CIAT policy brief

Plant Genetic Resources: Foundations for a Food-Secure and Climate-Resilient Future in the Caribbean[1]

Carolina Navarrete-Frías, Path Umaharan, Daniel Debouck, Sergio García, Carlos Fuller, Norman Gibson, Andy Jarvis, Nora P. Castañeda-Álvarez, and Andreea Nowak

Across the Caribbean, climate change will bring about not only challenges but also a wide array of opportunities, which lend greater significance to the region's wealth of plant genetic resources. Realizing the potential of those resources to help ensure food security and build more-resilient agricultural systems in the face of climate change will require stronger regional cooperation. Its central aims should be to develop timely interventions across national borders that improve the collection, conservation, and sharing of plant genetic resources.

Key Messages

- Plant genetic resources have great potential to strengthen food security and make agricultural systems more productive and resilient.
- The Caribbean region hosts plant collections of global significance, including cocoa, hot pepper (*Capsicum*), sugarcane, beans, cassava, and fruits.
- Using genetic resources for crop improvement can increase yields and nutritional value and make crops more resilient in the face of pests, diseases, drought, and flooding, thus reducing the region's dependence on food imports.
- Since older farmers are the main custodians of most of the region's plant genetic resources, it is important to pass along their knowledge about on-farm conservation to new generations.
- Plant genetic resources that are essential for food security, either at the national or global level, should receive high priority in the development of climate change adaptation strategies.
- Effective adaptation is a matter of urgency, requiring regional coordination and active involvement of women in participatory plant breeding to identify varieties that meet their specific needs.

Addressing the food security challenge

The 15 member countries[2] of the Caribbean Community (CARICOM) are home to 16 million people. Increasing food production to help meet the region's growing demand for food presents a major challenge, mainly because of weak land tenure schemes and limited availability of farmland.[3] As a result, the region has to spend nearly US$4 billion annually on imported food (Silva et al., (2012).

To address the food security challenge requires an integrated regional approach. The Guyana–Trinidad and Tobago partnership represents a step in the right direction. It aims to improve crop and livestock production in Guyana, so the country can supply food to other countries of the region. Strengthening that partnership and building new ones (e.g., with Belize and Suriname) could put the region on a promising path to greater autonomy in food production and to reduced economic dependency. Toward that end, CARICOM could be expanded to include the Dominican Republic as well as Cuba and Puerto Rico.

The importance of plant genetic resources

Historically, the Caribbean region has served as a bridge between the Mesoamerican and South American centers of biological diversity. As a consequence, the region is rich in plant genetic resources. Moreover, during the colonial period, plant materials of global significance were introduced from the Old World. To safeguard key resources, Trinidad and Tobago operates the International Cocoa Genebank – considered the largest and most diverse cocoa collection in the world – and also holds a very large Caribbean collection of hot peppers (*Capsicum*). Barbados harbors one of the world's largest collections of sugarcane.

Other important examples are the international pineapple collection in Martinique and the collections of Caribbean yam and maize in Guadeloupe, beans in Cuba and Puerto Rico, and squash in Puerto Rico. The Caribbean also holds collections of cassava, sweet potato, peanut, American cotton, *Anthurium*, and vanilla; a wide

1. This Policy Brief was prepared originally for the Caribbean Week of Agriculture, 13–20 October 2012, and was shared with CARICOM ministers during a workshop sponsored by the Technical Centre for Agricultural and Rural Cooperation (CTA).
2. Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago.
3. The Caribbean countries with the most land available for agriculture are Belize, Guyana, and Suriname.

variety of fruit trees (avocado, sapodilla, soursop, sugar apple, star apple, guava, papaya, and mamey sapote); and a large number of introduced species, such as breadfruit, mango, and banana[4].

Climate change impacts

Plant genetic resources provide a basis for developing more-resilient agricultural systems that can strengthen food security despite a variable and changing climate.

The negative impacts of climate change are expected to include sea level rise, coastal erosion, salt water intrusion, higher night temperatures, lower precipitation, and more frequent extreme weather events, such as hurricanes. As a result, agricultural productivity is likely to decline, as new pressures come to bear on an already fragile agricultural system characterized by high production costs, reduced competitive strength, and an aging farm population.

To ensure a food-secure future for the Caribbean, climate change adaptation measures must be rapidly mainstreamed in national and regional agricultural policies and programs. This is an important social responsibility, which the region ought not ignore, as the costs of inaction could be very high.

Given the limited adaptive capacity of individual countries, new efforts to conserve and use plant genetic resources should be coordinated across the region. Institutions such as the CARICOM Climate Change Centre (CCCCC) and Caribbean Institute for Meteorology and Hydrology (CIMH) should work hand in hand with the Caribbean Agricultural Research and Development Institute (CARDI) and the University of the West Indies (UWI) to map the expected effects of climate change on various crops in the short, medium, and long term. On this basis, they should then determine clear breeding objectives and identify environments elsewhere that are similar to those of the Caribbean, from which adapted germplasm could be obtained.

Climate-resilient varieties should be developed using a farmer-participatory approach. New varieties should be rapidly tested across countries, using a farmer field school approach. The International Cocoa Genebank offers an interesting case study of how the use of plant genetic resources for industrial development can have immediate impact.

Economic benefits of plant genetic resources

Using plant genetic resources for crop improvement, particularly if accompanied by improvements in agronomic practices, could bring economic benefits in the short, medium, and long term, mainly as a result of:

- **Increased yields and nutritional value** throughout the year
- **Enhanced crop resilience** to pests, diseases, drought, and flooding
- **Reduced food imports** in the region

Such improvements, if combined with the development of new options for value addition and direct marketing, could lead to new opportunities for economic diversification.

Investing in the conservation and use of Caribbean plant genetic resources could benefit not just the region's own agriculture but that of countries elsewhere. A regional seed system, for example, could give rise to a knowledge industry through which planting materials and practices used in the Caribbean provide a reference point for solving similar problems in other regions.

Research conducted by UWI in Trinidad and Tobago offers a clear example of how investing in plant genetic resources can contribute to economic growth and development. Five years ago, this country was the largest exporter of hot pepper in the Caribbean. Since then, however, the industry has stagnated to the point that pepper (*Pimenta*) exports have come to a halt. This was mainly the result of increased production costs, which amount to TT$6.00 per lb in a market where exporters are willing to pay TT$5.00 per lb. Hot pepper production in Trinidad is based on landraces yielding around 10–20 t/ha, whereas varieties grown in Mexico yield more than 100 t/ha. Research results showed that improving the hot pepper varieties could result in a tenfold production increase, reducing the cost of pepper production by TT$0.60 per lb and thus putting the hot pepper industry back on a profitable footing.

The Value of Crop Wild Relatives

Wild species related to crops contain genes for traits that are potentially useful in making agricultural systems more productive and resilient in the face of climate change. Yet, many of those species face extinction as a result of habitat destruction, agricultural practices, and invasive species, among other changes (Figures 1 and 2). Because of their weedy nature, many crop wild relatives (CWR) are more resilient than the domesticated species. Even so, many of these plants are already rare or of limited distribution and/or endemic.

CIAT takes part in a project called "Adapting agriculture to climate change: Collecting, protecting, and preparing crop wild relatives," which is led by the Global Crop Diversity Trust in association with the Royal Botanic Gardens, Kew, and supported by the Government of Norway. The project focuses on wild species in the gene pools of 26 major food crops, which fall under Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

The project encompasses some crop wild relatives that are native to the Caribbean Basin. Similarly, Bioversity International, another member of the CGIAR Consortium (www.cgiar.org/cgiar-consortium), is developing an action plan to strengthen the conservation and use of plant genetic resources in Mesoamerica.

4. The scientific names of the above-mentioned crops are: Pineapple (*Ananas comosus*), yam (*Dioscorea* spp.), bean (*Phaseolus* spp.), maize (*Zea mays*), squash (*Cucurbita* spp.), cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*), peanut (*Arachis hypogaea*), cotton (*Gossypium barbadense*), vanilla (*Vanilla* spp.), avocado (*Persea americana*), sapodilla (*Manilkara zapota*), soursop (*Annona muricata*), sugar apple (*Annona squamosa*), star apple (*Averrhoa carambola*), guava (*Psidium guajava*), papaya (*Carica papaya*), mamey sapote (*Pouteria sapota*), breadfruit (*Artocarpus altilis*), mango (*Mangifera indica*), and banana (*Musa* spp.).

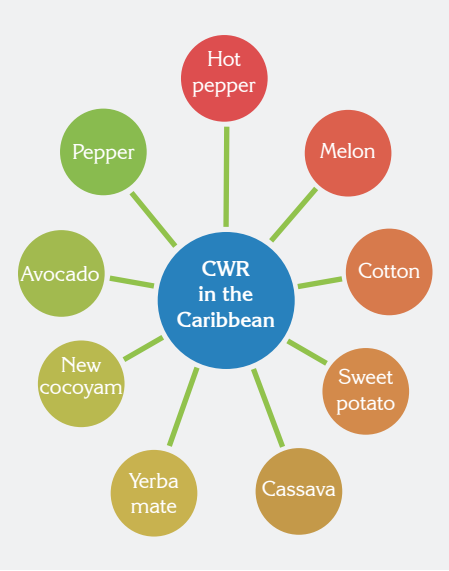

Figure 1. Crops that have wild relatives native to the Caribbean Basin. SOURCE: www.cwrdiversity.org

Challenges: Weak land tenure and an aging farm population

The amount of farmland available in the Caribbean is below 0.07 ha per capita. Land is particularly scarce in the region's small island states, where 90% of the CARICOM population lives. Land scarcity is aggravated by insecure land tenure together with the high cost of land, limited access to roads, and poor irrigation and drainage infrastructure – conditions that lower the profitability of agriculture and undermine food security. Government efforts to increase agricultural productivity in the region should therefore give high priority to land titling as part of a comprehensive approach that offers producers a wider variety of incentives. The government of Trinidad and Tobago has recently provided farmers with new incentives that are independent of their land ownership status.

Older generations of farmers serve as the principal guardians of most of the Caribbean's plant genetic resources by maintaining seed-saving traditions in backyard gardens and on small farms. The immigration of younger members of farm families to urban areas threatens the continuity of those traditions. To preserve important knowledge about plant genetic resources, it is important to properly conserve and document not only the germplasm itself but also associated local knowledge about use, conservation, management practices, and cultural traditions.

Opportunities: A regional policy framework for building climate change resilience

In 2012, the CARICOM heads of government endorsed the Implementation Plan for the Regional Framework for

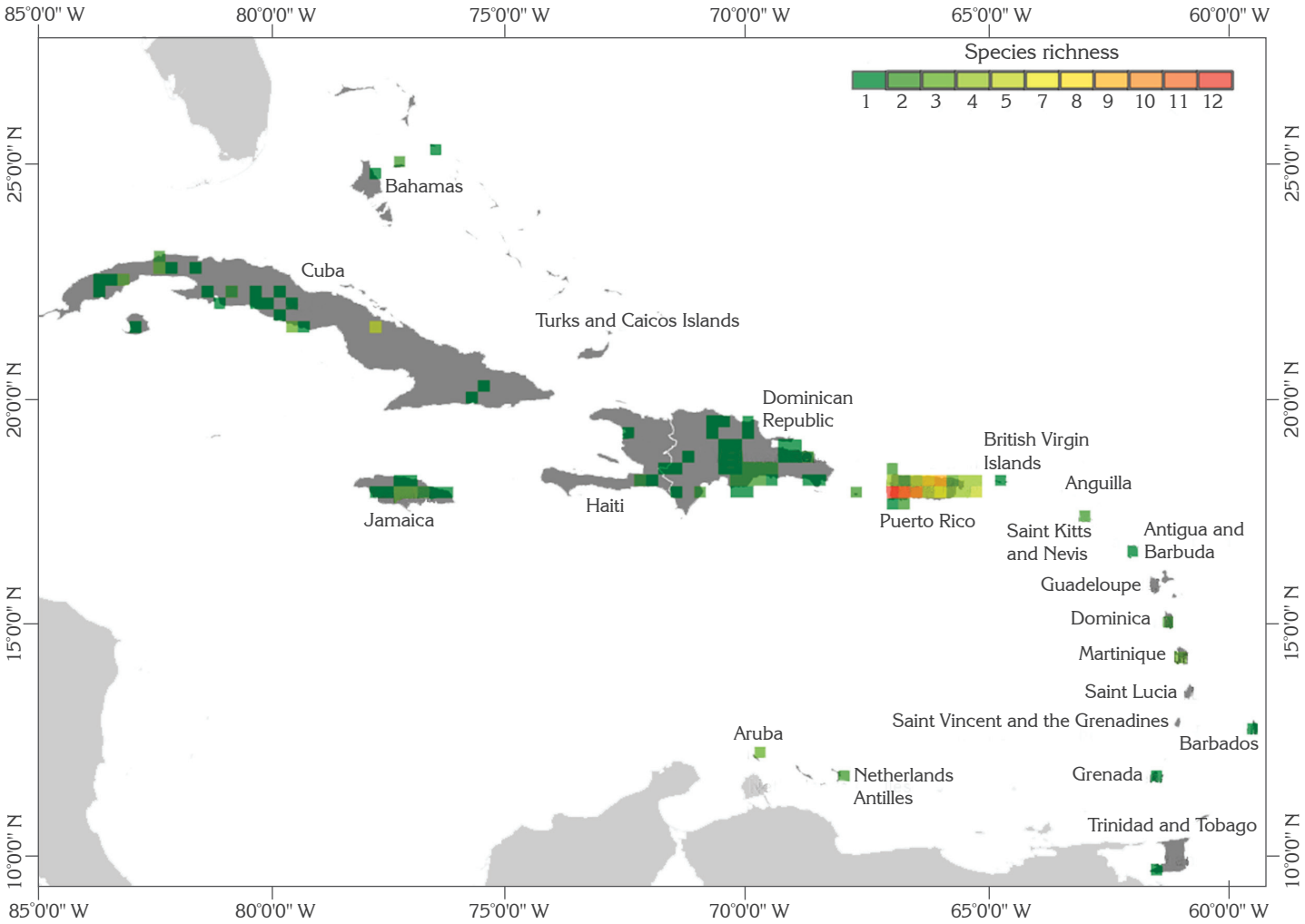

Figure 2. Species richness of crop wild relatives in the Caribbean.

Achieving Development Resilient to Climate Change, which calls for a strategic regional approach to cope with climate change in the period 2011–2021 (CCCCC, 2012). The plan puts agriculture and food security at the forefront of regional priorities. It also calls for coordinated action by the CARICOM Climate Change Centre and relevant regional organizations to identify and mobilize resources for agriculture-related actions. The plan further indicates which government organizations and ministries will take the lead in those actions, while ensuring these are linked with current efforts, such as the Jagdeo Initiative[5] and the Global Environmental Change and Food Systems (GECAFS)-Caribbean.

In recent years, the CARICOM heads of government have focused sharply on the agricultural sector. At their 30th meeting in Guyana during July 2009, they issued the Liliendaal Declaration, which reaffirms, *inter alia*, the importance of agriculture for food and nutrition security and for the economies of the Community. The Declaration further emphasizes the need for governments to give agriculture high priority when approaching development partners in the region and calls for commitment to allocate the resources needed to remove or reduce constraints to agricultural development.

As the Liliendaal Declaration recognizes, achieving food and nutrition security is a multidimensional challenge, which requires an urgent and coherent response. Action must be taken on a broad front covering several sectors of the regional economy – from food production and trade to health, education, and social welfare. The Regional Food and Nutrition Security Policy – rather than equate food security with food availability – provides a more comprehensive perspective (reflecting the concerns of both producers and consumers), which encompasses food access and safety, the stability of food supplies, nutritional security, health, and well-being.

5. CARICOM, www.caricom.org/jsp/speeches/44food_crops_society_bourne.jsp?null&prnf=1

A climate change adaptation pathway

Following are the key steps (Figure 3) in an adaptation pathway centered on native crops and crop wild relatives:

1. **Prioritizing and targeting** native crops and crop wild relatives require close attention, because they provide a rich source of adaptive traits needed for crop improvement. The usefulness of plant genetic resources for making agriculture more resilient in the face of climate change depends on how long they have been in the Caribbean. Resources that have been present for centuries tend to be more diverse and more adaptable to site-specific challenges; hence the importance of knowing about the native flora.
2. **Conserving plant genetic resources (***in situ* and *ex situ***)** merits higher priority and more resources because of their potential for crop improvement, in addition to their economic, cultural, and/or environmental importance. The Global Crop Diversity Trust is supporting the development of a conservation strategy for the Americas[6].
3. **Characterizing and evaluating** plant genetic resources are essential for identifying materials with useful adaptive traits.
4. **Developing crop varieties** that are tolerant to drought, waterlogging, and salinity is key for adapting production to progressive climate change.
5. This step consists of three parallel activities: (1) **identifying climate analogues** for exchanging germplasm that can respond to future climate challenges; (2) **investing in root crops** (such as cassava and arrowroot) to distribute risk through diversification, particularly in the face of climate variability and extreme weather events; and (3) **adopting a gender lens** in research on plant genetic resources, which means working with crops on which women most depend (e.g., vegetables and fruits) and understanding the traits they value.
6. **Testing and sharing** of crop varieties through national and regional networks should involve the use of farmer-participatory approaches.
7. **Adapting farming systems and value chains** to progressive climate change should receive high priority.

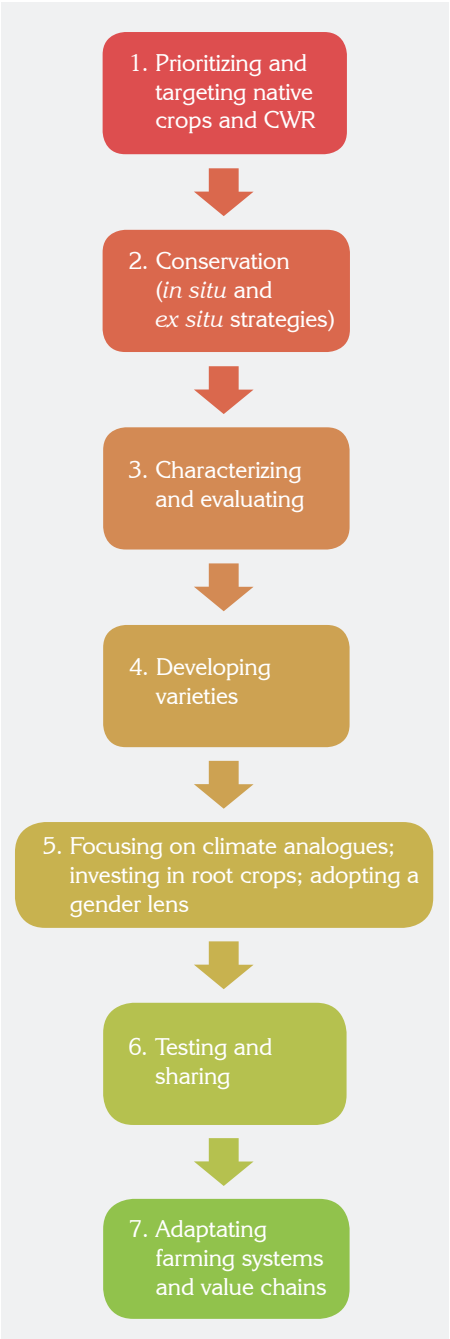

Figure 3. Key steps in an adaptation pathway based on plant genetic resources.

6. Global Crop Diversity Trust, www.croptrust.org/documents/regionalstrategies/Americas.pdf

Policy Recommendations

Two main policy recommendations were emphasized during the Caribbean Week of Agriculture, held on 13–20 October 2012[7]:

1. Strong national systems are needed to collect and safeguard the rich genetic diversity of the region's food and non-food crops, which underpins the agricultural sector.
2. In support of national and regional strategies, mechanisms for international germplasm sharing should be promoted to improve the robustness and resilience of each country's agricultural systems.

This brief further suggests specific policies related to climate change adaptation and plant genetic resources management, which may be summarized as follows:

Adapting agriculture to climate change

- The CARICOM Secretariat should encourage more countries to adhere to the **International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)**.
- National policies for adapting agriculture to climate change should include a **well-defined strategy for the use of plant genetic resources** (Guyana has already moved in that direction), and these strategies should be harmonized with international protocols and regional frameworks.
- Research and investment should distinguish between **plant genetic resources that are economically important** versus those that are **key for food security**. Priorities should also take into account cultural uses and value as well as global relevance. In addition, **high-value niches** should be identified, involving local genetic resources that show value-added potential for specialty markets.
- **Traditional knowledge** is central for using plant genetic resources effectively to develop adaptation pathways. It is also necessary for rescuing crops with high nutritional value and reintegrating them into people's diets.
- **Research on plant genetic resources should be strengthened at current research facilities**, such as those in Cuba and at the UWI. This should form part of an overall increase in budgets for agricultural research, with emphasis on building technical and scientific capacity, while gradually reducing dependence on foreign aid.
- **Research on the potential of plant genetic resources for helping adapt agriculture to progressive climate change should receive high priority.** Native crops and crop wild relatives with a long history in the region have the greatest potential for contributing traits that are important for breeding more-resilient crops.
- The collection, conservation, and study of **crop varieties exhibiting adaptive traits for climate resilience** are recommended across the Caribbean. Varieties of *Capsicum*, *Xanthosoma*, *Psidium*, *Bixa*, and fruit trees in the Sapotaceae family are of particular interest.
- In the short term, when possible, **planting periods** should be modified.
- **Climatic analogues** for the exchange of plant genetic resources, crop management practices as well as other adaptation strategies used *in situ* should be promoted.
- **Participatory breeding processes** are relevant and must be strengthened.
- **Climate change scenarios should inform breeding priorities** for key food security and cash crops in the Caribbean (with emphasis on tolerance to heat, salinity, waterlogging, etc.). For this purpose, it is important to identify hotspots as well as pressure and adaptation spots in the region (see Eitzinger et al., 2012, on hotspots, pressure and adaptation spots in Central America).
- All producers (including landowners and renters) should receive **technical assistance and inputs,** with emphasis on eco-efficient approaches aimed at intensifying production through sustainable resource use, including improved soil health (see CIAT, 2012). Strengthening agricultural production is particularly important for countries like Guyana, which have the most farmland available and the greatest scope for increasing production and reducing food imports.
- Interactions between the **public and private sectors and academia** should be better articulated. Agricultural programs in higher education should emphasize empirical research that responds to the real needs of the region. This is especially important for UWI's new Food and Agriculture Program, which seeks to link the hotel industry supply chain with sustainable farming practices and technology.

Risk mitigation strategies

- **A regional seed policy** is required to reduce the risks associated with the centralized seed system run by multinational companies.
- Root crops offer a good option for coping with climate variability, since these crops are especially resilient in the face of natural disasters.

Collecting, sharing, and conserving plant genetic resources and associated data

- **Mechanisms for collecting social, economic, and climate-related data on plant genetic resources** need to be improved at the national scale and must be maintained over time.

7. Various institutions participated in this process, such as: the Inter-American Institute for Cooperation on Agriculture (IICA), Bioversity International, Caribbean Plant Genetic Resources Network (CAPGERNet), Global Crop Diversity Trust (GCDT), Centre for Pacific Crops and Trees (CePaCT), Cropper Foundation, Food and Agriculture Organization of the United Nations (FAO), ministries of agriculture of the region, and farmers, among others.

- A **regional information system** should be developed that maps the germplasm accessions available and the status of collection, sharing, and conservation in each country. Information on genetic resources of food and non-food crops should be handled by **national systems that collect and safeguard the region's rich diversity** of plant genetic resources.
- **Partnerships between research centers, civil society, and farmers' organizations** should be established to improve access to plant genetic resources. The EcoAgriculture Project, led by the Cropper Foundation, is a successful example of such partnerships, which can serve as a model for scaling up. Social networks, supported by extension services, can also be effective for fostering seed exchange between farmers across the region.
- Facilities for ***ex-situ* conservation** in the region should be improved. **Duplicate collections** of Caribbean germplasm should be placed outside the region (e.g., in the international collections held in trust by CGIAR centers) to ensure the safety of important materials over the long term.

A regional approach

- With the support of CARDI, CARICOM should lead a **regional initiative for the management of plant genetic resources**, aimed at establishing a **regional legal framework** for facilitating benefit sharing. This initiative should foster timely germplasm exchange and provide mechanisms to reduce risks (e.g., from diseases and invasive plants). A benefit-sharing mechanism that addresses property rights issues must be established for the exchange of crop varieties that were developed by particular countries but are valuable across the region.
- **South-South cooperation** between countries of the Caribbean, Latin America, Africa, and Asia (Pacific) should receive high priority, along with capacity building, knowledge exchange, and collection and sharing of plant genetic resources.

A gender lens

- Research on plant genetic resources should have a gender lens. This means giving **high priority to crops on which women depend** for income and food (e.g., vegetables and fruits) as well as engaging women in participatory breeding to identify varieties that meet their specific needs. Women often value crop traits, such as cooking time and nutritional quality, that may be less important for other stakeholders.

Further reading

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About the authors

Carolina Navarrete-Frías is Coordinator of CIAT's Decision and Policy Analysis (DAPA) Research Area.

Path Umaharan is Professor of Genetics and Head of the Cocoa Research Unit at the University of West Indies (UWI) in Trinidad and Tobago.

Daniel Debouck is Head of CIAT's Genetic Resources Program.

Sergio García is Programme Manager for Agriculture and Industry at the CARICOM Secretariat.

Carlos Fuller is International and Regional Liaison Officer of the CARICOM Climate Change Centre.

Norman Gibson is a Scientific Officer in the office of the Executive Director at CARDI Headquarters in Trinidad and Tobago.

Andy Jarvis is the Director of CIAT's DAPA Research Area.

Nora P. Castañeda-Álvarez is a Doctoral Researcher at the University of Birmingham and a Research Assistant with CIAT's DAPA Research Area.

Andreea Nowak is a Visiting Researcher in CIAT's DAPA Research Area.

For more information

Nora P. Castañeda-Álvarez
n.p.castaneda@cgiar.org.