Improving Caribbean food security in the context of climate change

SUMMARY OF RESULTS

Significant capacity in advanced germplasm management was built and in vitro facilities were strengthened. Risk maps for flooding, salinisation and drought for several locations in Barbados, Belize, St. Kitts and Nevis, and Trinidad and Tobago were developed and published, including detailed maps of the agro-ecological zones in these countries. Climate resilient germplasm of sweet potato, maize, cassava, pigeon peas and beans were identified and one germplasm bank of climate-resilient cultivars was established in each country. The banks are used to distribute the climate resilient germplasm to farmers. Genetic fingerprinting was completed for selected sweet potato varieties, providing the region with verifiable evidence of genetic differences/similarities among the various cultivars planted by farmers.

BACKGROUND

CARICOM’s food import bill now exceeds USD 4.5 billion and has increased the region’s vulnerability to external threats. Overconsumption of highly processed imported foods has also led to the current epidemic of chronic non-communicable diseases (NCDs). These have now become the leading cause of morbidity, low labour productivity and death in the Caribbean. Growing food and nutrition insecurity in the region has been exacerbated by climate variability and change. The current germplasm used by farmers is projected to become less productive as the climate models predict changes towards more extreme dry and wet seasons and stronger storms. This impacts all regional residents but is of particular importance to producers, processors and decision makers.

The critical questions to be answered by this project included:

- Are there distinct agro-ecological zones within the Caribbean that will support varying levels of production from crops that are important to food and nutrition security?
- What are the vulnerabilities of the identified agro-ecological zones to drought, flooding and saline intrusion?
- Can we identify and conserve climate resilient, market acceptable germplasm of the region’s important food crops?
- Are the identified cultivars genetically distinct? If so, what does that mean for nomenclature among the countries?
- What technical and policy capacity exists in the region to manage climate resilient germplasm and the associated governance systems?
- Will farmers adopt the new germplasm within their farming systems and how will the process of new knowledge dissemination and application be managed?

The project was designed to serve the needs of CARICOM through targeted research in Barbados, St. Kitts and Nevis, Belize, and Trinidad and Tobago, four countries which represent the climate quadrants of the region. The work included: the identification of important food and nutrition security crops; agro-ecological zone characterisation and the development of drought, flooding and salinisation risk maps; field experimentation to identify climate resilient traits among selected cultivars; germplasm management (conservation, sharing and utilisation); capacity building among key stakeholders; and the distribution of climate resilient cultivars to producers.

The 100+ stakeholders who benefited from the project included farmers’ organisations, producers, extension officers, technicians, scientists from the national agricultural research systems and CARDI scientists.
**METHODOLOGY**

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### Project initiation
The initial engagement of local stakeholders to discuss the project and to get buy-in was a critical first step which ensured that they understood and had the opportunity to contribute to the project implementation process.

### Baseline exercise
A literature review and scoping activity were performed to determine and quantify the edaphic, climatic and socio-economic architecture of the baseline. This consisted of sampling sites in specific agro-ecological zones and conducting interviews with stakeholders living in those areas. Time series climate data were collected and analysed. Agro-ecological data were also collected at various sites in the participating countries and drought, flooding and salinisation risk maps were developed.

### Germplasm management
For the development of germplasm banks, searching the databases and collections of the national systems and dialoguing with farmers and other stakeholders enabled the identification of candidate varieties of the food crops important for food and nutrition security (FNS). These included: sweet potato (*Ipomoea batatas*), maize (*Zea mays*), cassava (*Manihot esculenta*), beans (*Phaseolus* spp, *Vigna* spp.) and pigeon peas (*Cajanus cajan*). Some candidate varieties of maize were obtained from Belize and then trialled in Trinidad and Tobago. This was followed by the establishment of replicated trials in the different agro-ecological zones to determine statistical variation. Trials were done primarily to establish drought and flood tolerance and the resulting data were subjected to statistical analysis. Germplasm banks were established in each country to preserve the identified climate resilient cultivars.

Technicians, farmers and extension officers received training in weaning and hardening of tissue culture material, as well as in the establishment and maintenance of germplasm banks. This was done through different means: hands-on regional training sessions in Barbados aimed primarily at technicians; national trainings for farmers and extension officers held in each country; and additional training sessions conducted in collaboration with the Ministries of Agriculture for farmers to build capacity in the cultivation and management of the new germplasm. Two CARDI scientists were also trained at the Centre for Pacific Crops and Trees in Fiji in advanced germplasm management systems.

### Knowledge application
For the distribution of selected climate resilient cultivars to farmers, suitable sites were prepared and the germplasm introduced into existing banks. Where banks did not already exist, new germplasm banks were established. Introduction into existing germplasm banks necessitated their rehabilitation and strengthening, including the provision of irrigation systems to ensure sustainability. Two tissue culture facilities in Barbados and Tobago were strengthened to increase regional *in vitro* capacity to service the requirement for cross-border tissue culture services.

Stakeholders were re-engaged with dialogues on: climate change and its effects on agriculture and FNS, the role that climate resilient germplasm plays in strengthening FNS in a changing climate, the impacts on stakeholders (especially farmers), the responses needed to support agriculture sector resilience, and the need for supporting policy for the entire system. Project validation workshops provided the platform for dialogue and attending farmers were given improved maize germplasm.

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**Sweet potato drought trial data collection, Longdenville, Central Trinidad (March 2014).**

**CARDI technician collecting data from a bean drought tolerance trial in Belize (February 2015).**
• Drought, flooding and salinisation risk maps of agro-ecological zones in the Caribbean that represent the major farming areas.
• A crop modelling system that routinely collects data from meteorological stations for use in crop trials. The data more accurately match plant growth and development to measurable ambient conditions.

Crops
• New cultivars of maize (2 in Belize, 2 in Trinidad and Tobago), sweet potato (5 in Trinidad and Tobago, 2 in St. Kitts and Nevis, 2 in Barbados), pigeon peas (2 in St. Kitts and Nevis), cassava (1 in Barbados) and beans (2 in St. Kitts and Nevis, 2 in Belize) established and provided to farmers to enrich their selection of crops important for food production and climate resilience.
• Corrected identification of sweet potato varieties that have gone by different names in different parts of the region and even in the same country.

Facilities
• 1 germplasm bank of climate resilient cultivars of sweet potato, pigeon peas, maize, beans and cassava – 1 each in Barbados, Belize, St. Kitts and Nevis and 2 in Trinidad and Tobago.
• 2 national in vitro laboratories in Barbados and Tobago are equipped to produce, wean and harden tissue culture material for distribution to farmers.

Capacity building
• 3 scientists (1 female) trained in the protocols for germplasm collection for DNA fingerprinting.
• 15 scientists (9 female) trained in crop modelling using the ‘Decision Support System for Agrotechnology Transfer (DSSAT)’, a software application programme that comprises dynamic crop growth simulation models.

Publication
• Gibson N. et al., 2018. The role of plant genetic resources in building agriculture climate resilience in the Caribbean. Policy Brief. CARDI Publication. CARDI Headquarters, St Augustine, Trinidad and Tobago.
RESULTS

**Impacts**

**Usage**
- Farmers are using germplasm identified during the project and progress is underway towards more widespread adoption.
- The use of climate resilient varieties will: reduce the proportion of wheaten flour in food preparation in the Caribbean (cassava); improve the outcomes of persons suffering from nutrition-related non-communicable diseases (NCDs) (sweet potato); enable foreign exchange savings by reducing imports of this commodity (maize); and improve plant protein nutrition of rural communities (pigeon peas and beans).
- With the planned development of a PGR centre in Guyana and the increased capacity for germplasm management to produce materials for farmers, the expectation is that there will be reductions in food imports and increases in domestic economic activities.

**Policy implications**
- The CARICOM Council for Trade and Economic Development (COTED) has endorsed the decision by UWI, CARDI and the University of Guyana to develop a regional Climate Smart Agriculture (CSA) training programme for the retooling of agriculture extension officers, other professionals and members of farmers’ groups. The programme has been developed and will be taught at UWI.
- The CARICOM Ministers of Agriculture have adopted the resilience agenda that supports sustainable food production in the context of climate change. Building a climate resilient agriculture sector focusing on the management of key germplasm resources is being recognised as an important feature in safeguarding food and nutrition security. This new thinking is reflected in the following:
  - The proposal to make Dominica a Global Agriculture Resilience Centre.
  - The decision by CARDI to establish a regional germplasm centre in Guyana to facilitate the conservation, sharing and utilisation of regional germplasm resources.
  - The approval by CARICOM Ministers of Agriculture of the CARICOM strategic plan 2018-2022 which includes the establishment of a climate resilient food and agriculture system through a robust germplasm management programme.
  - The CARICOM strategic plan 2015-2019 that includes environmental resilience building through agriculture.
- Utility of climate resilient germplasm of important food crops for the implementation of the CARICOM Regional Framework for Achieving Development Resilient to Climate Change has been demonstrated. There is now a scientific basis to scale up and scale out these findings and to strengthen the policies that enable the cross-border movement of germplasm within CARICOM.
- CARDI is now a key contributor to the National Climate Outlook Forum (NCOF) organised by the Trinidad and Tobago Meteorological Services.
- CARDI has adopted a differentiated strategy to serve 14 countries with germplasm investments to strengthen regional food and nutrition security in the context of climate change.

**Sustainability**
- Continued interactions with farmers have spawned the implementation of a new project in 2017 which uses satellite imagery to rapidly conduct loss assessments on agricultural holdings in at risk Caribbean countries. In this regard, the promotion of new sweet potato germplasm among CARICOM Member States was facilitated by innovation platforms where farmers can influence decision making relative to R&D priority setting for the sweet potato industry.
- The continuation of research into climate-ready food crops will improve food and nutrition security in the Caribbean. The region is now very aware of climate change issues and is ready to support related research, particularly in relation to the new demands for nutrition-rich foods to combat the rise of chronic NCDs as the leading cause of death in the region.
- The enrolment of a young female scientist at Massey University (New Zealand) to read for the PhD in sweet potato breeding, tackling the intersection of climate resilience and nutrition security, particularly considering the epidemic of chronic NCDs in the Caribbean.

**TESTIMONIALS**

Jose Antonio Castalleda, farmer, Valley of Peace, Cayo District, Belize

“I have been working with CARDI for many years. The maize seeds of improved maize varieties perform better than the traditional seeds I have been planting for many years. The bean seeds I received also performed better. I am very happy to see these results and will continue using them as they provide me a much better income.”

Ramdeo Boondoo, farmer, Central Trinidad, Trinidad and Tobago.

“The project was of great interest particularly because sweet potato and cassava are good for promoting food security and the DNA work is a personal interest. I was proud to see that some of my germplasm was selected for DNA fingerprinting as I am a farmer that practices ‘plant breeding’. As such I was pleased that these selections were chosen for further characterisation work.”

ACP-EU Co-Operation Programmes in the fields of Higher Education and Science, Technology and Research

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