

APP Policy Brief No. 2

Intra-ACP Agriculture Policy Programme (APP) Caribbean Action, with funding by the European Union under the 10th European Development Fund (EDF)



Intra-ACP APP Caribbean Action

Working Together, CARIFORUM (CARICOM) Member States can make Valuable Strides toward Food and Nutrition Security through the use of Improved Germplasm

Improving Crop and Livestock Germplasm: What, Why, How & What Next?

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Key Messages:

- Improved germplasm is one means of addressing crop and livestock productivity, climate change and pest and disease challenges of especially small and medium size farmers in the Caribbean.
- The adoption of technologies and practices that foster development, conservation and use of better genetic material will help strengthen productive capacities, build resilience and create sustainable farming systems.
- In order to effectively support a successful germplasm improvement programme across the Region, proper facilities, management protocols and effective institutions must be in place, technicians and farmers must be adequately trained and basic and applied research supported by appropriate commercial trials must be done for selected priority commodities.
- Critically, arrangements must be made to have sufficient amounts of improved germplasm available to farmers which will require harmonization of standards and protocols for the creation and movement of such material into and within the region.



Training on techniques involved in improving animal germplasm.

(Photo: CARDI)

Food and nutrition security is a condition under which adequate food (quantity, quality, safety, and sociocultural acceptability) is available and accessible for all and successfully utilized by all individuals, at all times, to live a healthy and happy life (Weingartner, 2010). This policy brief focuses on the use of improved germplasm to contribute to food and nutrition security in the Caribbean. With a medium term regional target of achieving 25% food and nutrition security, “clean” planting materials, improved varieties and better-quality breeding stock will be required.

This Brief has been completed based on APP actions to date, including studies on the harmonization of protocols for movement of plant and animal germplasm across the Caribbean Region, the experiences of Regional technicians receiving germplasm training in Fiji, and field trials and training to improve the transfer and adoption of improved germplasm production and utilisation technologies”

Some politicians have equated food and nutrition security as having the same significance as national security, yet food and nutrition security continues to be a major cause for concern in CARIFORUM countries. This is clearly illustrated by the continued lamentations of CARICOM member states’ about their increasing and substantial reliance on food imports. These imports are estimated at more than US\$5 billion across the region annually, not to mention the steady increase in and volatility of food prices, and the decrease in investment in agriculture in the Region over the last decade.



Sweet potato conservation plot in Antigua

(Photo: CARDI)

Food and nutrition security and sustainable agriculture are among the European Union’s (EU) top international development priorities. These priorities are reflected in the objectives and interventions of the Caribbean Action under the APP, which has placed emphasis on enhancing

productivity of small and medium scale producers and entrepreneurs in CARIFORUM countries.

Increasing access to food products through more dynamic intra-regional trade in agricultural commodities is an important element of increased food and nutrition security in the Region. However, to foster more intra-regional trade, increased production in agriculture and food products is required, as well as improved quality and acceptability of both plant and animal products produced within the Region. These are essential elements of the import replacement strategy meant to tackle the high and rising food import bill.

Increased production of improved quality products starts on the farm, through the use of quality germplasm and the practices applied to its proper use and management. For these reasons, the APP, under Component 2, led by CARDI, includes actions that are focused on the improvement, multiplication and conservation of germplasm that is distributed and used in the Region.

WHAT is improved plant and animal germplasm?

In keeping with the focus of the CARDI work under the APP, ‘Germplasm’ can be described as ‘the living genetic resources, such as, seeds, animals or tissues, that are maintained for the purpose of animal and plant breeding, selection, propagation, preservation and other research uses (<http://www.encyclo.co.uk/meaning-of-Germplasm>).

For plants, according to the University of California Seed Biotechnology Centre, germplasm is the “living tissue from which new plants can be grown.” However, plant germplasm is not just seeds. It can be another part of the plant, such as a piece of the stem, pollen or even just a few cells, that can become a whole new plant. These tissues can be combined with tissues from another plant and because of meristem cells, the plant can grow all of the specialised cells that it needs to survive. Meristem cells are undifferentiated cells in the tissue of plants that can change into various organ cells required to keep the plant growing and healthy.

Germplasm breeding allows certain genes to be ‘knocked down’ by selectively adding desirable chromosomes from another plant to cancel out the useless or undesirable chromosomes of the first plant. This allows sensitive flora to become hardier. Improved plant germplasm is the plant material that has been scientifically engineered to be high yielding, disease and pest resistant or tolerant and adapted or resilient to the climate of the Region where it will be grown.



Training on techniques involved in improving animal germplasm

(Photo: CARDI)

options for improving livestock production in developing countries’, “improvement of livestock depends on access to genetic variation and effective methods for exploiting this variation. Genetic diversity constitutes a barrier against changes in the environment and is a key in selection and breeding for adaptability and production in a range of environments.”

This genetic diversity can be achieved through various means, such as artificial insemination of females with sperm from healthy male specimens from outside sources, embryo transfers from a genetically outstanding female donor to a female recipient, or the simple, natural breeding of female animals with genetically superior males from an outside source. Improved animal germplasm is the result of all of these practices which will lead to healthier and more productive animals and stronger livestock populations across the Region.

For animals, germplasm is a living, genetic resource from an animal, such as sperm, ova, embryos or even the animal itself. Like our own DNA, germplasm carries all of the genetic information which makes up the animal. According to J.E.O Rage, in his article, ‘Biotechnology

“Today we are seeing best practices in action,” said Rachel Kyte, the Vice President of the World Bank, at the 2012 G20 Conference in Mexico. “We know that, if scaled up with speed, these approaches (to improve food crop and livestock germplasm) could increase food production and

Important terms to help understand the germplasm improvement process are:

- **Biotechnology**, as described by J.E.O Rage, is a “means to address production constraints of small, medium scale or resource-poor farmers who contribute more than 70% of the food produced in developing countries”.
- **Cultivars and Varieties** are not the same thing and the difference between them is one of derivation. A variety is a type of plant that arose in nature, while a cultivar is the result of human intervention. Human intervention can mean the simplest act of collecting the plant or its seeds and planting it elsewhere, but the existence of the plant is due to human effort.
- **Cryopreservation** is the storage of biological material at an ultra-low temperature as a mechanism to prevent loss of a country’s vital germplasm material for both plants and animals
- **Ex situ conservation** means “off-site conservation”. It is the process of protecting genetic resources, particularly endangered and/or very desirable species, outside of their natural habitats. This can be done by removing part of the population from a threatened and/or normal habitat and placing it in a new or protected location, such as gene banks (seed, sperm and ova banks), in vitro plant tissue and microbial culture collections.
- **Genomes** are the complete set of chromosomes carried by a cell. Genomics is the study and exploitation of the Genome of an organism.
- **Multiplication** is the overall process of developing, growing and distributing improved varieties.
- **Tissue culture** is the growth of tissues or cells outside of the organism, in an artificial medium, under sterile conditions.
- **Weaning and hardening** involves nursing young plants to prepare for final transplanting into their permanent (generally field) location.

improve livelihoods without damaging the environment. We need to create conditions for innovation and then invest so that innovation moves from the lab to the farmer's fields."

It is important to adopt this attitude when it comes to improving germplasm in the Caribbean. The adoption of technologies and practices that will foster better genetic material will help create robust and sustainable farming systems. It will strengthen the productive capacities of farmers, especially small and medium sized operators, through among other things, the provision and use of adequate, quality, resilient and improved plant varieties and animal species.

WHY is the Caribbean putting emphasis on improving plant and animal germplasm?

There are specific food crops and animals that have been prioritized under the APP for germplasm improvement. These are cassava, sweet potato, yam and dasheen, in the roots and tubers group; corn, beans and peas, in the grains and cereals group; hot pepper, in the herbs and spices group; and goat and sheep, in the small ruminant group. These plants and animals were chosen because they have a long history of production in the Region, satisfy local food preferences, have potential to reduce the food import bill, and provide important sources of income for farmers in the Region. The list of priority commodities for the Region also includes banana and plantain, as well as a range of organic vegetables, including produce grown in protected agriculture systems (enclosed structures and shade houses).



Transplanting corn seedlings from improved germplasm.

(Photo: CARDI)

To Build Resilience to Climate Change

Most everyone now knows that climate change is not just about warmer temperatures. The effects of climate change are far-reaching, especially in the world of farming in the Caribbean.

Climate change has and will continue to impact water availability in the Caribbean, with longer periods of drought and changes in the timing of the wet and dry seasons. The change in seasonal peaks, as well as increased temperatures, leads to different pests and diseases which attack a commodity. An example of this was the recent massive outbreak of cassava hornworm (*Errinyis ello*) in Trinidad and Tobago after a prolonged drought. These types of incidents often lead to the use of different agri-chemicals to address the challenge. All of these factors put new and intense strain on a variety, which often leads to under-production or even crop failure. Consequently, improved plant germplasm needs to be carefully researched, developed and tested in different agro-ecological zones before being distributed in the Caribbean Region in order for crops to withstand these new challenges.



Impact of climate change on corn crop in the Caribbean

(Photo: CARDI)

To Sustain Yields & Output under Increasingly Difficult Conditions

Component 2 of the APP is complementing CARDI's mandate for the identification, selection, multiplication and distribution of appropriate varieties to the correct eco zones across the Caribbean. With higher quality and more resilient planting materials being used on a greater number of farms across the Region, an increase in production and productivity can be expected. This will result in the enhanced ability to support intra-regional trade and higher profits for farmers.

Farmers across the Region are already fully aware of what works best in their fields. They are indeed the experts. When conducting a baseline study on traditional knowledge under the APP, researchers found that there were many well-informed producers that were eager to share their suggestions on the best cultivars for their area.

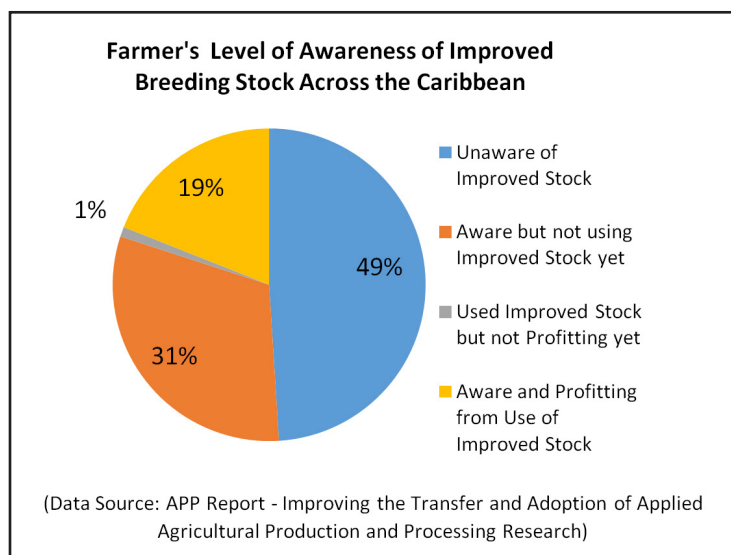
There were comments like, “The white and purple fleshed sweet potato survive during the dry period but don’t produce well. Black Rock does better when the weather is cool, while Mandella and Little Leaf do well in the dry season”. The volunteered information was often accompanied by general guidelines as to how and where the material could be sourced and even a willingness to share the cultivars if asked, for example a drought tolerant corn in the Rupununi Savannahs of Guyana.

All of this is encouraging behaviour. Farmers appear ready and willing to share information and experiences on perceived improved and resilient germplasm with the wider farming community; to contribute to the ongoing efforts to improve productivity and increase yields/output in a more sustainable manner. While definitely a good start, success in sustaining yields under increasingly difficult conditions will require that these and other farmers have ready access to adequate amounts of quality planting material and animal breeding stock that can withstand the new environmental realities in order to produce a product that is profitable, either as a fresh or value-added product.

acutely aware of the importance of quality breeding stock to the productivity and profitability of small and medium sized operations. Baseline surveys conducted by C2 from late 2014 confirm that the inherent effects of inbreeding were not lost on the small ruminant producers that were interviewed. Eighty-five percent of respondents recognized the value of accessing their breeding stock off-farm. However, 49% of respondents also said they were unaware of the presence and availability of improved breeding stock and a little less than half of those farmers that knew about the improved breeds, actually obtained these pedigree animals. Those that did however, reported almost 99% satisfaction with the improved performance and increased profits that were gained through use of the improved stock.

There are approximately 2.5 and 3.5 million sheep and goats, respectively, in CARICOM countries within CARIFORUM. Small ruminants are an important agricultural commodity in the Region. Unfortunately, the Caribbean produces only 15% of the demand for small ruminant products. The majority of the demand is met by imports from New Zealand, the United States and Australia. Clearly, there is an opportunity for growth in production within the small ruminant market that will directly addresses concerns about food and nutrition security and increased food import costs in the Region. However, there are currently several constraints to expansion and development of the industry, as identified in the APP study, ‘Harmonization of Germplasm Movement – Animal.’ Challenges noted include, difficulty in obtaining appropriate breeding stock to upgrade and maintain the flocks; limited knowledge by farmers of good animal husbandry and Good Agricultural Practices when it comes to reproduction and breeding; and understaffed, underequipped and often unavailable veterinary laboratories to support healthy flocks. Improved germplasm can help in addressing the first challenge. However, for the full impact to be achieved, governments have to implement an integrated and holistic programme of farmer and technician training, result driven research and development and the upgrading of relevant physical facilities.

“It is no coincidence that in countries where agriculture has taken off there have been large investments in research and infrastructure”, said Kanayo Nwanze, President of the International Fund for Agricultural Development (IFAD) at the G20 Summit in Mexico. Research and investment in the infrastructure required for improving germplasm for both plants and animals is sure to benefit the Caribbean in the same way.



Although not as extensive as crop agriculture, livestock production is taking off in the Caribbean, especially in the small ruminant industry, which is very appropriate for farming at the small and medium sized levels. For some time now, farmers in the Caribbean have been

HOW is improved plant and animal germplasm being supported under APP?

The Caribbean Agricultural Research and Development Institute (CARDI) has been working for some time with experts around the world who manage food crop and animal germplasm. Under the APP Component 2, CARDI is providing direct support to countries in building institutional and small farmer technical capacity to produce and sustain their own quality planting material. Multiplication units are being established both at agricultural stations and on farmer's fields. Local farmers and other partners are being, or will be trained to manage these units, and are in the process of producing quality planting material that will be distributed to local producers.

They have identified the necessary steps involved in the process of improving genetic varieties. They are moving ahead accordingly, as summarized below.



By Improving Facilities for Acquiring and Producing Germplasm

In order to properly support a successful germplasm improvement programme across the Region, proper facilities must be in place. Once improved germplasm has been researched, developed and tested, it is time to make more. Multiplication units and conservation plots are very important for food and nutrition security in the Caribbean. They are good sources of approved, possibly certified, plant material for propagation which can be easily used to facilitate urgent production required for post-emergency recovery.

The availability of adequate quantities of improved varieties to farmers will require the development and

introduction of high quality germplasm and its subsequent multiplication under controlled conditions. The production of animal germplasm and planting material calls for quality physical and technical resources. As a result, it is financially and technically prudent to have specialised regional centres that will supply material to Member States as required. Through the work of CARDI, recently enhanced by the APP, there have been significant and focused initiatives in countries across the Region to improve the facilities needed for acquiring and producing germplasm.

Examples by Commodity Group include:

- **Roots and Tubers:** Weaning and hardening facilities and humidity bins to assist in the growth of plantlets were refurbished and upgraded in Antigua and Barbuda and St Vincent and the Grenadines. This will increase capacity for propagation of improved cassava planting material. Propagation structures for sweet potato were upgraded to increase production of planting material in Grenada, as well as demonstrate a water harvesting system in St. Kitts and Nevis. In Antigua and Barbuda, on the Betty Hope CARDI Field station, 65 sweet potato varieties are being maintained for both multiplication of planting material and research and validation under open field conditions.
- **Hot Pepper:** To date, four accessions of hot pepper have been screened and selected for the ex-situ conservation plot, established as a germplasm bank, located at the CARDI field station in Barbados. These protected hot pepper plots will be used to produce seeds and establish more adapted varieties and new germplasm. The plot will continue to be maintained by CARDI at the end of the APP programme.
- **Bananas:** Tissue culture facilities at the University of Suriname were refurbished, timers and misting systems were put in place and new lab equipment was purchased for plant tissue culture propagation testing and operations.
- **Small Ruminants:** A centralized breeding goat house for farmers of the North Eastern Farmers Organisation in Grenada was upgraded, housing and forage delivery systems in Jamaica refurbished, and a small ruminant breeding facility in Guyana is under renovation.
- **Corn and Beans:** The APP has supported expansion and maintenance of a gene bank for corn material in Belize. These ex-situ conservation plots are the only germplasm banks for corn in the Region. Improvements in the management of same, and

research results generated, will be important for future research as well as for supply of improved planting material to local farmers and producers around the Region.

- **Multi-crops:** The CARDI Field Station germplasm facility, at Dennerly in Saint Lucia, is being refurbished and outfitted with propagation bins, a saran netting roof and a misting irrigation system. The structure will be used for propagation and multiplication of vegetables, tree crops, mainly passion fruit and wax apple, and root crops, particularly sweet potato and sweet cassava for the APP programme.

By Strengthening Arrangements for Acquiring and Producing Germplasm

With proper facilities in place, countries can move forward with confidence in the process of developing, multiplying and managing improved germplasm for both plants and animals. Consequently, the next step is to ensure that protocols are in place to simplify the movement of disease and pest free germplasm and planting material within the Region. To achieve this, receiving countries must be assured that their agriculture will not be compromised or threatened by the incoming material.



Humidity bin at MOA Cotton Station in Antigua

(Photo: CARDI)

Under the APP, a consultancy was carried out to develop protocols to facilitate intraregional movement of improved plant material in such a way that it is acceptable to both the sending and receiving countries. The consultancy began by looking at existing standards and guidelines in various CARICOM countries, as well as examining the scientific principles associated with crop specific pests and diseases and the risks that they may pose. A review of the International Standards for Phytosanitary Measures

(ISPMs) pertaining to the movement of planting material, was also carried out.

A draft for possible protocols was developed and efforts are being made to obtain endorsement of these protocols by the Caribbean Plant Health Directors Forum (CPHDF) and the Caribbean Agricultural Health and Food Safety Agency (CAHFSA) for consideration as Regional standards and recognised by member countries. This will take time, however it is a necessary step in order to support a successful and safe germplasm improvement programme in the Caribbean.

An additional consultancy was commissioned under the APP to develop mechanisms to simplify the regulations governing the intraregional movement of live animals, embryos and semen. The first step in the consultancy was to collect and review existing national protocols. These protocols were then assessed to see if they were consistent with internationally accepted norms and if they could be used to develop harmonized regional policies. Once this was complete, protocols were recommended that, with minor adaptations, could be used by all Member States of CARIFORUM and represent a harmonized framework.

By Developing the Capacity of Institutions to Manage Improved Germplasm

The training of key institutions' human resources is very important in the initiative to improve germplasm. Once sufficient facilities are in place and work has begun on creating acceptable protocols for the movement of germplasm, the next step is to ensure that competent and qualified human resources, along with certified institutions, are in place in the identified locales to support a programme to produce and propagate improved genetic material.

Under the APP, in early 2015, concerted effort was taken to develop capacity for the management and multiplication of germplasm by institutions, namely in:

1. **Jamaica (24-25 March):** A workshop was conducted on production, processing and storage for breeders' and the foundation and commercial seeds of hot pepper, maize, sorrel and pumpkin. These workshops were carried out by the CARDI Plant Breeder for technicians of the Ministry of Agriculture and students of the Ebony Park Heart Academy.
2. **St Vincent and the Grenadines (25-26 March):** Twelve technicians from CARIFORUM countries were trained in weaning and hardening of tissue culture plantlets.

Also under the APP, two technicians from Ministries of Agriculture in Jamaica and Saint Vincent and the Grenadines, and one CARDI scientist, participated in an eight-week internship on improving germplasm in Suva, Fiji at the South Pacific Community (SPC) resource centre. Through lectures and laboratory and field activities, the trainees learned about plant breeding, including different evaluation methods used in assessing crops for tolerance to varied climatic factors, natural disasters and pests and diseases. They studied breeding and selection processes for desirable traits, as well as integrating livestock production with tree crop production. Participants visited both a soil regeneration and reforestation project designed to restore a soil's biological and chemical properties, and farmer's cooperatives to discuss models for cooperative quarantine, grading, certification and sorting services. They were also introduced to irrigation intervention, the use of low-tech mini nurseries and pot culture in mitigating risks of natural disasters, and the use of various ameliorants and fertilizers.

Another main focus of the internship was instruction on tissue culture techniques used in the growth and/or maintenance of disease free plant cells, tissues and organs for preservation and distribution to farmers. The overall process entails:

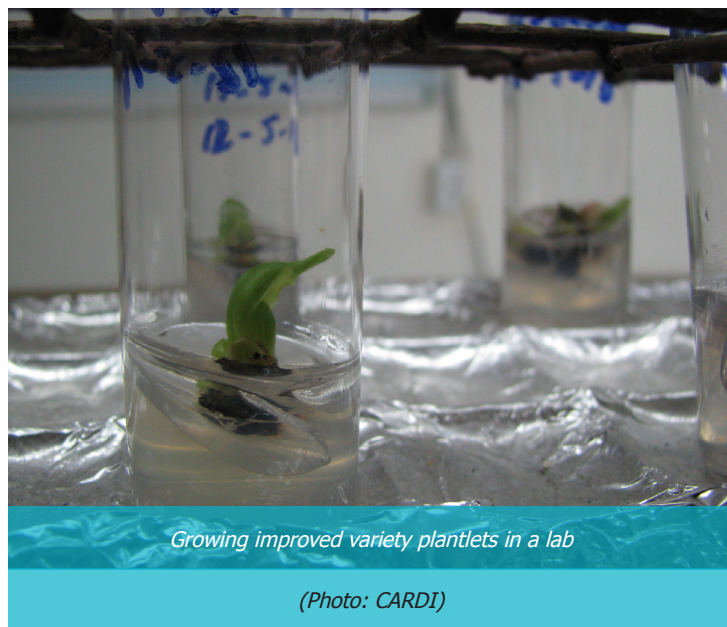
1. Selection of healthy growing meristemic portions from respective crops.
2. Cleaning and trimming down to sizeable portions for initiation.
3. Placing plant excise in growing medium, in suitable vial and storing.
4. Sub-culturing, which involves producing new plantlets by transferring some or all tissue from a previous culture to a fresh growth medium.

The Fiji trainees also learned about cryopreservation and DNA Extraction for exploitation and use at a later date. CARDI small ruminant breed improvement programmes have benefited from cryopreservation in the past where straws of semen and embryos were imported at various periods for artificial insemination (AI) and embryonic transfer (ET) in the form of cryopreserved material in liquid nitrogen. CARDI has also been actively engaging with centres of excellence in the United States of America, and some CGIAR Centres, for the cryopreservation of some hot pepper varieties and cultivars.

By Enhancing the Capacity of Small Producers to Develop, Multiply and Manage Their Own Improved Germplasm

Action under the APP seeks to help small and medium scale farmers to produce their own high quality planting material in a sustainable manner. Local farmers, including youth and women's groups, have and will continue to receive tools, information and training to enhance their skills in multiplying and managing their own improved germplasm and propagation material, as well as the infrastructure to produce them.

Actions are underway in many CARIFORUM countries to move this initiative forward. In Grenada, a Saanen buck was purchased and provided for stud services to more than 60 does. The buck has been placed on a mother farm and the offspring will be distributed to over 40 individuals in the small ruminant producers group. Training will also be taking place shortly in the Dominican Republic under Component 2 of the APP and in cooperation with the Dominican Institute of Agricultural and Forestry Research (IDIAF). This training will focus on small ruminants and the subjects of breed management and embryonic transfer.



Growing improved variety plantlets in a lab

(Photo: CARDI)

In Saint Lucia, sweet potato and cassava plantlets and cassava planting materials were distributed to various producer groups, including farmers in the Baboneau Cluster and, in the following months, training workshops were given to the same groups on cassava germplasm production. In Dominica, open-pollinated yellow corn and Red Kidney bean seeds, with the potential to establish 10 and 20 acres of production respectively, were distributed to farmers for post-Tropical Storm Erika recovery in two communities. The improved seeds will enhance food and income security, as well as assist in building self-reliance

and resilience to any future disasters. Farmers will also be provided the technical support necessary to ensure that the fields are re-established using good agricultural practices.

The UWI Faculty of Science and Technology in Mona, Jamaica hosted a Research and Technology Day in early 2016. There, the opportunity was taken by CARDI to demonstrate and transfer knowledge, through research under C2, on the roots and tubers tissue culture propagation process. This included a public lecture on the weaning and hardening of tissue culture material, conducted by a CARDI Biotechnologist. A wide cross section of participants, including technical persons, extension personnel, technical staff of other research institutions and youth, were in attendance. The opportunity was also used to distribute planting material.



Examining a sweet potato demonstration plot in St. Vincent and the Grenadines

(Photo: CARDI)

Practical hands-on and classroom training has also taken place in Dominica and St. Vincent and the Grenadines for propagators, producers, producer groups and extension officers in the demonstration of the rapid multiplication of sweet potato and taro. This training built on previous training in General Production, Pest Management and Post-Harvest practices for taro and cassava production techniques.

In Suriname, plantain and cassava farmers were provided with training on the rapid multiplication of their crops using new methods. These methods will be used to develop improved germplasm and will be demonstrated to other farmers in the community. Research findings and training were also shared on the control of Leaf Cutter Ants that were causing huge losses to farmers and are now being controlled, and the selection of planting material that is free from frog skin disease.

It is these kinds of actions that are necessary to arm the first line of defence, that is, the farmers themselves, in the improved germplasm process.

By Validating Production, Productivity, Value-Add and Marketing Prospects of Selected Germplasm

Before too much time is invested in developing improved germplasm of a particular commodity, work needs to be done to ensure that it is the right commodity to support. Getting the right product with the desired characteristics to the consumer is about having the right variety to begin with. Research must be done to determine how well various varieties meet product requirements and if the product is even desirable at the fresh market or for processing into value added products. Then, once the right commodities are identified for improvement within selected markets, validation varietal and cultivar trials must take place.

Several validation trials are underway under Component 2 of the APP. These include a cassava validation trial in Trinidad, which is testing the adaptation to both the wet and dry seasons; three dasheen (taro) validation trials in Dominica using planting material from the local CARDI gene bank and two sweet potato validations for testing drought tolerance; eight sweet potato trials with five varieties using rain-fed techniques and drip irrigation in Jamaica; sweet potato validations in St. Vincent and the Grenadines which are focused on creating resilience in small farming systems for climate change impacts; corn and bean trials in Belize; and organic tomatoes under protected agriculture conditions in the Dominican Republic.

Similarly, on the animal side, a trial for small ruminants is underway in Jamaica, where animals from a previous project are participating in feeding trials to validate the use of local forages as de-wormers. On each site, fifteen weaner does were selected and treatments randomly assigned to groups. The remedies being used are herbs, including aloe vera, moringa, neem and garlic with benvet, which is the commercial dewormer used as the control. CARDI will augment this information with results from similar trials undertaken in Grenada and the Dominican Republic under Component 2. The results and recommendations from the research will also be shared and discussed with producers and disseminated to small ruminant farmers in Jamaica and the rest of the Caribbean.

WHAT are the NEXT STEPS in the process of improving plant and animal germplasm in the Caribbean?

Much work has already been done by CARDI and further enhanced under the APP, to facilitate the use of better genetic materials for crops and livestock production in the Caribbean. CARDI is also involved in other germplasm projects and activities, namely:

1. The 10th EDF project on regional food and nutrition security in the context of changing climate.
2. The Caribbean Coconut Industry Development project, which has a major component on germplasm.

The final step in the process of having improved germplasm used as a tool to advance regional food and nutrition security is distribution of the superior genetic material to local farms. This activity requires the safe and acceptable distribution of improved materials to farmers within the community and the country, as well as those across the Region through local germplasm management facilities. However, the process is not as simple as just giving improved germplasm to farmers. There is first a need to ensure the protection of human, animal and plant life from the risk that can arise from the entry of new pests, diseases or disease carrying organisms which may be found in the germplasm. Accordingly, all germplasm earmarked for export should be indexed for known or suspected viruses and pests, and, in the case of animals, the same should apply to offspring of recently introduced breeding lines.

Furthering the Improvement of Plant Germplasm

The development of enhanced varieties that can (i) withstand the new environmental realities brought on by climate change and (ii) produce larger and healthier crops, may be achieved through improved plant germplasm. Recommendations for moving in this direction include:

1. Create a complete set of production protocols that are available for utilization by all Member States. Currently, some Member States do not have established protocols.
2. Simplify and harmonize protocols in all CARICOM countries for the timely and safe movement of clean planting material within the Region.
3. Consider additional crops for further study that were flagged by some countries. These crops include rice, banana, plantain, pineapple, medicinal and culinary

herbs and a range of vegetables, such as, carrot, onion, cucumber, christophine and tomato. Special attention should also be paid to organic production and protected agriculture.

4. Revisit the 1990s Pest Quarantine (PQ) list of the Caribbean Plant Protection Commission (CPPC) with a view of adopting applicable organisms into their national quarantine lists and consider deleting those that have since spread throughout the Region.
5. Enhance the national focal point contact listings and country willingness to report pests of quarantine concern to the International Plant Protection Convention (IPPC).
6. Require phytosanitary laboratories to conform to the standards of ISO/IEC 17025: 2005, "General requirements for testing and calibration laboratories".
7. Include aspects of the import or growth of living modified organisms (LMO) intended for food, feed or processing, in any harmonized regional revision of regulatory frameworks.

Furthering the Improvement of Animal Germplasm

The development of the small ruminant subsector in the Region would also be of significant benefit to small and medium scale farmers and vital to the enhancement of the Region's food and nutrition security. For this to happen quality breeding stock must be made available. This can be achieved through the use of improved germplasm. Recommendations for moving in this direction include:

1. Create a complete set of protocols for all Member States. Currently, some Member States do not have established protocols.
2. Simplify and harmonize protocols in all CARICOM countries. Examples of such protocols would include harmonized:
 - a. conditions for controlling the importation of live animals, embryos and semen (mostly in relation to small ruminants), including certification, identification, and health standards and similarly, harmonized protocols for movement of said organisms throughout the Region
 - b. testing standards before importation
 - c. embarkation statements which require specific information that must be made available before animals, embryos or semen can leave the port

3. Publish protocols on the relevant Government websites so that they are easily accessible. If possible, the application process to obtain a permit should be able to be completed on the website, including payment of any fees incurred.
4. Establish dedicated breeding farms in selected Member States to produce improved quality animals for use throughout the Region
5. Develop an integrated regional programme for research on forage for use by small ruminants and the local production of inputs, including crop residues, to make quality commercial feeds. The Region can no longer depend on imported production inputs and products which increase the cost of commercial feeds.
6. Facilitate the continuation and improvement of artificial insemination projects that are ongoing throughout the Region. The full impact of these projects may not be seen for another five or so years but the long term results will be improved breeding rates and increased number of breeding stock.
7. Encourage membership by all Member States in the World Organization on Animal Health (OIE). Currently only nine CARIFORUM countries are members of the OIE. Membership by all will ensure that a Caribbean technical perspective is provided as new standards are developed and existing ones rewritten. This is vital as these standards impact all, not only member, countries that trade in animal and animal by-products.
8. Collaborate with the Chief Veterinarian Officers (CVOs) as a group to help them recognize the importance of improving animal germplasm in the strengthening of the subsector, the quality of rural life and the Region's food and nutrition security. Request that they respond in a timelier manner to legitimate requests for information.

Going forward, CARDI is gearing up to begin a genomics programme to breed new germplasm or consolidate existing germplasm. With projects such as this and the recommendations noted, regional small and medium scale farmers would be able to expand their production base and target both national and regional markets, therefore improving the food and nutrition security situation across the Region.



Humidity bins at MOA Green Castle Station in Antigua

(Photo: CARDI)

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