization and deployment of scientists, other professionals and national resources, which ensured the successful implementation of the ASARECA projects. I would like to acknowledge the ASARECA Board of Directors that guides the work done by ASARECA. I would also like to thank and acknowledge the contribution of our development partners for their commitment and dedication to bring about economic growth and improved livelihoods and to fight poverty in our sub-region through their indispensable and critical financial support, without which our achievements would not have been possible. The partners include the African Development Bank (AfDB), Department for International Development (DFID), Canadian International Development Agency (CIDA Canada), European Union (EU), International Development Research Centre (IDRC), Swedish International Development Cooperation Agency (SIDA-Sweden), United States Agency for International Development (USAID) and the World Bank – Multi Donor Trust Fund (MDTF).

I would also like to thank and acknowledge the contribution of the professionals and scientists from the national and international agricultural institutions who implement the activities. Last, but not the least, I would like to thank and acknowledge the contribution of all the ASARECA Secretariat staff for their support in the technical, financial, administrative and secretarial management and coordination of the projects. Their dedication, commitment and enduring hard work are much appreciated.

Dr Seyfu Ketema
Executive Director, ASARECA

Central to the vision and mission of ASARECA is the recognition of the value of collaboration among member countries to overcome poverty and hunger, and foster the development aims of broad-based economic growth, poverty eradication and improved livelihoods

Landscaping—one of the innovative approches farmers have adopted

ASARECA at a glance

The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) is a sub-regional not-for-profit association. It was established in 1994 by 10 member countries, which were represented by their national agricultural institutes. The 10 member countries are: Burundi, DR of Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania, and Uganda.

Vision

Regional leader in agricultural research and development for improved livelihoods in eastern and central Africa (ECA).

Goal

Enhanced sustainable productivity, value addition and competitiveness of the sub-regional agricultural system.

Purpose

Enhanced utilization of agricultural research and development innovations in ECA.

Mission

To enhance regional collective action in agricultural research for development, extension and agricultural training and education to promote economic growth, fight poverty, eradicate hunger and enhance sustainable use of resources in ECA.

ASARECA treasures partnerships and collaboration

Central to the vision and mission of ASARECA is the recognition of the value of collaboration among member countries to overcome poverty and hunger, and foster the development aims of broad-based economic growth, poverty eradication and improved livelihoods.

ASARECA adds value to the work of National Agricultural Research Systems (NARS) in the sub-region through:

- identification of shared goals and the promotion of economies of scale and scope through collaboration, specialization and sharing of results.
- identification of sub-regional public goods that would be under-produced in the absence of shared goals and a regional mechanism.
- sharing of knowledge and experiences with institutional innovation for more effective agricultural research for development, extension and agricultural training, and education.

ASARECA sees improved delivery and impact of scientific knowledge, policy options and technologies as powerful instruments to drive the sub-region towards meeting the Comprehensive African Agricultural Development Programme (CAADP) goals, which is the agricultural agenda of the African Union's New Partnership for African Development (AU/NEPAD).

ASARECA is positioned to contribute towards achieving the vision of AU/NEPAD by using strong partnerships at all levels. It serves as a forum for promoting regional agricultural research for development. It is a forum for strengthening relations among NARS, international agricultural research institutions, universities and other advanced research centres. ASARECA links agricultural research to political dialogue through the East African Community (EAC), Common Markets for Eastern and Southern Africa (COMESA), and the Forum for Agricultural Research in Africa (FARA) and AU/NEPAD.

Working to deliver on the CAADP agenda

The ASARECA strategic plan is aligned to CAADP and its implementation guidelines, the Framework for African Agricultural Productivity (FAAP). The ASARECA operational plan has established good corporate governance and management structures, systems and directions for the implementation of the CAADP agenda.

ASARECA is working with the CAADP country teams set up by COMESA to identify key areas of intervention to accelerate the country round table processes in the member countries. Using the rich network of National Agricultural Research Institutes (NARIs), ASARECA is working with AU/NEPAD, COMESA and FARA to identify priority investment areas, especially in research, and to facilitate implementation. This effort/collaboration is also to ensure the development of sound country compacts and investment documents for the country CAADP processes in the member countries. ASARECA contributes directly to CAADP Pillar IV and supports the other three Pillars through its seven programmes, which enhance regional collective action in agricultural research for development in the member countries. The seven programmes include: (1) Staple Crops, (2) High-Value Non-Staple Crops, (3) Livestock and Fisheries, (4) Agro-Biodiversity and Biotechnology, (5) Natural Resource Management and Biodiversity, (6) Policy Analysis and Advocacy, and (7) Knowledge Management and Upscaling.

Laboratory equipment at plaforms funded by ASARECA

Processors training at CFPTC1

Expanding agricultural research, and technology dissemination and adoption is CAADP's Pillar IV.

The ASARECA strategic plan is aligned to CAADP and its implementation guidelines, the Framework for African Agricultural Productivity (FAAP). The ASARECA operational plan has established good corporate governance and management structures, systems and directions for the implementation of the CAADP agenda1

The programmes are implemented through partnership and collaboration of the NARS in member countries, the Consultative Group on International Agricultural Research (CGIAR), universities and other advanced research centres. While ASARECA mobilizes operational finances for sub-regionally planned programmes, the partner NARS contribute in terms of infrastructure, personnel and some funding towards the sustainable implementation of the programmes. The highlights for 2010 come out of the efforts of these programmes and partners.

Striga, a notorious weed, is threatening to bring 17 million hectares of farmland in the ECA out of sorghum production.

Farmers celebrate the product of hard work

Highlights of 2010

Responding to the need for demand-driven agricultural technologies

Exciting advances in striga resistance research

It is a fact that is no longer disputed – striga, a notorious weed, is threatening to bring 17 million hectares of farmland in the ECA out of sorghum production. In 2009, we reported that the research efforts of scientists in Eritrea, Kenya, Sudan and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), coordinated by ASARECA, in using marker-assisted breeding produced technological advances leading to the generation of 50 striga-resistant sorghum lines.

The significance cannot be overstated: the lines are capable of yielding up to 3.6 t/ha. In 2010, our partners from Sudan advanced more than 20 of the 50 lines towards stable lines. Some of these lines may be released towards the end of this year. Once released, this will signal rapid progress towards restoring the productivity of 17 million hectares of land threatened by striga, thereby saving 300 million people in Africa from hunger. Sorghum

At a plant genetic resource laboratory in Sudan

Rasha Ali has mapped genes associated with striga resistance

is the fifth most important cereal crop worldwide and together with maize and pearl millet, form the most important dryland cereal crop for the semi-arid tropics. It is grown in at least 86 countries, on an area of 47 million hectares, with an annual grain production of 69 million tonnes and average productivity of 1.45 tonnes per ha. Sorghum grain yields in farmers' fields in Africa generally have been low (500 to 800 kg ha-1) compared with yield levels of up to 7 tonnes per ha in developed countries, which do not experience attacks by the parasitic weeds, including *Striga hermonthica*.

Sorghum is the fifth most important cereal crop worldwide and together with maize and pearl millet, form the most important dryland cereal crop for the semi-arid tropics

In addition to the generation of striga-resistant lines, one of the ASARECA sponsored PhD students, Ms Rasha Ali, from the Agricultural Research Corporation in Sudan, completed fine mapping genes associated with striga resistance in sorghum. Using laboratory facilities at ICRISAT, Ali completely saturated two Quantitative Trait Loci (QTL) regions associated with striga resistance. These are regions that may contain the gene of interest. This means that it will now be possible to identify, isolate, and clone genes for striga resistance, which may be used to enhance breeding of cereals for striga resistance .

Integrated package tames drylands

Taming the landscape

However, the striga-resistant technology is not sufficient as a stand-alone to attain sustainable productivity in the drier areas. The scientists, therefore, employed weather modelling. This is a technique that analyses the physical resource base for crop production in the area, such as long-term weather data, soil fertility and management conditions, to predict likelihood of weather vagaries and guide decision making for production. Using powerful modelling tools such as Decision Support System for Agrotechnology Transfer (DSSAT) and Agricultural Production Systems Simulator (APSIM), scientists worked towards validating an integrated technology and establishing the best package for Eritrea, Sudan and Kenya. DSSAT is a model that integrates the effects of soil, crop phenotype, weather and management options and answers "what if" questions. APSIM is a farming systems model that simulates the effects of environmental variables and management decisions on crop yield, profits and ecological outcomes.

Farmers are now able to access basic information that guides them on simple aspects such as the best time for planting, which fertilizer to use on which soil and which variety is most suited for which location so that they can maximize their yields.

The researchers combined striga and drought-tolerant cultivars of sorghum with fertilizer, water harvesting and date of sowing to develop an integrated package that is suitable for the drier areas. This package out-yielded all the other sole packages in all the research station and field trials. Average grain yield in the integrated package was 3.2 tonnes per ha, a tonne higher than the sole packages of 2.1 tonne per ha. This has generated excitement amongst the farmers, who have for long demanded increased productivity, grain quality and yield stability.

Striga-resistant sorghum variety in Sudan

Training for effective use

Over 303 stakeholders along the sorghum value chain in Eritrea, Ethiopia, Kenya, Sudan and Tanzania were trained in the application of integrated technologies to utilize the technologies effectively. These included farmers, researchers, farmers, seed enterprises, extension staff, traders and processors (millers, confectioners, brewers). More specialized training in marker-assisted breeding for striga resistance is ongoing. One PhD student (female) and three (two female and 1 male) MSc students will attain expertise in this research area.

In addition, the technology is being promoted to farmer groups across the target countries through farmer field schools. The farmers, together with extension workers, researchers, NGOs and community-based organizations (CBOs) learn to apply what they have learnt through participatory activities.

According to Dr Negusse Abraha, a scientist with NARI Eritrea, farmer field schools create farmers who are experts on their own farm and by example encourage adoption. In Golij, in Eritrea, for example, 50 farmers have formed a group in which they take turns to teach and learn new farming technologies. They were inspired by a fellow farmer, who, after receiving training on integrated technologies for drought mitigation, planted a tiny pilot plot, which posted unprecedented yield.

A product of crossing sorghum which is highly resistant to striga, and that which is suceptible

Sorghum that is highly suceptible to striga

Beyond drought and striga: expanding benefits from sorghum

Beyond the challenge of drought and striga, another major challenge to the research and development of sorghum in ECA is the wrong perception that it is a poor man's crop. Yet, conversely, it is also true that sorghum ranks as a staple crop in the region, with perhaps the highest potential to withstand harsh conditions like drought compared to other cereals like maize, millet and rice.

Against this background, researchers from Eritrea, Kenya, Tanzania, Uganda and Sudan, supported by ASARECA, in 2009, initiated a process to change the perception that sorghum is only for the poor. Through projects managed

The new products are meant to appeal to various consumers, especially the urban and formally employed consumers (white and blue collared) who require food products that are colourful, convenient, tasty and economical and have a long shelf-life

Sorgum popcorn

Sorgum cookies

Sorgum cake

Sorgum bread

Sorgum mandazi

Sorgum meal

Sorgum samosas

by the Staple Crops and Agrobiodiversity and Biotechnology programmes of ASARECA, scientists in the region set out to add value to sorghum by developing processing technologies and highly improved and attractive products.

Fourteen products developed

The new products are meant to appeal to various consumers, especially the urban and formally employed consumers (white and blue collared) who require food products that are colourful, convenient, tasty and economical and have a long shelf-life. This, it is hoped, will expand and diversify the way sorghum is used and, thereby, make it more competitive.

With full farmer participation, a total of 33 varieties of sorghum were tested for grain and flour quality and five varieties (*Kari Mtama1, Kari Mtama 2, Epuripur, Sekedo* and *Gadam*) were selected for processing into value-added products.

About 1.5 tonnes of foundation seed of these varieties was produced and supplied to farmer groups through a community seed multiplication programme to make the varieties more easily available to growers. The selected varieties were used by small-scale producers to develop 14 value-added products, including bread, cakes, biscuits,

sorghum rice, *tambi/baghia*, *viko-koto*, pop sorghum, composite flour, weaning foods, beer, *supa mtama*, cereal vegetable soup, animal feeds and soured sorghum flours. These products now fetch premium prices in supermarkets, retail markets, shops and kiosks in Uganda and Tanzania.

Mr Ebiyau Johnnie, a researcher with the National Semi Arid Resources Research Institute in Uganda, is confident that through participation a critical mass of processors and users of innovative technologies will emerge. This would ultimately enhance the use of sorghum.

Bacterial ooze from banana stem infected by BXW

Tackling BXW, the banana disease

Banana Xanthomonas Wilt (BXW), also known as Banana Bacterial Wilt (BBW), is a disease caused by a bacterium, *Xanthomonas campestris p.v musacearum* (Xcm). It affects the entire banana plant, leading to a marked reduction in plant growth and overall bunch size and weight. In severely affected plants, the development of the banana fingers is severely hindered, leading to bunch weight reduction of up to 78%.

BXW was first reported in Ethiopia about 40 years ago. It broke out in Uganda in 2001 and, in recent years, has wreaked havoc on farms in Tanzania, Kenya, the DR Congo, Rwanda, and, more recently, in Burundi. At its height in Uganda, in 2005, BXW caused yield losses estimated at US $ 136 million. In some areas in DR Congo, where communities depend mostly on banana for food and income, farmers who previously produced about 20 tonnes per ha per year and earned about US$1,600 per ha per year, experienced total yield loss as they now produce less than one tonne per hectare due to the devastation caused by the disease.

Healthy banana bunch

Against this backdrop, ASARECA, in collaboration with the NARIs of Uganda, DR Congo, Kenya, Tanzania, Rwanda and Burundi, initiated three projects to address the production and marketing constraints of banana in the six countries. The projects focus on how to use existing technologies for disease management as new innovations are being developed.

Regarding disease management, progress was made in deploying existing cultural control options in BXW hotspots in the participating countries. Having suffered crop loss due to BXW earlier than the regional partners, Uganda had contained and reduced its incidence and had developed considerable capacity and experience in its management, which it shared with the other countries. The control options deployed include removal of male bud (debudding) using a forked stick, single-stem removal – removing an infected plant from a cluster of banana plants (a mat), destroying affected mats, suspending pruning in the affected fields for up to three months and disinfecting tools with fire.

Single-stem removal was the most popular management method. According to Dr Margaret Onyango, a researcher at KARI Kisii in Kenya, BXW infection often starts from the upper parts of the plant and moves slowly downwards. "This gives the farmer an opportunity to remove the infected stem, saving the rest of the mat from infection," says Dr. Onyango. "It is very effective and has reduced disease incidence by up to 64%. The farmer, therefore, is able to harvest healthy bananas without replanting."

Dr Jerome Kubiriba of NARO Uganda states that, during 2010, the proportion of farmers who effectively controlled BXW using single-stem removal increased from about 5% to 60% in Uganda and DR Congo. As a result, banana yield has improved from a mere 2.5% to 30% across four hotspots in Uganda – Rwamucucu and Kaharo in Kabale district and Bunghoko and Bududa in Mbale district. In addition to working with farmers, the project also carried out massive awareness campaigns through radio talk shows in Uganda and DR Congo, and distributed posters in several languages, including English, French, Swahili, Kinyarwanda, Kirundi, Luganda and Runyankore that provide information on the disease and its management. These efforts have led to a change in beliefs and attitudes that came with the epidemic.

Having gained an upper hand in managing BXW, scientists are promoting value-addition technologies that could stimulate increased demand for banana

In addition to engaging in BXW management, scientists in the region are researching on innovations in the control of BXW. The key to initiating an effective management strategy for the disease is understanding its biology and how to identify it. This knowledge will aid propagation and movement of clean tissue planting materials within the region. To initiate this activity, in 2009,, scientists in the affected countries were trained in the use of DNA capture tools.

DNA capture tools consist of dipsticks and Whatman FTA cards. Dipsticks offer a quick and easy method of assessing the presence of the pathogens (bacterium). FTA cards provide a safe secure and reliable method for collecting, storing and transporting the DNA of the BXW pathogens. During 2010, scientists in the affected countries were able to use the DNA capture kits to send pathogen samples for laboratory tests at Biosciences Eastern and Central Africa (BECA) in Kenya. Scientists at BECA are now able to detect the pathogen in plant material. This will help enhance availability of disease-free planting materials essential for the rehabilitation of banana plantations.

Ripe bananas

The kits capture only the DNA of the pathogen, thus disabling its pathogenic properties. The exciting news is that the kits can also be used for other banana and crop diseases. It has significantly reduced research costs of and improved the capacity to conduct research on diseases affecting important crops in the ASARECA sub-region.

Budding banana products

Having gained an upper hand in managing BXW, scientists are promoting value-addition technologies that could stimulate increased demand for banana.

Researchers can now determine the shelf-life and juice storage conditions by observing the physical changes in the juice

These technologies help produce commodities with market appeal. In Rwanda, for example, banana wine and juice are hot items on the shelves of supermarkets. Traditional methods of juice and wine processing, including stamping with feet to squeeze juice, dominate the informal juice-processing sector. Apart from the lack of appeal and poor hygiene, these are rather outdated processing methods. According to Dr Shingiro Jean Bosco, a scientist with Institut des Sciences Agronomiques du Rwanda (ISAR), Rwanda, the search for better markets has led to the demand for credible, hygienic (uncontaminated), quality and cost-effective value-adding technologies. In response to this demand, through an ASARECA project, ISAR scientists have developed an improved banana ripening and processing technology, which has boosted the production of banana wine, juice, flour, bread and cakes. The new technology helped augment productivity following the acceptance of the processed products by the market.

The technology was further modified to address the challenge of sedimentation in banana juice following a visit by an ISAR researcher to a commercial fruit-processing firm in Uganda. Researchers can now determine the shelf-life and juice storage conditions by observing the physical changes in the juice. Today, a new, long-life banana juice brand is available on the shelves in the Rwandan market.

Juice processing

Juice processing traing

Processed and packaged juice

Providing farmers clean banana planting materials

Another ASARECA project, "Transfer of banana tissue culture, tissue culture certification and Tissue Culture Business Network", is complementing the efforts to curb BXW and stimulate banana production using virus-free plantlets. In 2010, just a year after the

Farmers, civic leaders, trainers of trainers and other stakeholders were sensitized about the need to use tissue culture banana plantlets and better management systems

Banana is a source of income

introduction of the project, scientists in Uganda have been able to produce and disseminate more than 10,000 tissue culture banana plantlets to small-holder farmers.

Ten banana seed nurseries and demonstration gardens managed by women were also established and are operating efficiently. Farmers, civic leaders, trainers of trainers and other stakeholders were sensitized about the need to use tissue culture banana plantlets and better management systems. As a result, more than 200 farmers adopted pest and disease-free banana plantlets. This has the potential to increase crop yield from 5 tonnes per ha currently, to the full potential of 60 tonnes per ha.

Also, in response to possible challenges in the movement of the materials, the project facilitated the development of a certification scheme for the exchange of banana tissue culture planting materials in 2010. Already in draft form, this will provide assurance to tissue cultured materials buyers/importers that the materials are authentic. It will also reduce fears that pathogens that cause infections on the host plants will be transmitted through vegetative materials.

In addition, a draft strategic plan for tissue culture business network (TCBN) was developed and is now being reviewed by stakeholders. It is hoped that this will boost sourcing of investments into TCBN to promote tissue culture business development, strengthening partnerships, exchange business information and scientific data, capacity building, policy advocacy and creation of technology delivery mechanisms. ASARECA is implementing the project in partnership with Agrogenetic Technologies.

Pursuing the enemy: developing weapons against cassava, potato viruses

Cassava and sweet potato are the key food security and income-generation crops in ECA. In East Africa, cassava production, on an average, is 10 tonnes per hectare, which is half of the produce in India, where farmers get up to 31.4 tonnes per hectare. The low yields are a result of several factors, including susceptibility to diseases and pests and varying climate patterns. Viral diseases, however, are the most devastating vectors to cassava in tropical Africa.

Scientist displays cassava infected by the cassava brown streak disease

Clean cassava planting materials

Cassava brown streak disease, which is caused by cassava brown streak virus, is the most damaging disease, causing up to 100% yield loss and threatening the livelihoods of farmers in the sub-region. Sweet potato is the third most important tuber crop in the world and a food staple in the East African region. It is susceptible to the sweet potato virus disease, which can reduce its productivity drastically and has been associated with the disappearance of the once elite cultivars.

To address the problem, ASARECA in partnership with BECA and the International Institute for Tropical Agriculture (IITA) initiated a project to develop tools to detect and eliminate viruses from tissue culture materials used by farmers. In 2010, the project achieved a number of technological breakthroughs. A scientific technique for conducting diagnostic testing on the tissue culture materials for viruses was developed and is being optimized. In addition, protocols for using DNA-based tools to detect cassava and sweet potato viruses were established and were proved to be practical in the laboratory.

Antibody-based diagnostics for cassava brown streak virus is almost complete**.** By the end of 2010, scientists were on the verge of deriving the proteins required to produce antibodies. Once this is achieved, the expressed coat protein will be injected into rabbits to produce a polyclonal antibody to develop ELISA-based diagnostics tools. These tools are crucial in diagnosing sweet potato and cassava viruses because they are more sensitive compared to protein-based tools, which are currently being used. The tools are also recommended for use in quarantine and sweet potato research laboratories. If successfully adopted and utilized, the technologies will boost access to virus-free planting by farmers in the region. The tools will also be used in the certification of tissue culture planting materials and ease their movement across borders, thus improving access to cassava and sweet potato clean planting materials.

ASARECA in partnership with BECA and the International Institute for Tropical Agriculture (IITA) initiated a project to develop tools to detect and eliminate viruses from tissue culture materials used by farmers

Case study 1

Farmers, at the frontline with scientists, generate lasting climbing bean innovations in Rwanda, Burundi and DR Congo

Beans are a very important food crop in eastern and central Africa. In Rwanda, Burundi and the DR Congo, beans are eaten at almost every meal. They are a primary source of proteins (21%), carbohydrates (60%), minerals (iron, zinc) and vitamins (19%) and other nutrients for the rural population. The consumption of beans in the three countries is estimated to be more than 60 kg per person per year. However, small-scale farmers, who are the major producers of beans, face a number of challenges, including severe shortage of arable land, leading to land exhaustion; food and nutrition insecurity; lack of appropriate climbing bean varieties; poor agronomic practices; shortage of strong woody stakes and appropriate staking materials; and lack of appropriate market and value chain information.

In response to these challenges, ASARECA initiated a project called Intensification of Climbing Bean Systems. The aim of the project was to validate the existing climbing bean production systems and identify what is most beneficial to increase bean production and productivity, increase food and nutrition security, protect the environment and improve livelihoods.

The project is being implemented in Rwanda, Burundi and DR Congo by the ISAR, Institut des sciences agronomiques du Burundi (ISABU) and Institut National pour l'Etude et la Recherche Agronomique (INERA) respectively. The institutes are collaborating with the National University of Rwanda and small-scale farmers in the three countries.

Through on-farm trials, farmer field schools, exchange visits and demonstrations, the project evaluated several intensified bean production systems. Farmers identified and selected two potentially beneficial intensified climbing-bean production systems suitable for use in the three countries: inter-cropping climbing bean and maize and mono-cropping, also known as crop rotation, of maize and climbing beans. Both systems have been adopted widely in Rwanda and DR Congo and Burundi. Farmers preferred intercropping climbing bean with maize to intercropping with banana or cassava because maize provides strong and straight live stakes.

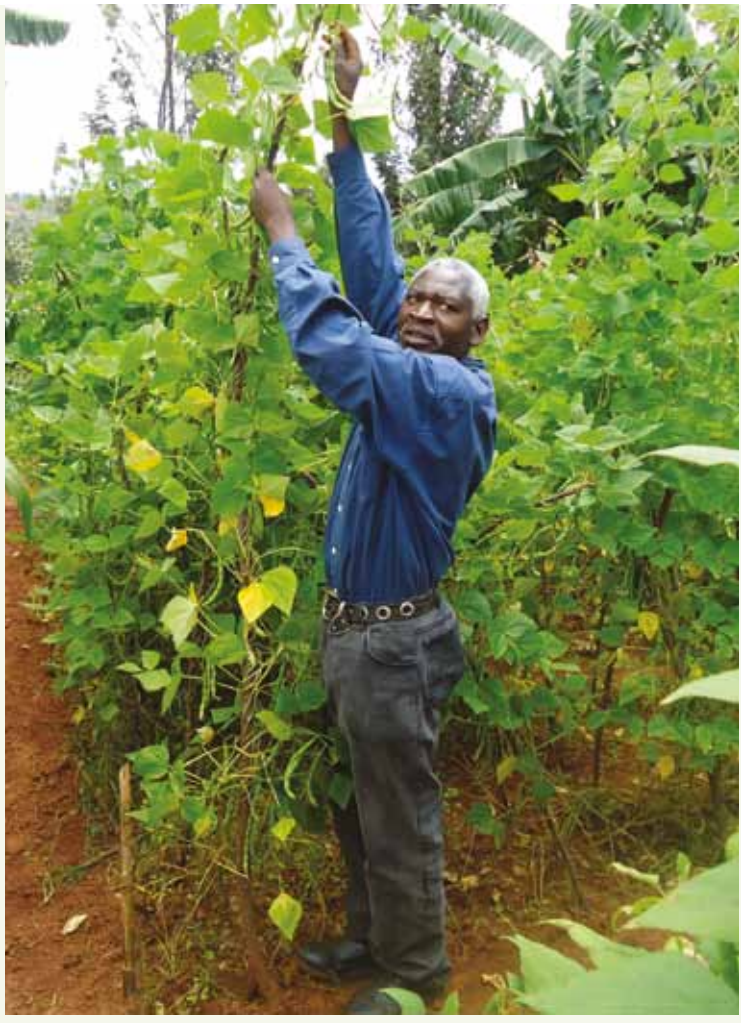
Another key area addressed by the researchers through this project was staking. Staking climbing bean has improved yields and led to higher output. However, lack of appropriate staking materials is a key challenge to climbing bean production in the project area.

Properly managed snap bean garden in Nairobi

Different domestic staking materials and factors that affect staking efficiency, such as density, stake length, and quality of staking material, were verified. Woody stakes like *Eucalyptus, Grevillea Robusta coffee*, forage shrubs like *Cedrella, Leucaena*, *Calliandra,* and grass species like *Pennisetum,* and bamboo were planted along terraces or at the borders of the farms and evaluated.

Although woody sticks are traditionally accepted as the strongest and best stakes, they are scarce. It

also requires considerable labour and time to cut the sticks, transport them to the field and store them in a safe location at the end of the season. In addition to this, they are very costly and also susceptible to breakage and damage by termites. Due to these challenges, the project sought alternative stakes and identified sisal strings and banana fibre as good alternatives to woody stakes. String stakes, which include sisal and banana fibre, were also evaluated under the same conditions as woody stakes. In DR Congo, the banana fibres are entwined into ropes to make them stronger. The farmers selected different types of stakes based on what was locally available, the cost, the time and labour requirements.



Farmer shows the yield potential of climbing beans

Though cheaper than woody stakes, sisal is not as cheap and readily available as banana fibre. The introduction of sisal and banana fibre reduced the burden on the environment caused by deforestation.

The scientists developed packages for climbing bean production which include:

1. Different improved climbing bean varieties enriched with protein, and micronutrients especially zinc and iron, with a yield two to three times more than that of the bush type. Some have a yield potential of 3.5–5.9 tonnes per hectare, exhibit better resistance to fungal foliar diseases and root rot diseases, are more marketable, and are tolerant to drought.
2. Good agricultural practices, including quality seed, soil conservation, use of organic and inorganic soil amendment in soil nutrient and water management, planting methods, timely planting, integrated pest and disease management and others.
3. Promotion of the climbing bean value chain. Although climbing beans are fairly new compared to bush beans, all the key players of the climbing bean value chain (the producers, agro-input dealers, buyers, the extension staff and others) have been brought together by the project to share information and experience. They have developed an organized commodity value chain, which provides production, post-harvest and handling, and market information, thereby improving the lives of the small-scale farmers.

Following the adoption of the two intensified climbing bean production systems and the packages for climbing bean production, the farmers now use the scarce arable land more efficiently. They have learnt good agronomic practices. The new staking materials, especially the sisal string and banana fibre, help conserve the environment as it reduces the felling of trees.

Due to better access to improved varieties, the farmers have reported increased household food and nutrition security. The utilization of these varieties is expected to provide a sustainable solution to malnutrition and mineral deficiency. Since the development and implementing procedures were participatory, farmers have extensively adopted this technology.

Case study 2

Livestock and crops – the excellent mix

How ASARECA crop-livestock innovations are boosting food security and income in Burundi, Kenya, Tanzania and Uganda

Mr Peter Ddaki and his wife, Mrs Nnalongo Ddaki, are a happy couple. Every year, they produce enough food for sale and for family consumption and can meet their nutritional needs, pay school fees and fulfil other financial obligations. They are also able to save a reasonable amount of money for financial security and future investments.

This modest, but impressive, success is no doubt the result of hard work, which includes the implementation of activities supported by ASARECA through a project on Crop-Livestock Integration. The success is also largely stimulated by a range of facilities, practices and technical support as enumerated in the following paragraphs.

The Ddakis are proud owners of an underground rain-water tank. They use it to irrigate the various food and fodder crops on their four-acre farm in Kitenga village, about four miles from Masaka town in south-western Uganda.

A woman picks amaranth leaves for sale and for home consumption

"We harvest enough water to irrigate the banana plantation, indigenous vegetables like *nakatti* (*solanum aethiopicum*) and *dodo* (*amaranthus sp*), beans, and fodder crops like *Lablab, Gliricidia, Calliandra,* Napier grass and others," says Nnalongo Ddaki. "We also use harvested water to provide drinking water for our three cross-breed dairy cows and other livestock."

The Ddakis are also proud owners of an improved forage cutter, which they use to chop chosen mixtures of forage for their livestock. Previously, like other farmers, they used crude tools like the machete to chop forage and this came with the risk of family members chopping off their fingers.

The Ddakis use cow dung and urine, collected from the zero grazing unit, and other readily available organic materials to make compost manure, which they use as the major farm fertilizer.

The numerous banana plants, at various stages of growth, thrive side-by side with those yielding large healthy bananas, thanks to the rich soil and additional water. The banana plantation is a source of regular income and food for the entire family. The banana leaves and trunks provide mulching material for the soil and plants. With time, the leaves decompose to form organic manure for crops like *nakkati*, cabbages, *dodo* and so forth. In short, every part of the farm benefits the others in one way or the other.

The Ddakis get about 41 litres of milk daily from their three dairy cows. They keep five litres for home consumption and sell the remaining quantity daily. This gives them about Ushs35,000 (US$15) in daily income and about Ushs1 million (US$ 430) monthly.

Rain water harvesting tank at the Ddakis' farm

The Ddakis and many other farmers in Masaka are part of a group of beneficiaries in eastern and central Africa that ASARECA is supporting to produce crops alongside livestock in a project; the group is called "Crop-livestock integration for sustainable management of natural resources and building livestock resilience in Eastern and Central Africa".

The project is implemented by the National Livestock Resources Research Institute (NaLIRRI) in Uganda, the Kenya Agricultural Research Institute (KARI), the National Livestock Research Institute (NLRI) in Tanzania and ISABU.

Under the leadership of NaLIRRI, the project is implementing activities to enhance the use of smallholder crop-livestock innovations to improve efficiency and the quality of production and thereby to increase profitability. The project is implemented at Wote and Machakos, peri-urban areas in Kenya, in the Nyamagana and Ilemela districts in Tanzania, in the Masaka and Kumi districts in Uganda and the Songa district in Burundi.

The intervention by ASARECA and partners is informed by the knowledge that mixed crop-livestock production is a major source of livelihood for numerous households in eastern and central Africa. However, the increasing effects of climate change, coupled with other social, economic and political issues in the region, have escalated farmers' risks and losses and increasingly reduced crop and livestock production.

Against this background, ASARECA and partners see integrated crop and livestock innovations as a way of achieving maximum use of available resources on farms. In addition, ASARECA is promoting land and water management technologies and practices, exploitation of market opportunities and institutional and policy innovations to address the needs of farmers.

Dairy production, a source of nutrition and income, is crucial to crop-livestock systems in ECA. Therefore, solutions to address problems in these systems should focus on dairy-based mixed farms. Similarly, vegetables contribute significantly to household nutrition and income. Crop residues are a source of livestock feed. ASARECA and partners see vegetables as a key factor in healthy crop-livestock systems.

Through irrigation, vegetables are available throughout the year

The households supplied with drip irrigation kits reported a 40% increase in productivity in their plots, which were irrigated and fertilized, when compared to those without the interventions

Baseline surveys were conducted on the smallholder crop-livestock farm households prior to the start of the project. The surveys identified inadequate feed supply, insufficient water for livestock, shortage of labour, poor soils, frequent dry spells, and lack of basic information on best practices as the major problems hindering profitability. The Ddakis' farm stands testimony to the success of interventions by ASARECA.

Rain-water harvesting for vegetable and dairy production

The project has constructed rain-water harvesting tanks of about 15,000 to 35,000 litres in four homesteads in Masaka in Uganda. In Kenya, roof catchments have been constructed above-ground tanks at some of the participating homesteads. Micro catchment holes (*tumbukiza*) and shallow wells have been dug in fodder fields and at other locations to demonstrate simple water-harvesting and conservation techniques; they have been integrated with the drip irrigation techniques and cattle manure application in vegetables and fodder gardens.

The project supplied drip irrigation kits to facilitate year-round vegetable production to eight households in Masaka growing cabbages. These households have reported a 40% increase in productivity in their plots, which were irrigated and fertilized, when compared to those without the interventions. Twenty-three households in Wote and Machakos in Kenya also received kits for tomato production.

Multi-purpose fodder trees

Fodder trees, namely *Gliricidia sepium* (Gliricidia), *Calliandra calothyrsus* (Calliandra), *and Sesbania sesban* (Sesbania), were also introduced on

Forage seed production field

the farms. These were specifically meant to supplement feeds for dairy cattle while fixing nitrogen in the soil and controlling soil erosion.

In Kenya and Burundi, the multipurpose *Leucaena* has been planted. On-farm case studies showed that supplementing 2 kg dry matter of *Calliandra* leaf hay with 1 kg of maize bran to feed dairy cattle previously fed on low quality forages and crop residues improved daily milk production by over 30% during the dry season.

Intercropping practices

Napier grass* with *Centrosema pubescens

The farmers received technical advice on intercropping Napier grass with *Centrosema pubescens,* a tropical forage legume. As a result, the Napier grass fodder dry matter yield increased from 10 to 12 tonnes per hectare per year. The forage legumes contributed about 26% of the total fodder yield, improving the availability of crude protein to the dairy cattle. In Tanzania and Kenya, the tropical legume *Clitoria ternatea* was used instead of *Centrosema pubescens* because it yields larger quantities of fodder in those agro-ecologies. The legume was also planted in some farms in Kenya.

Maize with *Lablab*

Fodder and grain yield increased by 26% and 6% respectively when maize was intercropped with the forage legume, *Lablab purpureus*. Lablab notably controls the weeds that often compete with maize for nutrients and moisture. This represents a weeding cost saving of about US$50 per hectare. Farmers have noted that maize–lablab intercropping

Fodder trees, namely *Gliricidia sepium* (Gliricidia), *Calliandra calothyrsus* (Calliandra), and *Sesbania sesban* (Sesbania), were also introduced on the farms. These were specifically meant to supplement feeds for dairy cattle while fixing nitrogen in the soil and controlling soil erosion

Collection of valuable resources at NARO, Uganda

Forage seed harvest

Farmer prepares cattle feed

increases fodder production and is, therefore, important in filling the feed gap during the dry season.

Small-scale hay and silage making techniques

The project promoted forage conservation technologies, especially silage and hay making, to address the scarcity of feed in the dry season. Farmers and other stakeholders have been trained in forage production, conservation and utilization. Over 100 farmers (80% women) received training in using grain stovers, hay and silage as resources for dry season feeding.

Fixed-knife forage choppers

The project introduced fixed-knife forage choppers to reduce the labour burden for women and children in chopping fodder for feeding dairy cattle. The manual method of forage chopping using *a panga* or machete is tedious, time-consuming and risky. Farmers often chop off their fingers in the process of chopping the fodder. In addition, the chopped pieces turn out irregular in length, which contributes to reduced feed intake by the cattle. The fixed knife forage choppers cost about $70 per unit compared to the motorized chopper, which costs about $1,100. The fixed knife forage choppers reduced forage wastage by 20%. Farmers have reported that chopping time has been reduced by about 30%.

Addressing components of the value chain

Through the project, a milk producers' group comprising 25 men and 15 women was formed in Nyamagana district in Tanzania to address the challenges of marketing milk .

In Uganda, four farmers' marketing associations with 30 members per group have been established to address marketing of vegetables in Kumi district. The groups have been guided to make constitutions for their associations and register their associations. In addition, three vegetable marketing collection centres have been initiated in Kumi district. In Kenya, farmer groups have been supported to identify suitable equipment for processing ghee and yoghurt.

Farmers have received training in improved fodder production; vegetable production using a simple irrigation drip kit to ensure year-round vegetable supply; production and utilization of fodder trees; forage conservation and utilization; and feed formulation.

Reducing crop failure through response farming

In many parts of ECA, farmers face varying rainfall patterns, making it difficult for them to prepare for the next cropping season. This greatly increases the risk of total crop failure.

To survive, farmers, especially those tilling dry land, have to make quick decisions to be able to realize a reasonable yield whatever the rainfall pattern. Their decisions and actions help them to ensure efficient use of water to optimize yield.

In the Central Rift Valley of Ethiopia, in particular, seasonal rainfall variability is, perhaps, the leading cause of irregular crop yield risk and, many times, total failure. Climate change is likely to exacerbate this rainfall variability.

In response to this situation, farmers have developed a range of innovations to cope with the risks. The starting point is defining rainfall characteristics in terms of time of onset. In this case, the farmers have noted that rains that fall at the beginning of the planting season last longer and provide more water compared to those at the end of the year.

Based on this experience, farmers tend to grow early maturing crops in the first and longer seasons, and plant long-to-medium maturing, higher-yielding cultivars. In the second or late season, they often switch to shorter maturing crops and cultivars.

Should the rains fluctuate in the first or early season, putting the crop at risk, they quickly switch to medium-maturing cultivars. In case both the early and the medium-maturing crops fail, they plant short-maturing crops. The logic behind this practice is that farmers have established that the first season is highly risky, but offers quite a good harvest, so, they are willing to take the risk, but with some contingency at hand. The contingency comes in the form of late-season planting of short-maturing crops, which offers a fairly low risk of total failure. The yields in this season, however, are generally poor and farmers are aware of this.

This phenomenon is what is referred to as Response Farming. Response farming can therefore be defined as a set of strategic and tactical adjustments in cropping based on the amount of rainfall that is expected and the actual amount received during the year. As illustrated in the farmers' model, response farming relies on forecasting the amount of moisture from early rain occurrences. From these predictions, farmers are able to choose the crops and agronomic practices that suit the forecast.

Response farming can be defined as a set of strategic and tactical adjustments in cropping based on the amount of rainfall that is expected and the actual amount received during the year

GMO maize at a screen house at Kenyatta University

Beans doing well in land that was originally uncultivable

Response farming is a multi-layered decision system incorporating seasonal rainfall onset dates, close monitoring of actual rainfall, variable plant numbers, and deciding whether or not to add fertilizer as a base for the pending season.

Realizing the potential of response farming to mitigate the effects of climate change on food production in the region, partners, through the project "Making the best of climate—adapting agriculture to climate variability", conducted an extensive field-testing and verification exercise in Ethiopia to demonstrate the usefulness of rainfall forecast for response farming adoption. The exercise was conducted in two semi-arid locations of Adama Marabe Marmarssa and Adami Tulu in the Central Rift Valley of Ethiopia.

The feasibility of response farming was tested onsite with 76 farmers during the 2010 cropping season. Across all study sites, average maize yields increased by about 58% as a result of using response-farming methods. Response farming therefore holds a big promise in reducing crop failure and increasing yield.

A portable raingauge and soil moisture measuring devices were used to predict the approximate dates when the approaching season was likely to start. The rain gauge also measures the amount of rainfall from the onset up to the seedling season. These tools facilitate decision making in terms of choice of crop and the quantity of variable inputs and second-level decisions on whether the original crop should be maintained and whether or not additional fertilizer should be added.

The agronomic forecast of rainfall based on the date of onset and the subsequent actual rainfall following onset, could become a handy tool for farmers to make strategic and tactical decisions, compared to the conventional large-scale forecasts issued by meteorological departments. The agronomic forecast facilitates choice of crops and of input levels, land preparation practices, including spacing and plant populations.

In other words, response farming is a kind of Plan A/Plan B system, with Plan A geared for higher yield potential and Plan B meant to minimize failures and reap some reasonable yield.

Response farming could be a useful approach for improving traditional adaptation strategies, and in making farming ecologically sustainable and economically feasible as climate change occurs.

Keeping ticks and tick-borne diseases at bay

Ticks and tick-borne diseases are the most devastating afflictions to strike livestock in ECA . East Coast Fever, a tick-borne disease, places over 1.1 million cattle at the risk of death, or at least in a state of diminished productivity annually. The conventional methods of controlling ticks and tick-borne diseases using synthetic acaricides (pesticides) are limited due to the prohibitive costs. Despite being in use for nearly a century in Africa, acaricides have not created any significant impact. Acaricides are not bad per se. However, a lack of knowledge on how to use them without harming the environment, undermines recent efforts by several African governments to rehabilitate and expand their livestock industries to increase the production of milk, meat and other animal products.

Environment experts in ECA have noted that toxic residues from acaricides are potential pollutants of the food consumed by human beings, animals and birds, and the general environment. Some farmers have contaminated their

bodies while mixing acaricides with their bare hands, when spraying their cattle or through poor disposal of the containers. Acaricides also create undesired effects on non-target organisms and set off endemic instability in animals that have undergone prolonged exposure to it.

At the manufacturing level, firms are no longer producing new molecules of acaricides due to high investment costs of research and development. As a consequence, tick and tick-borne diseases have developed resistance to common acaricides.

In 2009, ASARECA supported experts on tick-borne diseases from the six countries of Uganda, Kenya, Tanzania, Burundi, Sudan and Madagascar in a project to develop, validate and promote appropriate technologies for the control of these diseases in pastoral and agro-pastoral farming systems. From 2009 to 2010, the project conducted epidemiological studies of tick-borne diseases in Burundi, Madagascar and Sudan; identified various options for management of these diseases for different livestock production systems; and identified and documented best-bet practices for ticks and tick-borne disease control in Uganda, Kenya, and Tanzania.

The project also trained various stakeholders on ticks and tick-borne disease management, produced dissemination materials, provided policy advice on the use of acaricides and facilitated the formation of a network of practitioners on tick-borne diseases in the region. The project has created awareness among various stakeholders, especially farmers, on best practices for managing tick-borne diseases. The project has also supported multi-stakeholder interactions to overcome socio-cultural barriers, which inhibited acquisition of new knowledge. As a result, stakeholders have learnt from one another practices and processes of using conventional acaricides along with new innovations.

Epidemiological studies of tick-borne diseases were conducted in Sudan, Madagascar and Burundi. Thirty male and five female veterinarians and technicians were trained in tick ecology, survey, collection, preservation, identification, diagnosis, prevention and control, and proper use of acaricides. About 100 male and 30 female farmers were trained in tick-borne disease diagnosis and the use of acaricides.

Farmer shows cattle bought from QPM cash

Feeding dairy cattle well for good results

Using best practices for managing ticks and tick-borne diseases results in healthy animals

The training also covered geographical distribution of ticks, infestation levels of cattle with different tick species and graduate training (1 PhD and 4 MScs) for academic staff in participating institutions.

In Kenya, Tanzania and Uganda, stakeholder consultations and household surveys identified *Rhipicephalus appendiculatus* associated with East Coast Fever, *Amblyomma sp.* associated with Heartwater (Cowdriosis),

Boophilus decoloratus associated with *babesiosis* and *B. microplus* associated with Anaplasmosis as the four most devastating ticks and tick-borne diseases.

Tick-borne diseases were rated as the biggest challenge to the pastoralists and agro-pastoralists. It was also noted that three categories of acaricides, namely organophosphates, armitraz and synthetic pyrethroids, are commonly used to manage ticks and tick-borne diseases in different production systems.

The project identified improper use of the products (by deviating from specified prescriptions), which could promote development of tick resistance and rampant non-observance of withdrawal periods after drug administration, as some of the major constraints faced by farmers in implementing the control technologies.

Surveys also showed that over 80% of the agro-pastoral and pastoral livestock keepers were not fully aware of the cost-benefit considerations in relation to tick-borne disease control. In Kenya, Uganda and Tanzania, over 50% of the farmers did not understand and appreciate the benefits of the "infection and treatment" method of immunization against East Coast Fever. To close the information gap, the project trained the livestock keepers in disease management.

Private veterinarians, acaricide retailers, pharmaceutical companies and the veterinary departments in the three countries were mobilized to train and share experiences with the farmers on ticks and tick-borne disease management

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Private veterinarians, acaricide retailers, pharmaceutical companies and the veterinary departments in the three countries were mobilized to train and share experiences with the farmers on ticks and tick-borne disease management. The training covered the basics on ecology of ticks; epidemiology of ticks and tick-borne diseases; tick diagnosis, characterization and choice of acaricides and drugs; best-bet practices of administration of acaricides and drugs' malpractices associated with misuse of acaricides and drugs; and implications associated with malpractices.

Two brochures outlining the survival mechanisms and effects of ticks in eastern and central Africa, tick management and control, and tick-borne disease management were printed and distributed to stakeholders in the

GMO maize at a screen house at Kenyatta University

Research on maize for the future at Kenyatta University

region. A regional paper and a training manual for farmers on ticks and tick-borne disease management have been drafted. A paper on tick and tick-borne diseases management will be submitted to a peer-reviewed journal for publishing.

The training and distribution of information materials, have markedly improved the level of awareness on proper prevention and control of ticks and tick-borne diseases. In addition, stakeholders in Kenya, Tanzania and Uganda are in the process of engaging policy makers on policies related to tick-borne diseases control.

Healthy pigs ensure quality pork for healthy people: checking epilepsy by treating Taenia solium *in pigs*

Pig keeping and pork consumption in ECA is increasingly becoming a lucrative job. In some parts it is proving to be more rewarding than raising goats and cattle, which traditionally dominated the commercial livestock sector. Research has shown that the emerging trend is a result of a combination of factors, including lack of grazing land for ruminants and the recognition by farmers of a quicker and more worthwhile return on investment from rearing pigs.

There have been reports of a high and increasing prevalence of epilepsy, a condition caused by *Taenia solium*, a tapeworm transmitted by pigs

Unfortunately, there have been reports of a high and increasing prevalence of epilepsy, a condition caused by *Taenia solium, a* tapeworm transmitted by pigs. Human beings are infected with tapeworm when they eat raw or undercooked pork contaminated with *Taenia solium* larvae.

People suffering from epilepsy (cysticercosis) often become incapacitated, less productive and are stigmatized. In the face of this health and economic problem, ASARECA and its partners in Burundi, DR Congo, Kenya, Tanzania, and Uganda, and the International Livestock Research Institute (ILRI), initiated a project to develop, make available and promote the use of appropriate diagnostic and control tools and strategies for *Taenia solium*.

A study of the related epidemiological and impact data in ECA showed that 32% of the farmers do not know what to do when they discover that their pig is infected with the nodules. The study also revealed that 16% of the farmers opt to sell the sick pig, while 16% treat it using herbs or veterinary medicine.

ASARECA has funded the buiding of this screen house at MARI under the transformation platform project

The study also found the prevalence rate of *Taenia solium* in pigs in Uganda to be 15%. About 20%–50% of the small-holder pig farmers suffered losses because veterinary officers condemned their pigs after diagnosing them with *Taenia solium* cysticercosis. In Uganda, analysis of the blood samples collected from 242

epileptics showed that 17 were *Taenia solium* cysticercosis positive. This means that 7% of epileptic cases were caused by *Taenia solium* cysticercosis. In Tanzania, 30%–50% of the epilepsy cases were found to be positive for *Taenia solium* cysticercosis.

Through the project, a vaccination trial against *Taenia solium* has started. The vaccine being used is a recombinant one that was developed by Professor Marshall Lightowlers (Veterinary Clinical Centre, University of Melbourne, Werribee, Victoria, Australia). It was developed based on earlier evidence that immunization of sheep or cattle with antigens from infected pigs offers protection. By the end of 2010, a user-friendly diagnostic test kit for *Taenia solium* cysticercosis had been developed. Totally, 300 kits were produced and are now being tested on a number of pigs in the region.

Through the study, information on the prevention and control of porcine cysticercosis and human cysticercosis is now available. The information is crucial in developing and promoting control options among relevant stakeholders and strengthening national capacity for surveillance.

Racing against drought: Impressive progress in genetic maize research

In 2009, ASARECA reported a number of technological breakthroughs in the search for a maize variety that can withstand drought, the most consequential factor to maize production in Africa. Researchers coordinated by ASARECA successfully introgressed drought-tolerant genes into the maize genome from a desert plant, *Xerophyta viscosa*, and a model plant species, *Arabidopsis thaliana.*

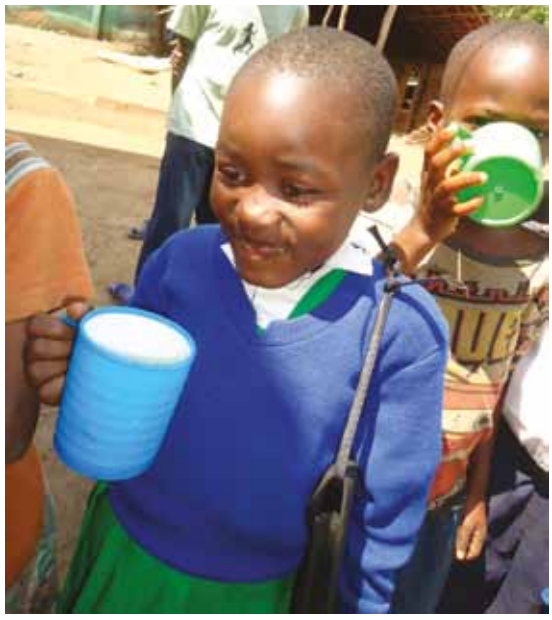
Since then, concerted efforts towards mitigating the drought challenge have continued through the project "Genetic engineering of maize for drought tolerance in ECA". These efforts yielded successful transformation of nine maize lines with drought-conferring genes. The lines are now being multiplied in a screen house at Kenyatta University, Kenya in preparation for confined field trials. They include two Ethiopian lines, three Kenyan lines, two Sudanese lines and two Tanzanian lines. They have been transformed with amiRNA1 gene, amiRNA3 gene, NHX1, PMI genes, XvPrx2 gene and CBF1 gene. One technology has focused on suppressing the expression of PARP1 gene. This is important becausethe ability of maize to withstand drought is enhanced by blocking the gene. The gene is generally muted to allow more efficient energyuse by plants in stress circumstances, including drought.

The first phase of the project will end on September 30, 2011. The seeds for on-farm-confined trials for the nine farmer-preferred tropical lines will be ready by the end of this phase. A second phase, lasting for about five-years, will be required to advance the materials for commercial release. ASARECA and partners anticipate that the new varieties, once released, will increase maize production by 70%, thereby alleviating the problem of food insecurity.

Initial stages of tissue culture maize ongoing at Kenyatta University

ASARECA attaches value to this project because maize is the most important staple food for more than 300 million people in sub-Saharan Africa. It is affected by drought, which is the single most important abiotic stress responsible for reduced maize productivity in the arid and semi-arid areas, resulting in up to 70% crop loss. Led by Professor Jesse Machuka from Kenyatta University, the project has brought together young talent in the form of PhD and MSc

QPM is an improved variety of maize, which contains twice the *Lysine* and *Tryptophan* amino acids essential for protein synthesis in humans and monogastric animals like pigs and poultry



Children enjoy nutritious QPM porridge

students from Kenya, Tanzania, Sudan and Ethiopia to champion Africa's efforts in developing and using genetic modification technologies.

Unleashing the full potential of Quality Protein Maize

It is estimated that about 30% of the children in Sub-Saharan Africa suffer from protein-energy malnutrition. Most households in Africa consume insufficient amounts of protein. They reduce or cut out protein from their diets because protein-rich food like milk, meat, fish, eggs, beans is relatively expensive compared to staple food like maize. This has led to increased malnutrition among the most vulnerable—the urban and rural poor—especially affecting the children and the elderly.

Quality Protein Maize (QPM) is one way of alleviating this situation. The technology is a result of previous research carried out by scientists in the region. QPM is an improved variety of maize, which contains twice the *Lysine* and *Tryptophan* amino acids essential for protein synthesis in humans and monogastric animals like pigs and poultry. It can meet protein requirements in a person's diet, especially in the case of children, young women, pregnant women and lactating mothers. It has 90% of the nutritional value of skimmed milk, which, according to UNICEF, is the standard for adequate nutritional value.

QPM can be consumed without supplementing with other protein sources such as fish, meat or beans. This characteristic of QPM is advantageous to poor households, which cannot afford these other protein sources. The yield from QPM varieties is equal to, and sometimes higher than that from ordinary improved maize varieties. In addition, QPM varieties come with value-addition technologies, which enables it to be used to produce various other foods for human consumption.

To unleash the full potential of QPM, ASARECA is implementing two projects: "Dissemination of New Agricultural Technologies in Africa (DONATA)" and "The development and Dissemination of Quality Protein Maize Agro Enterprises for Improved Household Income". Through the first project, started in 2008, ASARECA is promoting QPM technologies in eastern and central Africa. It is being implemented in DR Congo, Kenya, Tanzania and Uganda. The second project was conceived to increase production, nutrition, value addition and competitiveness of QPM by promoting low-cost QPM-based animal feeds, high-yielding QPM varieties and stimulating value-addition to QPM products. It is being implemented in Kenya, Tanzania, and Uganda. The projects are implemented through partnerships among NARIs, NGOs, CBOS, the private sector and CGIAR.

QPM is preferred over normal maize because it is protein-rich and has a sweet taste. People who suffer from malnutrition, especially children suffering from kwashiorkor, have been shown to recover faster when their diets included QPM

Promoting the technologies

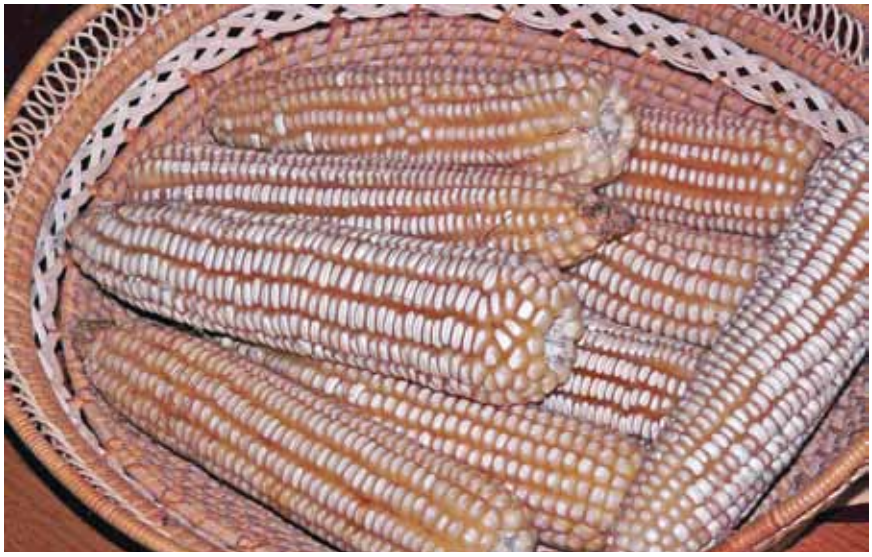
In 2009, six QPM varieties were popularized among different stakeholders in the participating countries. These were *Longe 5* and *Salongo* in Uganda, KH631Q and KH500Q in Kenya, and Lishe K1 and TAN H611 in Tanzania. Farmers reported increased QPM yields with big cobs compared to the other maize varieties. As a result, demand for QPM seed spiralled among farmers across the region. By the end of 2010, each of the four countries where QPM was being promoted had established innovation platforms, where key stakeholders like organized farmer groups, national research institutes, private seed companies, seed inspection agencies, public extension and NGOs were engaged in fast tracking QPM seed production and distribution. Depending on the country and the varieties (either open pollinated or hybrids), QPM seed was produced in the form of certified or quality declared seed and distributed through private companies or directly sold to farmers.

During 2010, Ugandan scientists distributed 7.9 tonnes of foundation seed to certified agencies for multiplication. As a result, Fica Seeds, a seed company in Uganda, produced 28 tonnes of certified seed; it made available substantial quantities of certified seed to farmers. From this seed, grain amounting to 88 tons in Bugiri, 48 tons in Iganga, 80 tons in Masindi and 40 tons in Lira were produced during the two seasons of 2010. In addition, organized farmer groups in northern Uganda produced and distributed 15 tons of seed.

In DR Congo, where no QPM varieties were available before the project, three varieties—Mudishi 1, Mudishi 2 and Mudishi 3 —were officially released in 2010 as a result of farmer participatory selection of QPM *Longe 5* material from Uganda and other materials from the International Maize and Wheat Improvement Centre (CIMMYT) and International Institute of Tropical Agriculture (IITA). About 4 tons of seed were produced.

In Tanzania, over 2 tonnes of foundation seed and 10 tonnes of certified seed were produced by Tanseed International Ltd, a Tanzanian seed company. From this seed bank, a total of 6.8 tonnes of grain was produced in Tanzania by AMINATA Quality Seeds (3.1 tonnes), Kware Lishe Group (2.2 tonnes), and Kilimo Kwanza Group (1.5 tonnes). In addition, the grain was supplied to Tanfeeds, another company in Tanzania, for animal-feed processing. Meanwhile, farmers in the Muheza innovation platform established seed plots totalling over 80 acres, which produced about 40 tons of certified seed, most of which was

QPM products on a shelf in a supermarket in Morogororo, Tanzania



Snacks made from QPM

Woman displays products from QPM

sold to Tanseed International Ltd. Farmers in Kilindi district produced 450 tons of QPM grain.

In Kenya, prisons farms were provided with certified seed through partnership between scientists at KARI and the seed company FRESCHO. They produced 0.5 tonnes of grain, in addition to 0.9 tonnes that KARI produced and 29.2 tonne that farmers in Muranga district produced, with most farmers producing an average of 1.2 tonnes per acre.

QPM is preferred over normal maize because it is protein-rich and has a sweet taste. People who suffer from malnutrition, especially children suffering from kwashiorkor, have been shown to recover faster when their diets included QPM. In the regions where it has been promoted, QPM is being increasingly used in households, schools, prisons, health care centres and orphanages. In 2010, four schools, two prisons and one orphanage benefited from QPM in the Iganga and Bugiri districts of Uganda. In Tanzania, 26 feeding programmes and two QPM villages were created; and, in Kenya, 0.2 tonnes of grain was donated to GK Prisons for feeding inmates.

A prison farm in Bugiri district, Uganda, was able to produce 256 tonnes of grain. The management fed the prisoners with a part of the harvest. The other part of the harvest was sold to generate income.

QPM can also be used make thick porridge locally known as *ugali* or *posho*. One orphanage centre in Kilosa district Tanzania serves QPM porridge every day for breakfast to its 49 inmates. The centre grows most of the QPM it uses and receives some as donations.

A number of success stories are beginning to emerge, further fuelling demand for the technology and increasing the training on utilization. Farmers interviewed in focus group discussions reported various stories of change. Virtually all of them who had grown QPM said that it was tastier and more marketable than normal maize and that they preferred to grow it than ordinary maize. On an average, farmers are realizing higher

Snacks made from QPM

Virtually all of them who had grown QPM said that it was tastier and more marketable than normal maize and that they preferred to grow it than ordinary maize

School children feed on QPM bread

yields with QPM. For example, in Gulu district, Uganda, farmers reported increased yields of 2-3 tonnes per ha with *Longe 5* compared to 0.6–1 tonne per ha from ordinary maize.

QPM Agro-enterprises

Information is beginning to reach a fair proportion of farmers and stakeholders about the nutritive benefits of QPM, and the different value-added products that could be produced for home consumption. QPM-based products such as flour, confectioneries like cakes, cookies and biscuits, *mandazi*,*samosa* and animal feed are being actively promoted through agricultural shows, trade fairs, local FM radio channels, field days and promotional materials like leaflets and fliers. During 2010, in Kenya, information regarding QPM products was disseminated among an estimated 3,000 stakeholders; in Tanzania the number was 12,500; in Uganda over 700; and in DR Congo about 200 people.

Capacity building has also been an integral part of the QPM projects and focuses on imparting skills to farmers and other end-users on QPM grain production and preparation of the various value-added products for human consumption. Nearly 1,400 farmers and over 500 TOTs were trained in 2010 in QPM grain production and use. Overall, 25 QPM recipes were developed in the region. A recipe book is being prepared to enhance the use of the QPM grain by end-users, especially entrepreneurs. The publication will be out soon.

The project has reported increased production and use of QPM products as a result of the improved access to QPM seed, information and training in new technologies, including training in the use of the various recipes.

QPM flour can now be found in some local markets and supermarkets in some of the countries where the project is being implemented.

QPM benefits have also spread to livestock feeding. In 2010, the seed company Tanfeeds International formulated two diets for poultry using QPM grain. Farmers reported that poultry fed on QPM formulations grow faster and gain 10% more weight than those fed on ordinary maize feed. Meanwhile, in Kenya, about 1.21 tonnes of grain was used for chicken feeding trails in KARI, Embu district. The result was equally impressive.

Production of seed and grain, and consumption of meals and other products prepared from QPM is increasing. In the DR Congo, awareness and interest in QPM technologies and the nutritive benefits has increased tremendously. Communities in the two districts neighbouring the ones where the project started have expressed interest in the technologies.

With three varieties released in 2010 and efforts to enhance seed production underway, dissemination and access to the technologies is expected to spread to the new areas. In Uganda, several more seed companies now have access to breeder and foundation seed. Of all the participating countries, Tanzania is perhaps the one country that is well advanced in enhanced access and use of QPM technologies. In the three participating districts of Muheza, Kilindi and Kilosa, the area under QPM seed and grain production is growing rapidly.

The demand for QPM-based food products in the market has led to the creation of a production-consumption chain for QPM. QPM products are marketed by various enterprises, including high-end outlets like supermarkets, offering a win-win situation for every stakeholder, be it a scientist, seed grower, farmer, processor or consumer. There is no doubt that the opportunities that QPM offers to the region are immense, and its production and use needs to be scaled up as quickly as possible so that other regions also benefit.

Quality protein maize

Farmers reported that poultry fed on QPM formulations grow faster and gain 10% more weight than those fed on ordinary maize feed

African indigenous vegetables: a profitable business for smallholders

African indigenous vegetables (AIVs) are becoming significant contributors to household nutrition and income. The demand for AIVs in rural and urban markets has soared over the last two decades outstripping the supply in most countries in the ECA sub-region.

A farmer processing improved indegineous vegetable seed

Nutrition experts say that eating African indigenous vegetables contributes to micro-nutrient intake in a way that exotic vegetables do not

Nutrition experts say that eating AIVs contributes to micro-nutrient intake in a way that exotic vegetables do not. AIVs, notably African nightshade, amaranth, crotalaria, spider plant, jute mallow and African eggplant, have become very popular among consumers in the sub-region, especially in Kenya, Uganda, Tanzania and Rwanda. Research indicates that, in Kenya, AIVs account for 30% of all vegetables sold, most of which are produced by smallholders, often women and the youth.

However, production of AIVs is hampered by limited supply of quality seed. This is because observing the growing demand for these vegetables and the problem of seed supply, farmers ventured into AIV seed production using local and traditional technologies. They produced seeds, which they sold informally in local markets or on-farm. Such seeds were often of poor quality and did not meet the recommended standards. Most of the seed farmers lacked access to the various improved seed varieties coming from the research institutes. These limitations were revealed in a study commissioned by ASARECA, in 2008, to identify viable smallholder AIV seed enterprises that could be scaled up. Following this study, a project entitled, "Scaling up farmer-led seed enterprises for sustained productivity and livelihoods in eastern and central Africa", was started in December 2009. The project, covering Kenya and Tanzania, aims to increase smallholder access to quality AIV seeds that can be sustainably produced. It supports organized farmer groups who are keen on transforming themselves into commercial AIV seed enterprises. Others involved in this project include research institutions, NGOs, private seed companies and seed quality regulatory organizations.

CABI Africa is the lead institution in this project. Other collaborators include KARI Kisii, Kenya Seed Company, Horti-Tengeru, Inades Formation Tanzania and Tanzania Official Seed Certification Institute (TOSCI). Most of the Kenyan farmers in the project belong to a CBO in Nyanza called Technology Adoption through Research Organization (TATRO). The goal of the project is to improve the livelihoods of smallholder farmers. The project has an action research and learning orientation focus and aims at facilitating seed access and adoption through different seed production and marketing models. The project is a year old, and farmers are ambitious to exploit the opportunity to become viable AIV seed producers and merchants. Mr. Paul Okon'go, a retired teacher and the chairperson of TATRO, is convinced that farmers have clearly identified an opportunity, which they are determined to exploit. However, they require access to improved technology. He observes that, "the small-

holders have discovered a market for the indigenous vegetables, but they need seeds that produce high yields and are disease free." They also require capacity development not only in seed production but also in practical business and entrepreneurial skills.

The project has identified and characterized three models for production, bulking and distribution of AIVs: (i) A formal system that involves a private seed company and where smallholders are engaged as contracted seed growers. In this model, the seed company may produce its own foundation seed (as in Kenya) or it may obtain the foundation seed from a government agency (as in Tanzania). (ii) A semi-formal system where organized farmer groups obtain foundation seed from a research institution and are assisted in producing quality seed under inspection by a seed quality agency such as Kenya Plant Health Inspectorate Service (KEPHIS) in Kenya or TOSCI in Tanzania. (iii) An informal system, where individual farmers retain seed from their own crop. These models provide various entry points for farmers to be AIV seed growers. The project is working with farmers across these models with the objective of developing their capacity and linking them to research institutions, certification agencies, the private sector and the market for AIV seeds.

In Kenya, 283 (131 male and 152 female) farmers, organized into 8 farmer groups, are participating directly under TATRO. Around 185 (110 male and 75 female) farmers, organized into 4 groups, have secured contracts with the Kenya Seed Company to produce seeds of various AIVs.

The groups under TATRO receive technical support from the KARI seed unit. The project has identified capacity building needs and has prepared a draft training curriculum, which is being reviewed to produce training manuals. Through participatory approaches and market analysis, five AIVs have been identified and are being given priority when it comes to the development of the seed enterprises. In Kenya, the AIVs were ranked from top to bottom as follows: African nightshade, Amaranth, Crotalaria, Spider plant and Jute mallow. In Tanzania, Amaranth was ranked highest, followed by the African eggplant and then the African nightshade.

Though the project is barely a year old, the farmer groups have started to produce seed and to market their yield through the media and at agricultural shows.

Spider plant at flowering stage

Traing on AIV production

Through participatory approaches and market analysis, five AIVs have been identified and are being given priority when it comes to the development of the seed enterprises

Amaranth

Researchers share experiences with amaranth farmers

Processing amaranth

Training on amaranth processing

AIVs, notably African nightshade, amaranth, crotalaria, spider plant, jute mallow and African eggplant, have become very popular among consumers in the sub-region, especially in Kenya, Uganda, Tanzania and Rwanda

Preparing amaranth seed

Dried amaranth prepared by trainees

Amaranth soup

Enhancing agricultural productivity through policy options

Expanding benefits from cassava and potato by harmonizing quality standards

Cassava and potato have been identified as crops with a potential to reduce poverty and spur growth in ECA. The NEPAD has launched a Pan African Cassava Initiative that seeks to tap the enormous potential of the crop for food security and income generation. Consequently, cassava has been prioritized as a strategic commodity in the CAADP as a means to increase food supply, reduce hunger and improve responses to emergency food crises.

Market failure is one of the topmost constraints in realizing the potential of root crops such as cassava and potato. These market failures are manifested in the lack of key institutions and frameworks to enhance efficient marketing along the commodity value-chain. Most countries in ECA lack the standards necessary for commercial utilization of cassava and potato.

Cassava and potato have been identified as crops with a potential to reduce poverty and spur growth in ECA

Further, value-addition technologies, though well developed for some products, are still under-utilized due to a lack of clear guidelines on standards and supportive policies. Efforts by key stakeholders in the value-chain are disintegrated with no clear partnership structures, which are crucial to a well-functioning producer-to-market value-chain.

Cassava and potato are perishable, high-volume, low-value commodities in their raw state. This undermines their position in the market. Processing would improve storability; reduce unit marketing costs; and ultimately stabilize prices received by farmers for their food produce. Value addition through product development can enable smallholders to access different niche markets. The good news is that technologies like waxing, fermenting, application of fungicides and storage in plastic bags are able to minimize loses.

Healty cassava plant

When dried, chipped, or converted into flour, cassava has a longer shelf-life, allowing longer-distance marketing. A major challenge for cassava producers and processors is access to markets and creating interest in new market opportunities through product diversification in the form of high quality cassava flour; improved

and more convenient versions of traditional processed products; starch and sugar syrups; energy drinks; use in livestock feed rations and use in bio-ethanol production. High quality cassava flour is of particular interest because it can substitute wheat flour in pies, pastries, cakes, biscuits and doughnuts. It also has some industrial applications.

To enhance the value of cassava and potato, conducive policy frameworks that support commercialization of these crops are necessary

To enhance the value of cassava and potato, conducive policy frameworks that support commercialization of these crops are necessary. In pursuit of this objective, ASARECA, in 2006, initiated a project on development of standards for root crops in the region. The work was continued, in 2008, through the "Rationalization and harmonization project". The project's aim was to harmonize standards of root crops to allow the inclusion of cassava and potato products in the production of industrial products, for example, in confectionery and animal feed, and promote trade in cassava and potato products. The project is aligned to the cassava mega-project of ASARECA: "Unlocking the potential of cassava in ECA", which pursues interventions along the whole cassava value-chain.

The Uganda National Bureau of Standards (UNBS) spearheaded the process of development, harmonization and gazetting of regional root crops standards, focusing on cassava and sweet potato in 2006. UNBS compiled a list of 14 proposed standards, and using the EAC template, formally sent the list to the other four countries as zero drafts for consideration and adoption as regional standards. This proposal was tabled before the EAC Standards technical sub-committee and approved at a meeting held from November 23 to 25, 2009 in Arusha, Tanzania.

Using its vantage position as a sub-regional research organization, ASARECA supported the technical departments of the standards bureaus of Burundi, Kenya, Rwanda, Tanzania and Uganda to convene national consultative workshops to discuss the zero drafts during November and December 2009.

In early 2010, UNBS collated the comments and prepared them for discussion at a regional forum from March 22 to 24 2010, in Kigali, Rwanda. Participants included representatives from the national standards technical committees, the IITA, the International Institute for Potato Research, cassava and potato researchers, and a representative of Uganda's parliamentary committee on agriculture and environment.

Healthy and good looking cassava

Some consumers buy the cassava directly from the field

Cassava field

Eleven draft standards were presented to the Eastern Africa Standards[1] (EAS) technical sub-committee at a meeting in Arusha from May 10 to 12, 2010. The committee recommended the adoption of the standards by the EAC council of ministers, which was done. The following are the harmonized standards:

1. EAS 738: Fresh sweet cassava specification
2. EAS 739: Dried cassava chips specification
3. EAS 740: Cassava flour specification
4. EAS 741: Cassava wheat composite flour specification
5. EAS 742: Food-grade cassava starch specification
6. EAS 743: Cassava crisps specification
7. EAS 744: Cassava determination of total cyanogens
8. EAS 745: Potato crisps specification
9. EAS 746: Frozen potato chips specification
10. EAS 747: Fried potato chips specification
11. EAS 748: Fresh (ware) potato specification

According to the EAC Standardization, Quality Assurance, Metrology and Testing Act 2006, within six months of the declaration of a standard, the partner states have to adopt it as a national standard and withdraw any pre-existing national standard with similar scope and purpose. Efforts are currently underway to support implementation of the standards at the national level.

Following these developments, opportunities for farmers in Kenya, Tanzania, Uganda, Burundi and Rwanda are set to expand as they access improved varieties and processing technologies, and improve their competitiveness to tap into the growing food market locally and internationally.

1. The standards were published in *the EAC Gazette. 2010. Declaration of East African Standards. Legal Notice no. 22. Vol. AT – 1. No. 007. Arusha 16 July 2010.*

Case study 3

Breaking barriers: Stimulating regional seed trade through common policies

For decades, seed trade in ECA has been a nightmare. Procedures for seed variety tests and approval, phytosanitary (plant health) inspections, certification, and plant variety protection have for long hindered seed trade, resulting in slow adoption of new seed varieties beyond national boundaries.

Seed trade procedures were generally designed to meet the needs of public research institutes and state-owned seed enterprises within countries. This led to delays in release and often rejection of useful varieties that did not meet the criteria and procedures of other countries. A public variety released in one country faced long battles to gain release in a second country. Phytosanitary regulations that were not based on scientific evidence further restricted possibilities for trade. Commercial seed trade was also hampered by lack of intellectual property protection for plant varieties and by different procedures for import and export of seed.

It is against this background that the ASARECA seed policy harmonization project was initiated in 1999. The project, in its pilot phase, undertook wide-ranging analyses of the seed systems in Kenya, Tanzania and Uganda in an effort to rationalize and harmonize the regulatory and legal frameworks governing the seed sector in ECA. This was followed by national and regional activities, leading to an agreement for policy reform and mechanisms for coordination and implementation in 2002. By 2004, the initiative had expanded to other ASARECA member countries: Burundi, DR Congo, Eritrea, Ethiopia, Rwanda, Madagascar and Sudan.

The Eastern Africa Seed Committee (EASCOM) comprising representatives of the private sector, breeders associations, regulators and policy makers in each country was formed. EASCOM was mandated to spearhead the operationalization of the agreement. This included reviewing policies, laws and regulations, strengthening national seed associations, setting up a regional seed database, and capacity building. EASCOM represents the seed sector in the EAC and the COMESA.

This initiative provides an excellent example of how collective action involving public and private sector partnerships, as championed through EASCOM, could lead to harmonization of procedures across borders, thus addressing anomalies in the policy environment for trade.

Policies, procedures reviewed

The project facilitated technical seed working groups, joint seed certification exercises and a review of seed policies and regulations through EASCOM. This resulted in the revision of certification procedures; development of regional seed standards, quarantine pest lists; publication of variety lists; harmonization of variety release and registration procedures; and harmonization of import/export procedures in Kenya, Rwanda, Tanzania and Uganda.

Initially, only Kenya had a Plant Variety Protection (PVP) system. The focus on harmonization resulted in the PVP Act of 2003 in Tanzania and a draft PVP Bill for Uganda. Tanzania and Rwanda enacted the Seed Acts in 2003 and 2004, respectively. In Sudan, the seed law was revised in 2006. These policy reforms have translated into tremendous benefits in trade and welfare terms.

Strengthening the associations

Business plans for seed traders associations in Burundi, DRCongo, Sudan, Rwanda and Tanzania were developed, which further strengthened the associations. Burundi reviewed existing guidelines for implementation of the Seeds Act (2003) and the Plant Breeders Act (2002). The acts became operational in Tanzania with the

establishment of the TOSCI to manage seed testing and quality. Kenya endorsed revised regulations for variety release and registration in 2009 and launched the national seed policy. These changes enable greater participation of the private sector by providing for accreditation of some functions of the national certification agency to the private sector. This move was also embraced in Burundi's new seed legislation.

Private sector comes on board

With the liberalization of the seed sector in Uganda, entrepreneurs were encouraged to establish seed companies, and more agro-input dealers entered the market. Today, there are 23 companies engaged in seed growing, processing and marketing as well as selling agro-inputs like fertilizers, agro-chemicals and farm equipment in Uganda. Of them, 18 are members of the Uganda Seed Trade Association (USTA). This growth in private sector participation has been replicated throughout the region. By 2009, Burundi had three seed companies, two of which are privately owned. Ethiopia had 30 active seed companies, with 24 of these in the hands of the private sector. Of Kenya's 74 seed firms, 70 were privately owned; while Tanzania had 30 private seed firms, with one state-owned firm.

John Baptist Bbosa, a farmer, has been growing hybrid maize seed on an average of five acres and rice seed on three acres for NASECO for over 10 years. He says his livelihood has improved with the company's growth. He now owns a herd of cattle and pigs. He has also built a permanent house and all his children are studying in good schools.

Some level of regulation is now privately managed. USTA have introduced a tamper-proof system of seed labels to check trade in fake seeds. The system was expected to start functioning at the end 2010. It is expected to provide information on seed production, which will be captured in a database that will, in turn, generate information based on the number of labels issued.

Similarly, the involvement of the private sector in variety breeding has greatly improved compared to the situation before 2000. For instance, out of the total of 140 seed varieties released for commercialization in Kenya between 2000 and 2008, 43 of them (30.7%) represented varieties bred by the private sector, while 77 varieties (55%) were bred by NARIs, including KSC. The varieties released under collaboration with CGIAR were 20 (14.3%). In Uganda, 27 new varieties were released between 2000 and 2007 and, in Tanzania, 121 new varieties were released in the same period. Obviously, this was a marked improvement compared to the eight and 27 seed varieties that were released before 2000.

Seed companies employing farmers

Seed production and export companies in Uganda like Nalweyo Seed Company (NASECO) Limited, FICA Seeds Limited and Victoria Seeds Uganda Limited, which are participating in the ASARECA seed initiative through their umbrella body, USTA, have also reported increasing participation of ordinary farmers in seed production as out-growers.

NASECO and FICA are operating on 150 and 1,000 hectares of land respectively. The companies employ 60 people on an average, excluding casual labourers. They also involve farmers in managing specific requirements for seed production as out-growers.

NASECO has about 500 individual seed out-growers who produce seed on their own land. FICA has several block farms. One of the farms in Kisindi, in Masindi district, has about 300 contracted seed growers on about 1,000 acres of land.

Spreading benefits to former Internally Displaced Persons

Victoria Seeds is piloting a social entrepreneurship model in northern Uganda, a post-conflict area, which is largely considered unprofitable by financial institutions. In 2008, the company signed up with 214 contract

growers. The number has since grown to 912 farmers, who operate in farmer field schools. They are trained and provided credit and tractor-hire services. The farmers manage the credit, while the company works out models to link them to microfinance institutions in the long run. It is estimated that about 160,000 households have benefited from the company's operations.

Local seed production in Uganda, Kenya and Tanzania tripled from 43,000 to about 122,000 tonnes between 2002 and 2008. Seed imports into the region almost doubled from 9,000 to about 15,000 tonnes over the same period. As a result, intra-ECA seed trade grew more than three times. In Kenya and Uganda, exports increased from less than 1,000 tonnes to more than 3,000 tonnes in the same period. Additionally, private sector involvement in variety breeding and release helped increase the number of high-performing seed varieties in the market.

A rationalized and harmonized seed policy regime has boosted seed quantities exported to the neighbouring countries of southern Sudan, Rwanda, Burundi and DR Congo. The increased demand for seed in the region as a result of more open borders has enabled the participation of a larger number of farmers through out-grower schemes.

Certification scheme for tissue culture planting materials

Recent efforts to increase agricultural productivity have included strategies for conservation and sustainable use of plant genetic resources. In the ECA sub-region, some countries collect and conserve their genetic resources in gene banks. These genetic resources can be shared with other countries to increase the productivity of their agricultural system. However, the importation of planting materials, especially those with vegetative propagation material and seeds, often greatly increases the risks for new pests and diseases.

To transfer plant germplasm across borders, certain phytosanitary regulations need to be followed. Seed certification is a system that provides assurance to seed buyers and importers that the seeds being purchased are what they are represented to be by the producer or seller. This phytosanitary system is well developed for seed, and a functional seed certification scheme exists in all the countries in ECA.

A collection of some of the seeds that are being conserved at NARO, Uganda

The scope of this certification system, however, does not extend to vegetatively propagated plants and seedlings produced by tissue culture technology. Infected seedlings or planting materials are easily transported to new areas, resulting in the invasion and establishment of new pests and diseases in another country. Hence there is an urgent need to develop a certification system for vegetatively propagated plants and seed materials produced by tissue culture.

To guarantee the supply of good quality planting materials especially for crops like banana, cassava and sweet potatoes, it was important that a system of certification and standardization of planting

Plant genetic resources conservation in Sudan

To guarantee the supply of good quality planting materials especially for crops like banana, cassava and sweet potatoes, it was important that a system of certification and standardization of planting materials be established

materials be established. This would support phyto-sanitary regulations for importing vegetatively propagated materials and germplasm exchange. It would promote access to an adequate supply of clean planting materials, which was necessary for increased agricultural productivity.

ASARECA, in partnership with Agrogentic Technologies Limited, African Biotechnology Harvest Foundation International and the Ugandan ministry of agriculture animal industry and fisheries sought to develop a certification system for the safe exchange of tissue-culture planting materials.

By the end of 2010, a draft certification scheme to enhance the use of tissue culture application in the ECA sub-region had been produced. It complies with national and international standards and regulations to guarantee the quality of planting materials. This process basically involves assessing the risks (pathogens and pests), selection of clean-planting material, virus testing, micro propagation and tests for genetic fidelity. Only plants that are produced as per the directive of the scheme are certified.

A Regional Accreditation and Certification System (RACS) has been proposed to provide an organized structure for the certification and maintenance of quality standards. This will enhance safe movement of the germplasm of micro-propagated plants. The modalities suggested for implementation include:

Plant genetic resources of medicinal nature

Storage facilities for plant genetic resources

Clean planting materials produce plants like this

I. Accreditation of laboratories and certification of production facility
II. Certification of micro-propagated plant production facilities
III. Standards for production of micro-propagated plants
IV. Criteria for accreditation of laboratory facilities for virus diagnosis/ quality testing of micro propagated plants
V. Standards for certification of micro-propagated plant production units
VI. Certification of tissue culture plants

Exploiting market opportunities for value-added dairy and meat products in ECA

FAO statistics show that the eastern and central African countries are net importers of dairy and meat products. This means that the domestic dairy and beef industries are not meeting local demand for value-added dairy and meat products.

Most of the milk and meat is traded in informal, traditional markets, with little or no value addition. At the same time, supermarkets and tourist hotels are rapidly expanding in the region. These high-end markets demand high quality and safe value-added products. Small and medium-scale producers and processors can play a significant role in bridging the demand–supply gap for value-added products in the region.

To respond to these challenges and opportunities, ASARECA initiated a project to enhance the performance of the livestock sector in Ethiopia, Kenya, Rwanda and Uganda. The project aims at promoting policies that increase value addition in the dairy and meat sub-sectors. It also aims at strengthening the capacity of smallholders and small and medium enterprises (SMEs) to engage in the dairy and meat markets in the sub-region.

ASARECA initiated a project to enhance the performance of the livestock sector in Ethiopia, Kenya, Rwanda and Uganda

To understand the market structure and performance, rapid market assessments for the dairy and beef value chains were conducted in the capital cities and one regional town in each country in 2010. The assessments were followed up with in-depth consumer studies designed to elucidate consumer demands for quality and safety of milk and dairy products and beef.

The assessments were complemented by proof of concept and risk analysis studies for safety of milk and beef traded in informal markets. This was done using identified microbiological food safety hazards such as toxin producing *Staphyloccus aureus* in milk and thermophilic *Campylobacter spp.* in roast beef in Tanzania.

In Kenya, studies on milk payment systems based on quality, and handling practices in beef abattoirs to minimize contamination are ongoing.

Results of the assessment in Tanzania showed that most consumers bought their meat from a local butcher rather than a supermarket or grocery. Income differences did not seem to influence choice of type of meat or market source of meat consumed. These results mirror those of Ethiopia and Kenya. Results of conjoint analysis of consumer willingness to pay for quality and safety of milk in Kenya, showed high willingness to pay for unadulterated, clean and creamy milk as well as packaged and labelled milk. There were variations across sites and income strata.

The food safety risk analysis studies conducted in Dar es Salaam and Arusha, in Tanzania, showed that *S.aureus* was prevalent in 23.2% of producer-level raw milk, and the probability of purchasing boiled milk served hot, and contaminated with the pathogen was 0.2. The study on raw beef, *"nyama choma"* (roast meat) and *"mishikaki"* (meat skewers) showed a contamination rate with Campylobacter of 24% on raw beef and probabilities of consuming contaminated meat with Campylobacter at *"nyama choma"* pubs was 15.5% and at *"mishikaki"* shops was higher at 34.7%. A similar study of *S.aureus* in milk was conducted in Ethiopia, revealing prevalence rates of *S.aureus* in raw milk to be 43% and 5% in cottage cheese.

Appropriate feeding for high milk yield

In 2010, policy analysis studies conducted in all the countries revealed differences in the regulatory environment for the two commodities milk and beef. Milk attracts a higher proportion of informal trade practices and more stakeholder concerns regarding an unfavourable business environ-

Milk attracts a higher proportion of informal trade practices and more stakeholder concerns regarding an unfavourable business environment caused by overlap of functions of several regulators compared to beef

Appropriate livestock feeding practices increase milk yield

ment caused by overlap of functions of several regulators compared to beef. Gender studies showed how cultural norms have influenced lower extent of involvement of women in beef value chains compared to dairy across the four countries.

In the previous year, the project identified capacity building needs for producers, traders and processors. The major skills required were proper feeding of dairy cows for farmers and basic hygienic practices for traders and small-scale processors. These were addressed during the reporting period by training farmers and other value-chain actors. In Uganda, 203 value-chain actors were trained in 2010.

Hundreds of target farmers in Kilimanjaro/Arusha highlands have responded to simple innovations such as improved methods of planting Napier grass, use of hay box baler, in-plastic bag silage making, and use of hay rack in hay making during the rainy season. Training in use of the Hazard Analysis Critical Control Point (HACCP) system was conducted in 2010 to improve the quality of sausages made by a small-scale meat factory in Arusha, Tanzania. It set an example for the food industry SMEs and showed that HACCP could be implemented if the management was committed. In Uganda, owners of a small-scale abattoir and roadside meat vendors want to stay and grow in the business and have demonstrated willingness to innovate and comply with regulatory requirements.

These finding have significant value-chain hygienic practices, public health and policy implications. If these factors are improved, they can positively impact the livelihoods of millions of smallholder farm families and consumers across the region.

The pilot studies provide lessons and examples that can be upscaled to wider communities in the study countries and in the region. The major lessons being:

1. Improved and hygienic methods of roasting beef
2. In-bag silage making
3. Use of a hay rack for making hay during the wet season when grass is abundant
4. Application of HACCP in quality assurance for value addition to livestock products by SMEs

At the farm level, the enthusiastic response to the project intervention and results show that farmers and other value-chain actors need constant support from service providers for them to constantly innovate.

Catalysing agricultural research through capacity development

Catalysing agricultural productivity through EAAPP

In 2009, while world food prices were skyrocketing and rendering poor families across the globe uncertain of their next meal, a project with the potential to rekindle hope in the desperate women, children and men was being drawn up—the East African Agricultural Productivity Programme (EAAPP). EAAPP is a regional initiative where four countries, Ethiopia, Kenya, Tanzania and Uganda, are scaling up national research programmes into Regional Centres of Excellence (RCoE). The national programmes manage investments with regional objectives to foster agricultural development. The four governments signed agreements to implement EAAPP with the support of ASARECA and the World Bank.

A RCoE is a leading agricultural technology programme with the capability to: establish research and training initiatives; forge partnerships; and develop innovations with businesses, non-governmental organizations, universities, and farmer organizations. It has highly skilled staff who are able to spearhead sub-regional initiatives and link them to the international agenda. Further, these centres have high quality research facilities and are equipped to manage projects.

Dairy, cassava, wheat and rice top of the agenda

Kenya is the centre of excellence for dairy, Uganda for cassava, Ethiopia for wheat and Tanzania for rice.

In all the countries, the agricultural sector faces challenges, notably the absence of adequate improved technologies for farmers and fragmented research efforts across small programmes. RCoE will facilitate better use of scarce expertise and resources that are scattered across the sub-region by sharing resources, knowledge and technologies among EAAPP countries through the existing mechanisms championed by ASARECA. They are programmed to coordinate with each other to reduce the barriers of movement of technologies across borders. By the end of 2010, three countries, Kenya, Tanzania, and Ethiopia, had officially launched EAAPP. Uganda was set to launch early 2011 following endorsement by its parliament.

In 2009, while world food prices were skyrocketing and rendering poor families across the globe uncertain of their next meal, a project with the potential to rekindle hope in the desperate women, children and men was being drawn up—the East African Agricultural Productivity Programme (EAAPP).

Research benefits to increase

EAAPP was designed to expand production of selected priority commodities, which had been identified by ASARECA as being of importance in fighting hunger and malnutrition. It is informed by the realization that the spillover of research benefits across national borders can increase rates of return. Statistics show that investments yielding regional benefits in African agriculture deliver as much as three to four times the gain over and above the direct benefits in the country of origin.

ASARECA considers RCoE as an excellent opportunity for transforming the sub-region's agriculture from subsistence to innovative, productive, commercially oriented and competitive agriculture.

Expanding Africa's agricultural research agenda

Given the expertise in coordinating regional research for development, extension, training and education, ASARECA was responsible for coordinating, networking, technical backstopping, monitoring and evaluation, policy harmonization and advocacy, capacity building, training, and management of EAAPP to facilitate spillovers of technologies and innovations generated through EAAPP. In 2010, ASARECA convened two sub-regional meetings of EAAPP to refine the roles and responsibilities of ASARECA in the programme, as well as to agree on the modalities for cooperation amongst the participant countries.

Why cassava, wheat, dairy and rice?

Cassava

Cassava is important for food security, and commercial applications. It is a staple crop for more than 200 million people and is the second most important food crop in Africa after maize. The Abuja Declaration (2006) identified cassava as one of the crops with the greatest potential to combat poverty and food and nutrition insecurity in Africa. Four of the ten ASARECA countries, namely DR Congo, Tanzania, Uganda and Madagascar, are among the top 10 world cassava producers after Nigeria, Brazil, Thailand and Indonesia. DR Congo produces approximately 16 million tonnes, Tanzania approximately 5 million tonnes, Uganda approximately 5 million tonnes and Madagascar approximately 3 million tonnes.

Overall, more than 30 million tonnes of cassava is produced annually in eastern and central Africa, which is more than any other staple crop. On an average, between 1961 and 1999, the value of cassava production (over US$2 billion annually) was the highest among all crops produced in the ASARECA region. Apart from obviously being a major staple food crop in most African countries, cassava has a range of domestic and industrial uses. Cassava is used to make glucose, fructose, lactose, and is a substitute for sucrose in making beverages, jams and canned fruits. It is mixed with active pharmaceutical materials to make capsules and tablets.

In homes and livestock farms, it is used as an ingredient in animal feeds. It is also used to produce liquor, and industrial and medical alcohol. Cassava starch is widely used in the production of foods such as instant noodles, tapioca pearl and seasoning sauce. Other uses include sizing yarn during the making of cloth; pressing, flattening and polishing paper; and high-quality glue for plywood binding. Cassava starch can also be mixed with biodegradable polymer to produce packaging material.

Cassava field infected with cassava mossaic disease

Cassava faces major production constraints and these mainly arise from pests and diseases, particularly cassava mosaic disease (CMD), cassava brown streak disease (CBSD), cassava bacterial blight (CBB), cassava mealy bug and cassava green spider mite. It is estimated that losses due to CBSD were above US$100 million in 2003. These pests and diseases need to be checked. Other research areas that the cassava centre of excellence will address include improving the root nutritional quality of cassava,

containing post-harvest physiological deterioration and increasing drought tolerance. Uganda is seen as a leader in the region in developing disease-resistant varieties, training and dissemination of technologies.

Wheat

Although wheat production is relatively limited in the region, CIMMYT has projected that the demand for wheat in Sub-Saharan Africa will rise from 9.4 million metric tonnes in 1997 to 19.1 million metric tonnes in 2020. Much of the demand is expected to be met by imports. Current production in East Africa is estimated at 2 million metric tonnes. Wheat production has the potential to expand in the region and is relatively profitable.

Dairy

Demand for dairy products is high within the region and is expected to grow, particularly in urban areas. EAC and COMESA have identified the regional dairy market as an area of high potential for increasing regional trade. In 2006, the value of actual regional trade was estimated at US$8.2 million compared to a potential market of value of US$139 million.

Dairy is a high priority for ASARECA countries and has emerged as the commodity with the highest potential for regional impact in recent assessments by ASARECA. Kenya has a strong dairy industry and has demonstrated success in breed improvement, disease control and nutrition. Other EAAPP countries will be collaborating with Kenya in technology sharing across the region.

Rice

Rice is an important staple that contributes to domestic food supply and acts as a food and cash crop in Sub-Saharan Africa, where it is grown on 8.5 million hectares. Almost all of the countries in the region grow rice. In most of these countries, more than 40% of the population lives in poverty.

Rice demand is increasingly out-stripping supply in Africa, unlike Asia, where per capita rice consumption is declining. In sub-Saharan Africa, in 2003, rice consumption grew by 3.2% compared with an annual production growth of only 2.4%. As a result, rice imports have grown rapidly.

Rice growing in Morogoro, Tanzania

Rice is an important staple that contributes to domestic food supply and acts as a food and cash crop in Sub-Saharan Africa, where it is grown on 8.5 million hectares

The share of imported rice in Sub-Saharan Africa compared to total rice consumed grew from 32% in 1990 to 45% in 2003. While the volume of imports increased at a rate of 5.6% per year. Sub-Saharan Africa now accounts for a quarter of the global import market and has some of the world's largest rice-importing countries. In 2003, 11 sub-Saharan countries imported more than 200,000 tonnes of rice.

The large expenditure on rice diverts financial resources that could be used to fund much-needed infrastructure development. Therefore, increase in rice production could enhance food security and save foreign exchange.

However, efforts to increase rice production and productivity in sub-Saharan Africa have been limited. The area planted with rice increased from 3.5 million hectares in 1970 to 8.5 million hectares in 2004, but the average rice yield remains low at 1.5 tonnes per hectare (t/ha).

Initial successes in the development and dissemination of rice technologies in the sub-region – such as New Rice for Africa (NERICA) varieties – show strong potential for scaling up. Tanzania has made rice production a strong national priority and has a strong network of research and development institutes for rice research. Other ECA countries will be working with Tanzania in conducting research in rice technologies under EAAPP.

Nurturing skills: The first batch of agricultural information and communication management professionals graduate

Research in Africa has generated agricultural technologies and innovations that can improve food security. But the impact was not felt in many households due to poor information dissemination. Well-planned communication of such knowledge can accelerate adoption of agricultural technology and innovations by a critical mass of farmers and industry; improve development planning; support agricultural marketing; and empower and enlighten communities with sound techniques for managing natural resources. However, institutions that engage in agricultural innovation have inadequate human capacity to organize and package it in the right form and disseminate it to the intended audiences. These institutions are slow to adopt information and communication technologies (ICTs), which, if properly used, can assist rural communities and other stakeholders to access appropriate information at the right time.

Between 2006 and 2007 ASARECA developed a postgraduate programme in agricultural information and communication management (AICM). The programme was a response to identified lack of skills in ICT and information and communication management (ICM) as a key intervention to support agricultural research and development for food security, and ultimately poverty reduction. The first of its kind in Africa, the programme was meant to enhance the competency of professionals in the agricultural field and other development workers in managing and communicating agricultural information. It also sought to strengthen the capacity of universities to provide high-level education and research services in AICM.

ASARECA then partnered with the Regional Universities Forum for capacity building in agriculture (RUFORUM) to implement the AICM programme. RUFORUM

Growing vegetables in small domestic plots following advice by scientists

worked with Egerton University in Kenya, in 2007, to implement the MSc degree in AICM. The University of Nairobi, Kenya, also went ahead to implement the programme.

Through the Strengthening the Capacity for Agricultural Research and Development in Africa (SCARDA) project, in 2007, ASARECA sponsored some students in the first batch to pursue the MSc course in AICM at Egerton University. Initiated by the Forum for African Agricultural (FARA) and the Department for International Development (DFID), a key component of SCARDA in the ASARECA region was sponsoring young and up-coming researchers from NARIs to undertake selected post-graduate courses in local universities.

The MSc in AICM was selected as one of the courses for which scholarships would be provided under SCARDA. Eight of the thirty-four SCARDA-sponsored students undertook this course at Egerton University, Kenya. They were from DR Congo (2), Uganda (2), Ethiopia (1), Kenya (1), Sudan (1) and Zimbabwe (1). By the end of 2010, six of the eight had submitted and defended their dissertations.

The students developed concepts to use information management skills to boost agricultural research in their organizations

The students developed concepts to use information management skills to boost agricultural research in their organizations. Some of the areas they worked on were: designing databases/reference systems for specific crops (Nada Siddig, Agricultural Research Centre, Sudan); effective communication for impact; communicating research findings to stakeholders (Manaye Simachew, Ethiopian Institute of Agricultural Research); strengthening vegetable value chains by working with local organizations (Caroline Sibomana, the DR Congo); upgrading information centres; and developing and posting modules on websites for different audiences (William Zendera).

The AICM scholars are participating in the on-going mentoring and coaching initiative initiated by SCARDA. This initiative links the students to more experienced professional staff to learn, gain confidence and deepen their skills. The AICM course was designed at a time when ASARECA and her stakeholders were adopting the agricultural innovations systems and value chain approaches that emphasize enhancing partnerships, networking and collaborating to foster agricultural research and development. Enhanced agricultural information and communication is critical in ensuring that players in the agricultural innovation platforms work together in a committed and transparent manner.

Annexes

Annex 1: Financial and Auditor's Report

Independent auditors' report to the board of directors of ASARECA

We have audited the financial statements of ASARECA, which comprise the statements of financial position as of 31 December 2010, statements of revenue and expenditure, statements of changes in fund reserves and statement of cash flows for the year then ended, together with a summary of the significant accounting policies and other explanatory notes, and, have obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purposes of our audit.

Respective responsibilities of the directors and auditors

The Association's directors are responsible for the preparation and fair presentation of these financial statements in accordance with ASARECA guidelines. This responsibility includes: designing, implementing and maintaining internal controls relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error, selecting and applying appropriate accounting policies, and making accounting estimates that are reasonable in the circumstances. Our responsibility is to express an opinion on these financial statements based on our audit.

Basis of opinion

We conducted our audit in accordance with the International Standards on Auditing. Those standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance as to whether the financial statements are free from material misstatement. An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on our judgment and include an assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, we considered internal controls relevant to the association's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by directors, as well as evaluating the overall presentation of the financial statements.

We believe that our audit provides a reasonable basis for our opinion.

Opinion

In our opinion, proper books of account have been kept by the Association and the financial statements, which are in agreement therewith, give a true and fair view of the state of affairs of the Association as of December 31, 2010 and of its surplus and cash flows for the year then ended in accordance with the accounting policies described in Note 1 of the financial statements and comply with the ASARECA guidelines.

Signed by

Partner, Delloitte and Touche
Certified Public Accountants (Uganda)

Statement of Financial Position on December 31, 2010

	Notes	2010 US $	2009 US $
ASSETS			
Non-current Assets			
Property and equipment	2	126,008	105,520
		126,008	**105,520**
Current Assets			
Cash in bank	3	6,689,721	10,987,899
Accounts receivable - NARI membership	4 (a)	222,549	212,407
Accounts receivable - Donors	4 (b)	136,089	98,241
Accounts receivable - Project sub-grantees	4 (c)	2,975,813	4,136,781
Accounts receivable - Others	4 (d)	558	1,249
		10,024,730	**15,436,577**
Total Assets		**10,150,738**	**15,542,097**
RESERVES AND LIABILITIES			
Capital Reserves			
Investment in fixed assets		126,008	105,520
Capital reserve fund		823,078	740,975
Accumulated operating surplus		3,204,192	3,023,889
		4,153,278	**3,870,384**
Liabilities			
Accounts payable - donors	5 (a)	5,473,469	11,165,758
Accounts payable - others	5 (b)	308,847	298,789
Accruals and provisions	5 (c)	215,144	207,166
		5,997,460	**11,671,713**
Total Reserves and Liabilities		**10,150,738**	**15,542,097**

The financial statements were approved by the Board of Directors on **May 5, 2011** and were signed on its behalf by:

Dr. Seyfu Ketema
Executive Director, ASARECA

Mr. Techalew Negash
Head of Finance, ASARECA

Statement of revenue and expenditure for the year ended December 31, 2010

	Notes	2010 US $	2009 US $
REVENUE			
Income from donations	6 (a)	15,115,141	8,999,204
Membership contribution	6 (b-i)	50,000	50,000
Other earned income	6 (b-ii)	212,406	226,389
Total revenue		**15,377,547**	**9,275,593**
EXPENDITURE			
Governance & secretariat management	7(a)	1,626,385	1,414,008
Programme management support	7(b)	2,011,247	1,770,294
Technical programmes and networks	7(c)	11,477,509	5,822,737
Total expenditure		**15,115,141**	**9,007,039**
SURPLUS FOR THE YEAR		**262,406**	**268,554**

Statement of changes in fund reserves for the year ended December 31, 2010

	Capital Reserve Fund US $	Accumulated Operating Surplus US $	Total Reserve Fund US $
On January 1, 2009	782,452	2,835,145	3,617,597
Investment in fixed assets – 2008	(121,287)	-	(121,287)
Surplus for the year	-	268,554	268,554
Capital charge transferred to capital fund	79,810	(79,810)	-
Investment in fixed assets – 2009	105,520	-	105,520
On December 31, 2009	**846,495**	**3,023,889**	**3,870,384**
On January 1, 2010	846,495	3,023,889	3,870,384
Investment in fixed assets – 2009	(105,520)	-	(105,520)
Gain on disposal of assets	3,412	-	3,412
Surplus for the year	-	258,994	258,994
Capital charge transferred to capital fund	78,691	(78,691)	-
Investment in fixed assets – 2010	126,008	-	126,008
On December 31, 2010	**949,086**	**3,204,192**	**4,153,278**

Annex 2: Publications list/ Knowledge resources

Publications

1. Kimaro DN, Semalulu O, Ayaga G, Mbeyale GE, Kasenge V, Gumisiriza, C, Kajembe, GC, Mogaka H. 2010. Promoting sustainable integrated natural resource management options through effective governance and farmer-market linkages in the highlands of East Africa. Keynote paper presented at the Philippines Institutional University Cooperation (PIUC) International Conference, February 2–4, 2010 in Baguio City, Philippines
2. Abdalla H, Mohamed, Rasha AM Ahmed and Gebisa Ejeta. An in vitro technnique for studying specific striga resistance mechanisms *African Journal of Agricultural Research*. Accepted 2010
3. Abdalla H Mohamed, Rasha AM Ahmed, Gebisa Ejeta. Inheritance of hypersensitive response to striga parasitism in sorghum. *African Journal of Agricultural Research*. In review 2010.
4. Abdalla H Mohamed, Rasha AM Ahmed, and Gebisa Ejeta. 2010. Inheritance of production of the haustoria initiation factor as mechanism of Striga resistance in sorghum. *Life Science International Journal:* 1449–1454
5. Abdalla H Mohamed, Rasha AM Ahmed, Gebisa Ejeta. 2010. An In-vitro method, Paper Roll Assay, for screening sorghum germplasm for specific Striga resistant mechanisms. *Life Science International Journal:* 1471–1479.
6. Tinzaara W, Karamura E, Kubiriba J, Byabachwezi M, Tushemereirwe W, Opio F. 2010. The Integrated Approach for the management of Banana Xanthomonas Wilt in East and Central Africa. Proceedings of the African Crop Science conferences, 27 September to 2 October 2009, Cape Town, South Africa.(in press).
7. Dawoud DA, Ahmed EA, Babiker AGT. 2011. Performance of Striga resistant African Cultivars under Sudan conditions. *Sudan Agricultural Research Journal* 17 (in press).
8. Karamura EB, Tinzaara W, Sssekiwoko F, Turyagyenda FL, Blomme G, Eden-Green S. 2010. *Xanthomonas Wilt of Bananas in East and Central Africa (Xanthomonas campestris pv. musacearum): Diagnostic and Management Guide*, Bioversity, Uganda, revised edition (in press).
9. Ndegwa. 2010. Snap bean production, postharvest practices and constraints in Kirinyaga and Machakos districts of Kenya. Paper presented at 12th KARI Biennial Scientific conference 8–12 November 2010, Nairobi.
10. Miriam Kyotalimye, Daniela Horna and Jose Falck-Zepeda. Willingness to pay for GM cotton seed in Uganda. Paper presented at the International Conference on Agro-Biotechnology, Biosafety and Seed Systems in developing countries, 8-11 March 2010, Imperial Royale Hotel, Kampala, Uganda
11. ASIESA planning meeting held at the Hilton Hotel, Nairobi, Kenya

Discussion papers

1. Bashaasha B, Waithaka M, Kyotalimye M. 2010. Climate change vulnerability, impact and adaptation strategies in agriculture in Eastern and Central Africa: a synthesis. Draft ASARECA Discussion paper, Entebbe, Uganda
2. Nzuma J, Waithaka M, Mulwa R, Kyotalimye M, Nelson G. 2010. Strategies for adapting to climate change in rural sub-Saharan Africa: A review of data sources, Poverty Reduction Strategy Programs (PRSPs) and National Adaptation Plans for Agriculture (NAPAs) in ASARECA member countries. IFPRI discussion paper 01013.
3. Waithaka M, Nzuma J, Kyotalimye M, Nyachae O. Forthcoming. Impacts of an improved seed policy environment in Eastern and Central Africa. Draft ASARECA discussion paper, Entebbe, Uganda
4. Discussion paper on farmer field schools, mother-baby trials, farmer groups, village committee approach, farmer participatory research, village training workshops and field days methodologies for uptake and scaling up soil fertility knowledge and technologies.
5. Seven draft scientific papers on Payment for Ecosystem Services (PES).

i. Status, challenges and new approaches for management of the trans-boundary Mt. Elgon Ecosystem: a review
ii. Status, challenges and new approaches for management of the trans-boundary Albertine Rift Mt. Rwenzori Ecosystem: a review
iii. Modelling the mountains of the East and Central African Region for watershed valuation: the case of Elgon
iv. Payments for forest environmental services: institutional forms and experiences in Eastern and Central Africa
v. Payment for ecosystem services (PES) in the Albertine Rift: potential benefits and challenges to scaling up
vi. Valuing forests for watershed management function, a methodological review
vii. A review of carbon sequestration models

Reports and proceedings

The following reports and proceedings were made available during the reporting period:

1. The ASARECA 2009 Annual report
2. The ASARECA 2011 calendar
3. Abass A, Missanga M, Mosha C, Mukuka I, Ranaivoson R, Bah A, Fannah S, James B, Dziedzoave N, Waithaka M, Cromme N. 2010. Safeguarding good health of consumers: the opportunities and challenges of attaining quality compliance for processed cassava products in Africa. Paper presented at 11th Symposium of ISTRC-AB, October 4–8, 2010, Kinshasa, DR Congo.
4. Admasu H, Thomas TS, Nelson G, Waithaka M, Kyotalimye M. 2010. Assessing the vulnerability of agriculture to climate change in Ethiopia. Draft report.
5. Ayele G, Omore A. 2010. Spatial Equilibrium Model for evaluating impacts of changing tariff and non-tariff barriers on dairy trade in East Africa (version 2). Draft report, Entebbe, Uganda.
6. Baramburiye J, Thomas TS, Nelson G, Kyotalimye M, Waithaka M. 2010. Assessing the vulnerability of agriculture to climate change in Burundi. Draft report.
7. EACS [East African Community Secretariat]. 2010. 14th East African Standards Committee Meeting. Ref: EAC/TF/46/2010. Report of meeting held 13–14 May 2010 at Snow Crest Hotel, Arusha, Tanzania.
8. ISAAA [International Service for the Acquisition of Agri-Biotech Applications]. 2010. Draft regional biosafety policies and guidelines. Proceedings of the ACTESA/COMESA regional workshop held from 19–20 April, 2010 at Hilton Hotel, Nairobi.
9. Makokha M, Thomas TS, Nelson G, Waithaka M, Kyotalimye M. 2010. Assessing the vulnerability of agriculture to climate change in Kenya. Draft report.
10. Kakuru W. 2010. Assessment of policy, legal frameworks and institutional governance structures in Bukwo and Kapchorwa Districts, Uganda. Draft report.
11. Karembu M, Wafula D, Waithaka M. 2010. Status of RABESA II. Policy brief.
12. Karembu M, Wafula D, Waithaka M. 2010 Status of Biotechnology policies and biosafety legislation in the COMESA Region. Policy brief.
13. Kilembe C, Thomas TS, Nelson G, Kyotalimye M, Waithaka M. 2010. Assessing the vulnerability of agriculture to climate change in Tanzania. Draft report.
14. Nyachae O, Tumuboine E, Mohamed RA, Mekonnen D, Njoroge P. 2010. Quarantine pest list of Kenya, Uganda and Tanzania for ten selected crops of major economic importance.
15. Nzuma J. 2010. Food prices in the Eastern and Southern Africa defy the global downward trend in 2009. Key paper in COMESA-WIDE policy forum held from 3–5 May 2010, Top Tower Hotel, Kigali, Rwanda
16. Ojok-Laker R, Kayobyo G, Wanda K, Juma L. 2010. Facilitating collective marketing best practices in Kenya and Uganda. Draft case study report.
17. ReSAKSS [Regional Strategic Analysis and Knowledge Support System Eastern Africa]. 2010. Addressing the food price situation in COMESA. Draft proceedings of the COMESA-WIDE policy forum held from 3–5 May 2010, Top Tower Hotel, Kigali, Rwanda.

18. ReSAKSS [Regional Strategic Analysis and Knowledge Support System Eastern Africa]. 2010. Crop prices rise in tandem with staple food prices. Third Policy Brief.
19. ReSAKSS [Regional Strategic Analysis and Knowledge Support System Eastern Africa]. 2010. Agricultural input-output linkages in the ESA region. Fourth Policy Brief.
20. Waithaka M, Kyotalimye M. 2010. Forthcoming. Regional trade – an opportunity to spur growth in eastern and central Africa. Proceedings of AGRA-ILRI markets forum in 11–13 May 2009, ILRI, Nairobi, Kenya
21. Yirga C. 2010. Forthcoming. Assessment of policy, legal frameworks and institutional governance structures in Dendi in Ethiopia.
22. Mugoya C, Masiga C. 2010. Proceedings of 2nd General Assembly of the Tissue culture Business Network (TCBN), March 2010.
23. Mugoya C, Masiga C. 2010. Proceedings of the Inception Meeting of the Transfer of Banna tissue culture Project, May 2010.
24. Lekule, Ngowi F,Mugoya C, Masiga C.2010. *Taenia solium* is a public threat in Tanzania, calling for urgent control measures. Policy brief.
25. Lekule, Ngowi F, Mugoya C, Masiga C. Proceeding of the Stakeholders' Workshop on Developing National Action Plans for Surveillance, Prevention and Control of *T.solium cysticercosis*, 13–14 November 2009, Golden Rose Hotel, Arusha, Tanzania.
26. Havyarimana P,Dikuriyo D, Ntibashoboka L, Mugoya C, Masiga C. 2010. Plan national de prevention, surveillance et de lutte contre le T*eania solium* « cysticercosis » au Burundi. Policy brief.
27. Regional project team. Integrated management options for sustainable lowland rice-legumes cropping system: proceedings of the Regional Inception workshop.
28. Mugoya C,Masiga C.2010. Enhancing sorghum productivity in the ECA: integration of available scientific tools and deployment of existing technologies. Proceedings of Conference held 25–28 October 2010, Khartoum, Sudan.
29. Mugoya C, Masiga C. 2010. Proceedings of the review meeting of diagnostic tools for *Teania solium* cysticercosis in Pigs.
30. Mugoya C,Masiga C. 2010. Proceedings of the review meeting of project on integrating agrobiodiversity with conservation for sustainable livelihoods in savannah ecosystem.
31. Ong'are D, Muiti V, Nikundiwe A, Macharia A, Wakibira J, Muchane M, Musyoki C, Masiga C, Mugoya C. (Draft). Communication guidelines for best bet practices in the Masai-Seregenti Ecosystems.
32. Ong'are D, Muiti A, Nikundiwe A, Macharia A, Wakibira J, Muchane M, Musyoki C, Masiga C, Mugoya C. (Draft). Educating for Sustainable Development within the Greater Seregenti Mara Region.
33. Macharia A, Ong'are D, Wakibira J, Muiti A, Muchai M, Nikundiwe A, Musyoki C, Mugoya C, Masiga C. (Draft). Methodology for uptake of agri-diversity best bets: Case study of the greater mara ecosystem.

Manuals/brochures

1. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. 2006. Uzalishaji nora wa maziwa: mwongozo wa kufundisha wafugaji na wahudumu wa maziwa Afrika Masahriki. Module 1. Translated into Kiswahili in 2010.
2. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. 2006. Njia bora za ukusanyaji na upimaji maziwa. mwongozo wa kufundisha wafugaji na wahudumu wa maziwa Afrika Masahriki. Module 2. Translated into Kiswahili in 2010.
3. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. 2006. Utunzaji, uhifadhi na usafirishaji bora wa maziwa: mwongozo wa kufundisha wafugaji na wahudumu wa maziwa Afrika Masahriki. Module 3. Translated into Kiswahili in 2010.
4. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. 2006. Biashara ya maziwa bora: mwongozo wa kufundisha wafugaji na wahudumu wa maziwa Afrika Masahriki. Module 4. Translated into Kiswahili in 2010.

5. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. 2006. Usindikaji bora wa maziwa: mwongozo wa kufundisha wafugaji na wahudumu wa maziwa Afrika Masahriki. Module 5. Translated into Kiswahili in 2010.
6. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. 2006. Misingi ya uendeshaji biashara ya maziwa na masoko: mwongozo wa kufundisha wafugaji na wahudumu wa maziwa Afrika Masahriki. Module 6. Translated into Kiswahili in 2010.
7. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. 2010. Draft manual on setting up and implementing a T&C BDS Scheme: Guide for practitioners. ASARECA, Entebbe, Uganda.
8. ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa]. Manual for Sustainable Land Management. Bye law development and implementation in Uganda. Entebbe, ASARECA.
9. Cherono P, Kurwijila L, Omore A. 2010. Commercialized supply of training and certification in Milk Quality Assurance in Eastern Africa. A guide for practitioners. ASARECA, Entebbe, Uganda.
10. MAAIF [Ministry of Agriculture Animal Industries and Fisheries]. 2010. Inspection and certification manual for vegetatively propagated planting materials. Draft, Entebbe, Uganda.
11. Draft training manuals under preparation for group dynamics and leadership, soil and water management, commodity value chain and beekeeping, PES.
12. A laboratory manual on diagnostics protocol for Napier grass smut and stunt disease produced.
13. Project on Napier grass stunt and smut diseases produced 6 leaflets and 10 posters to raise awareness of the diseases, and also to disseminate best practices for management to mitigate the impact of the diseases on Napier grass, and hence on smallholder milk production. Information and activities have been reported in four newspaper articles, three radio programmes andtwo TV programmes
14. Perspectives of quality and safety of SME's beef products in ECA and Perspectives of quality and safety of SME's value-added milk and dairy products in ECA.
15. Three brochures produced on TTBD management
16. Four leaflets respectively on *Calliandra*, *Lablab, Brachiaria, Gliricidia* establishment and management
17. A leaflet on smallholder drip irrigation for vegetable production, and a leaflet on use of gender friendly forage choppers.
18. Six posters and four leaflets on Napier smut and stunt diseases produced and disseminated in Kenya, Uganda and Tanzania.
19. Draft manual and poster on QPM technologies and outcomes in DR Congo
20. 600 brochures with guidelines on AIV vegetable production and indigenous vegetable recipes were produced and distributed during an outreach activity organized by the AVRDC in Tanzania.
21. Baguma Y, Otim M, Kawuki R, MugoyaC, Dubios T,Masiga C. 2010. Draft manual on tissue culture, conservation biotechnology and virus indexing.
22. A self-assessment tool adapted for use by farmer organizations to assess their capacity to deliver member-oriented services and their functionality.
23. Centre National de Recherche Appliquee au Developpement Rural (FOFIFA), Guidelines for irrigated rice production (in Malagasy and French).
24. ARIM, Guidelines for irrigated rice production (in Kiswahili).
25. ARIM, Guidelines for the production of rice Quality Declared Seed (QDS).
26. Mgonja F, Mmbaga T, Yangole C, Makoko B, Semlow M. Teknologia za kuhifadhi udongo na maji na mbegu za zinazostahimili ukame.
27. Mgonja F, Mmbaga T, Yangole C, Makoko B,Semlowe M. Teknologia za kuhifadhi udongo na maji na mbegu za zinazostahimili ukame.
28. Mukantwali C, Irene M, Betty. June 2010. Booklet on banana production, banana ripening, wine processing and good manufacturing publishing.
29. ARIM, Economics of rice-legumes spatial planting methods.
30. Mwangi H.Up-scaling of SWM technologies and drought tolerant maize varieties for improved maize productivities.
31. Manual on control options for *Teania solium* cystercicosis and human teanosis.

Documentaries

1. Best-bet practices for integrated soil fertility management practices.
2. Three documentaries on Napier grass stunt and smut disease.
3. Press interview conducted for the Cassava Brown Streak Disease (CBSD) awareness campaign. As a result, articles on CBSD appeared in three leading new papers – *The East African Business Week*, *New Vision* and *Daily Monitor*.
4. Twenty-minute video recording of the ISAAA 2009 report launch, March 7 2010, Kampala, Uganda.
5. A radio programme in Maasai language featuring awareness on best-bet practices for land use practices in the Savanna ecosystems of the Mara-Serengeti was broadcast on Kenya Broadcasting Corporation (KBC - Ki-Maasai Station on 747 MW radio) from 26 to 30 April 2010.
6. A radio programme in Ligala on *Taenia solium* was broadcast in DR Congo
7. DVD on climbing beans production

Website articles

1. Scientists, entrepreneur's strategies to produce millions of biotechnology planting materials. www.asareca.org/agrobio. February 2010.
2. Harnessing partnerships to develop drought tolerant maize for eastern Africa www.asareca.org/agrobio. April 2010.
3. Baseline for measuring impact of integrating agro biodiversity with conservation to improve livelihood in savannah ecosystem. www.asareca.org/agrobio.
4. Resistant genes deployed to boost sorghum productivity through marker-assisted breeding of Striga resistant Sorghum.www.asareca.org/agrobio. May 2010.
5. Coping with climate change through biodiversity and agro biodiversity in Eastern Africa.www.asareca.org. April 2010.
6. Brief note on the International Year of Biodiversity (IYB-2010). www.asareca.org. May 2010.
7. ASARECA facilitates development of EAC standards: www.asareca.org/index.php?page&as=191
8. Food prices to remain high, experts say: www.businessdailyafrica.com/Company%20Industry/Food%20prices%20to%20remain%20high%20experts%20say/-/539550/912134/-/t6femiz/-/index.html
9. Kenya cited as case study at food price talks: www.standardmedia.co.ke/InsidePage.php?id=2000009028&cid=4&

Posters

1. Fighting Striga: Resistance Genes Deployed to Boost Sorghum Productivity.
2. Dan Kiambi (ICRISAT), Abdalla Mohamed (ARC Sudan), Kahiu Ngugi (UON Kenya), Tesfamichael Abraha (NARI Eritrea) , Charles Mugoya and Clet Masiga (ASARECA).
3. PAAP, 2010. Policy Analysis and Advocacy Programme. Flyer.
4. ASARECA – Role in CAADP process.
5. CBSD fact sheet
6. CBSD a major threat to cassava industry and food security in many African countries.
7. A seed-plot technology for on-farm improvement of seed potato quality.
8. Mitigating the impact of Napier grass smut and stunt diseases for the smallholder dairy sector: key achievements.
9. SCARDA approach in the ECA Region: taking stock and lesson learning.
10. Strengthening Capacity for Agricultural Research and Development in Eastern and Central Africa (SCARDA – ECA).
11. Improving household nutrition, food security and livelihoods through orange-fleshed sweet potato technologies in ECA.

12. Orange-fleshed sweet potato vine multiplication and dissemination model.
13. Knowledge sharing and alleviation of malnutrition through Quality Protein Maize (QPM) in ECA.
14. Eastern Africa Plant Genetic Resources Network (EAPGREN Project): Enhancing poverty reduction and biodiversity conservation through sustainable management of plant genetic resources (PGRs).
15. African indigenous vegetables (AIVs) for improved livelihoods.
16. African indigenous vegetable seed in Kenya and Tanzania.
17. FOFIFA, Guidelines for irrigated rice production (in Malagasy).
18. Mgonja F,Yangole C.Teknologia za kuhifadhi udongo na maji na mbegu za zinazostahimili ukame.
19. Sensory evaluation of validated mixed mango-passion fruit juice.
20. Kyotalimye M, Waithaka M, Apolot S, Musingizi W, Adebayo A, Lemaga B. 2010. Standards on cassava and potato: set, endorsed and approved. Poster presentation 5th African Agriculture Science Week and FARA General Assembly 17–24 July 2010, Ouagadougou, Burkina Faso.
21. Waithaka M, Karugia J, Sika G. 2010. Persistence of high food prices in Eastern and Southern Africa: What role for policy? Poster presented at the Tropentag 2010, held September 14–16 at the ETH Zurich.
22. Nzuma J, Waithaka M, Mulwa R, Kyotalimye M, Nelson G. 2010. Adapting to climate change patterns. Poster presentation at the the 5th African Agriculture Science Week and FARA General Assembly 17–24 July 2010, Ouagadougou, Burkina Faso.
23. Waithaka M, Karugia J, Nzuma J, Kyotalimye M. 2010. We refuse to bow: food prices show defiance. Poster presentation at the 5th African Agriculture Science Week and FARA General Assembly 17–24 July 2010, Ouagadougou, Burkina Faso.

Newspaper articles

1. Resistant genes deployed to boost sorghum productivity through marker assisted breeding of Striga resistant Sorghum. *East African Business Week*, Vol. 5, issue 49, June 7–13, 2010.
2. Ugandan's top Adopters of Agricultural Biotechnology. *Sunrise Weekly*, April 2–8, 2010.
3. Uganda seeks to benefit from improved crops. *The Daily Monitor*, Friday, 19 March 2010.
4. Double tragedy for Mbulu area. An article featuring the findings and occurrence of *Taenia solium* cysticercosis in Mbulu area of Tanzania. *Sunday Citizen,* 29 November 2009.
5. Scientists want COMESA to adopt GMOs to curb food aid dependence. *Kenya Times,* Wednesday, 18 April 2010.
6. New GMO policies coming soon. *The EastAfrican, May 17–23, 2010.*
7. ReSAKSS and ASARECA 2010. Press Statement: Long term measures needed to feed Eastern and Southern Africa newspaper.
8. Food prices to remain high, experts. *Business Daily,*5 May 2010. http://www.businessdailyafrica.com/Company%20Industry/Food%20prices%20to%20remain%20high%20experts%20say/-/539550/912134/-/t6femiz/-/index.html.
9. New cassava, potato standards set for EAC. *Farmers Media*, June–July 15, 2010.
10. EAC develops standards for cassava and potato products. *New Vision*, 2 June 2010.
11. Experts develop East African Standards for the root crops: cassava, potato products enter the modern era. *The East African*, October 18–24, 2010.
12. Rural CBO perfects Seed Production for Native Vegetables: *Business Daily*, Kenya August 2010.
13. Uganda seeks to benefit from improved crops. *The Daily Monitor.* Friday, 19 March 2010.
14. Ugandan's top adopters of agricultural biotechnology. *Sunrise Weekly*, April 2–8, 2010.
15. Resistant genes deployed to boost sorghum productivity through marker-assisted breeding of Striga-resistant Sorghum. *East African Business Week*, Vol. 5, issue 49, June 7–13,2010.

The Agriforum Newsletter

Two issues produced – May, November

Policy Newsletters

Issue	Date/Month	Title
1	29th Jan	Best practices in gender mainstreaming in the NARIs of ASARECA
2	12th Feb	MDG 7: achieving environmental sustainability
3	26th Feb	Recommendations for improved biosafety regulations in developing countries
4	12th Mar	Agricultural research: rich versus poor countries—a growing scientific and knowledge divide
5	26th Mar	Social costs and incentives for optimal control depletion in the central highlands of Ethiopia
6	9th Apr	Determinants of smallholder farmers' participation in banana markets in central Africa: the role of transaction costs
7	23rd Apr	Policies and guidelines for genetically modified organisms (GMOs) in eastern and southern Africa
8	7th May	High food prices in eastern and southern Africa defy global downward trend: unaddressed issues could spark another crisis
9	21st May	East African community develops standards for cassava and potato products
10	4th Jun	Enhancing sustainable land management in the highlands of eastern Africa
11	18th Jun	Building partnerships and developing capacities in eastern and central Africa
12	2nd Jul	Strategy for high value non-staple crops in eastern and central Africa
13	16th Jul	Managing natural resources and biodiversity in eastern and central Africa
14	30th Jul	Facilitating best practices in collective marketing
15	13th Aug	Assessing the millennium development goals: ten years later
16	27th Aug	Formulating a position on the approach to research for development
17	10th Sep	Strategies for adapting climate change in rural sub-Saharan Africa
18	24th Sep	Climate change in agriculture: vulnerability, impact, cost and policy
19	8th Oct	Water security and climate change
20	22nd Oct	Sustainable land management: policy, legal frameworks and governance
21	5th Nov	Foreign direct investment in agriculture: the issues and policy options
22	19th Nov	Gender, human values and agricultural research

Others

1. EAC Gazette. 2010. Declaration of East African Standards. Legal Notice no. 22. Vol. AT. – 1. No. 007. Arusha, Tanzania.16 July 2010.
2. Government of Uganda. 2010. Seeds and Plant Regulations, 2010. Draft.
3. Transgenic harvest. African nations are laying foundations to extend the use of GM technology on the continent. 7 October 2010, Vol. 467, *Nature:* 633 © 20 Macmillan Publishers Limited.

Annex 3: ASARECA M&E information matrix – targets and actual

Indicator	Unit of measure (disaggregation)	Baseline (2008)[2]	OP target (2013)	2009 targets	2009 actual	2010 targets	2010 actual	2011 target
Goal: Enhanced competitiveness of Sub Regional Agricultural System[3]								
1. Rate of change in total factor productivity	%	1.3% (2000)	4.4% per year (MDG target)					
2. Percentage change in the value of agricultural output	%	TBD[4]	4% per year					
3. Percentage change in yield of selected crops and livestock	%	TBD	6% per year					
Purpose: Enhanced utilization of agricultural research and development innovations in eastern and central Africa								
1. Percentage of stakeholders adopting new technologies and management practices in selected development domains	Rate (by type of technology/ innovation)	TBD	20% increase over the baseline					
2. No. of policy options implemented by stakeholders	Number disaggregated by type of policy	3	15	3	3	4	2	11
Result 1: Strengthened gender responsive governance and management systems in ASARECA								
1.1 Pluralistic decision making process	Ratio (category of stakeholder by gender)	10 NARIs in the Board (all men)	Effective representation of both men and women in decision making as well as involvement of different stakeholder categories at all levels				18 BoD members representative of all stakeholder categories	
1.2 Compliance with organizational and operational procedures and standards	%	No operational manual and no governance manual	Governance structures and procedures, and operational manual revised. Constitution in place. 100% adherence targeted				Operationalization of OM sections, for example, recruitment, staff performance and development etc.	
Percentage increase in funding from development partners and/or private sector	%	ASARECA portfolio = US$7,436,820	50% (total portfolio)				9 new projects with funding up to $9.4 million, new MOUs with EAAPP, SIMLESA Annual budget increase by 9% in 2011 above 2010	
Result 2: Enhanced generation of demand-driven agricultural technologies and innovations								
2.1 Number of demand-driven technologies / innovations generated	Number (type of technology)	0	35 new technologies / innovations	332	332	538	668	145

2. Baselines for most output indicators have been set at zero considering the commencement of the Operational Plan in 2009. However, for some indicators, data is available from the current ASARECA programmes regarding their achievements in 2008

3. Following principles of subsidiarity, ASARECA will not track these indicators; rather it will rely on the activities of partner organizations such as ReSAAKS, COMESA and NEPAD.

4. Baselines to be determined (check footnote numbering)

Indicator	Unit of measure (disaggregation)	Baseline (2008)[2]	OP target (2013)	2009 targets	2009 actual	2010 targets	2010 actual	2011 target
2.2 Number of demand-driven gender responsive technologies made available to uptake pathway	Number (type of technology)	0	17 technologies / innovations	54	54	55	90	
Result 3: Enhanced adoption of policy options by decision makers to improve performance of the agricultural sector in ECA								
3.1 Number of policy options that enhance access to and use of resources by women, men and youth recommended to policy makers	Number (type)	4	16	10	10	23	8	4
3.2 Number of policy options presented for legislation or decree	Number (type)	4	10	1	1	16	3	17
Result 4: Strengthened capacity for implementing agricultural research for development in ECA sub-region								
4.1 Number of stakeholders who have acquired knowledge and skills in applying AIS as a result of ASARECA support	Number (stakeholder category by gender)	**0**	1,200	0	0	300	36 ASARECA sub projects, 102 ASARECA partner institutions	300
4.2 No of stakeholders trained based on the identified capacity building needs (includes both short-term and long-term training)	Number (stakeholder category by gender)	**0**	35,489	2,393	2,393	5,483	Short-term training = 8,149 Long-term training = 64	8,113
4.3 No of institutions benefiting from infrastructure development initiatives	Number (type of institution)	**0**	119	89	89	99	103	116
Result 5: Enhanced availability of information on agricultural technologies and innovations in ECA sub-region								
5.1 Number of appropriate information packages produced	Number (stakeholder category by gender and other socio-economic differences	**0**	210	30	30	69	169	16
5.2 Number of appropriate information delivery pathways used	Number (stakeholder category by gender and other socio-economic differences	0	2 delivery pathways per target audience	13	13	3	11	0
5.3 Access to disseminated information by various stakeholder categories	% (stakeholder category by gender and other socio-economic differences	0	80% of target users					

Annex 4: Acronyms and abbreviations

ACTESA	Alliance for Common Trade in Eastern and Southern Africa
AFSTA	African Seed Traders Association
AIS	Agricultural Innovation Systems
AIV	African indigenous vegetables
APA	Austroproject Association
APSIM	Agricultural Production Systems Simulator
ARC	Agricultural Research Cooperation (Sudan)
ARDI	Agricultural Research and Development Institute (Tanzania)
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AUC	African Union Commission
AYT	Advanced Yield Trial
BBW	Banana Bacterial Wilt
BECA	Biosciences Eastern and Central Africa
BUDLACC	Bukwo Land Care Chapter
BXW	Banana Xanthomonas Wilt
CAADP	Comprehensive African Agricultural Development Programme?
CBOs	Community based organizations
CBSD	Cassava brown streak disease
CBSV	Cassava brownstreak virus
CGIAR	Consultative group for international agricultural research
CGS	Competitive Grants Systems
CIMMYT	The International Maize and Wheat Improvement Center
CKMS	Communication and knowledge management strategy
CMD	Cassava Mosaic Disease
CMIS	Contracts Management Information System
COMESA	Common Markets for Eastern and Southern Africa
DAP	*Di-ammonium phosphate*
DBDS	Dairy business development service
DFID	Department for International Development
DONATA	Dissemination for New Agricultural Technologies in Africa
DRC	Democratic Republic of Congo
DRD	Department for Research and Development, Tanzania
DSSAT	Decision Support System for Agrotechnology Transfer
EAAPP	East African Agricultural Productivity Program
EAC	East African community
EAGC	East African Grain Council
EASCOM	Eastern Africa Seed Committee
ECA	Eastern and Central Africa
EIAR	Ethiopian Institute of Agricultural Research
EPRC	Economic and Policy Research Centre
ESA	Eastern and Southern Africa
ESASA	Eastern and Southern Africa Seed Alliance
ESRF	Economic and Social Research Foundation
EST	Expressed Sequence Tag
FAAP	Framework for African Agricultural Productivity

FARA	Forum for Agricultural Research in Africa
FFS	Farmer Field School
FOFIFA	Centre National de la Recherche Apliqué au Dévelopment Rural
FYM	Farm yard manure
GMIS	Grants Management System
GMOs	Genetically modified organisms
GTL	Genetic Technologies Ltd
HVNSC	High Value Non-Staple Crops
HACCP	Hazard Analysis Critical Control Point
IAR4D	Integrated Agricultural Research for Development
ICTS	Information and communication technologies
ICU	Information and Communication
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
INERA	Institut National pour l"Etude et la Rechaerche Agronomiques
INRM	Integrated Natural Resources Management
IPTA	Innovation platforms for technology adoption
ISAAA	International Service for Acquisition of Agro-biotech Applications
ISABU	Institut des Sciences Agronomiques du Burundi
ISAR	Institut des Sciences Agronomiques du Rwanda
ISFM	Integrated soil fertility management
IUCN	International Union for Conservation of Nature
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KADLACC	Kapchorwa Land Care Chapter
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspectorate Service
KIPPRA	Kenya Institute of Public Policy Research and Analysis
KMUS	Knowledge Management and Up-Scaling
KU	Kenyatta University
LFP	Livestock and Fisheries Program – ASARECA
M&E	Monitoring and Evaluation
MAF	Mutual Accountability Framework
MARI	Mikocheni Agricultural Research Institute
MDGs	Millennium Development Goals
MUK	Makerere University
NaCRRI	National Crops Resources Research Institute
NaLLIRRI	National Livestock Resources Research Institute
NARIs	National Agricultural Research Institutes
NARO	National Agricultural Research Organization
NARS	National Agricultural Research Systems
NASECO	Nalweyo Seed Company
NEPAD	New Partnerships for African development
NERICA	New Rice for Africa
NGOs	Non Government Organization
NLRI	National Livestock Research Institute
NPT	National Performance Trial
NRM&B	Natural Resource Management and Biodiversity program – ASARECA
NUR	National University of Rwanda

OFSP	Orange fleshed sweet potato
OP	Operational Plan
OPVs	Open pollinated varieties
PAAP's	Policy Analysis and Advocacy Program – ASARECA
PBS	Programme for Biosafety Systems
PCD	Partnerships and Capacity Development
PDP	Performance Development Plans
PER	Public Expenditure Review
PES	Payments for Ecosystem Services
PM&E	Planning, Monitoring and Evaluation
PMF	Performance Measurement Framework
PMIS	Programme Management Information System
PMP	Performance monitoring plan
PrMIS	Projects Management System
PTL	Plant transformation Laboratory
PVP	Plant Variety Protection
PYT	Preliminary Yield Trial
QDS	Quality declared system
QPM	Quality Protein Maize
QTL	Quantitative Trait Loci
RABESA	Regional Approach to Biotechnology and Biosafety Policy in Eastern and Southern Africa
RACS	Regional Accreditation and Certification System
RAILS	Regional Agricultural Information and Learning System
ReSAKSS	Regional Strategic Analysis and Knowledge support System
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SCARDA	Strengthening Capacity for Agricultural Research and Development in Africa
SIMLESA	Sustainable intensification of maize-legume cropping systems for food security in eastern and southern Africa
SLM	Sustainable Land Management
SME	Small and medium enterprises
SPCFV	*Sweetpotato chlorotic fleck virus*
SPCSV	*Sweetpotato chlorotic stunt virus*
SPFMV	*Sweetpotato feathery mottle virus*
SPMMV	*Sweetpotato mild mottle virus*
SSPT	Small seed plot technique
SSR	Simple Sequence Repeat
SUA	Sokoine University of Agriculture
T&C	Training and certification
TAMPA	Tanzania Milk Processors Association
TATRO	Technology Adoption through Research Organization
TCBN	Tissue culture business network
TDA	Tanzania Drug Authority
TDB	Tanzania Dairy Board
TLU	Tropical Livestock Units
TOSCI	Tanzania Official Seed Certification Institute
TTBDs	Tick and Tick-Borne diseases
UNBS	Uganda National Bureau of Standards
VVT	Variety Verification Trial

About ASARECA

The Association for Strengthening Agricultural Research in Easternand Central Africa (ASARECA) is a non-political organisation of the National Agricultural Research Institutes (NARIs) of ten countries——Burundi, D. R. Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania and Uganda.

ASARECA **mission** is to enhance regional collective action in agricultural research for development, extension and agricultural training and education to promote economic growth, fight poverty, eradicate hunger and enhance sustainable use of resources in Eastern and Central Africa.

ASARECA **Programmes** include:

- Staple Crops
- High-Value Non-Staple Crops
- Livestock and Fisheries
- Agro-biodiversity and Biotechnology
- Natural Resource Management and Biodiversity
- Policy Analysis and Advocacy
- Knowledge Management and Upscaling

Partnerships: Through ASARECA, agricultural scientists in the 10 countries work together and in partnership with farmers, extension, private sector, scientists of regional and international institutions and development partners to come up with new innovations that could lead to agricultural-led economic growth, poverty eradication and improved livelihoods.

ASARECA
Transforming Agriculture for Improved Livelihoods

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DFID Department for International Development

AFRICAN DEVELOPMENT BANK GROUP

IDRC CRDI

Sida