IICA

Climate smart agriculture in the Eastern Caribbean States

A Compendium of Stories from Farmers

Editors: Kelly Witkowski and Daniela Medina

Caribbean Climate Smart Agriculture FORUM

Resilience and comprehensive risk management in agriculture

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Foreword

Caribbean countries are particularly susceptible to climate change related risks, with their agricultural sectors being one of the most vulnerable. In response, farmers, governments, companies and others working in agriculture are actively seeking to develop production, processing and marketing systems that are resilient to climate related risks and stressors and that make efficient use of the limited available natural resources. To facilitate this, efforts must be made to develop, identify, promote and disseminate innovative farming systems, technologies, strategies and measures that will help to strengthen resilience and increase the productivity and viability of the agriculture sector in the region.

For these reasons, the Inter-American Institute for Cooperation on Agriculture (IICA), the Ministries of Agriculture of the Eastern Caribbean States (ECS) and other partners launched a Regional Competition to identify, document and disseminate successful cases of the implementation of technologies and practices that are contributing to climate smart agriculture in the ECS. This competition is part of a broader effort to develop capacities and strengthen institutions to enable an effective response to climate change by the region's agri-food sector.

This compendium of experiences highlights some of the early actions that farmers across the region are implementing with success. While the Caribbean still faces significant challenges in achieving sustainable agricultural development under the pressure of a changing climate, these stories reflect that there is enough knowledge, innovation and social capital to achieve these goals. The identification and evaluation of pilots of climate resilient technologies and practices will help to more quickly boost successful technologies for the benefit of all Caribbean citizens.

In sharing these experiences, we recognize and applaud the many actors – and in particular the farmers and organizations supporting them – who are working towards the realization of more resilient agricultural systems that contribute to improving the social, economic, and environmental conditions in local communities.

Climate smart agriculture in the Caribbean Region

The agricultural sector, which makes an important contribution to the economic and social welfare of the Caribbean, is particularly vulnerable to the changing climate. Impacts are already being felt by many farmers and rural communities throughout the region. Meanwhile, the climate is continuing to change at a rapid pace; 2016 again broke the record as the hottest year to date (NASA, 2017); sea levels continue to rise, and precipitation patterns are shifting (IPCC, 2013). This threatens not only the livelihoods of the region's farmers, but also the contributions to economic development, poverty reduction, and food security that the agri-food sector provides.

Climate vulnerability

Caribbean countries have historically been particularly vulnerable to the effects of severe hydro-meteorological events (Carby, 2011). Nine out of the top 20 countries that have faced the greatest losses from extreme events worldwide as measured per unit GDP between 1996 and 2015 are in the region (Kreft, Eckstein, & Melchior, 2017). Four of the top ten countries with the highest mortality risks from multiple hazards are also in the Caribbean (Dilley, Chen, Deichmann, Lerner-Lam, & Arnold, 2005). The risks of loss and damage from extreme events will most likely continue to rise with a changing climate (Nurse et al., 2014)

Under an intermediate low emissions pathway (Representative Concentration Pathway 4.5), the median projections for the years 2081-2100 show an increase in temperature of 1.4 degrees Celsius and a 5% decrease in rainfall in the Caribbean, when compared to the years between 1986 and 2005 (Nurse et al., 2014). Combined with the additional temperature increases between the Industrial Revolution and 1986, it is unlikely that warming will be limited to 1.5 ºC in the Caribbean – the goal many advocate for - even under the lowest emission pathway (Nurse et al., 2014). Overall, a decrease in wet season precipitation and greater seasonal and inter-annual variability of precipitation are expected, though there will be inter-regional differences (Nurse et al., 2014; Karmalkar et al., 2013). Given the small size of the countries, better observational data and improved modelling with greater resolution are needed to improve projections for the region (Karmalkar et al., 2013).

In conjunction with non-climate stressors, climate change will lead to a chain of impacts at the local, national and regional levels (Nurse et al., 2014)s. Longer dry periods with more frequent and intense droughts are expected to increase water demand in the region (Nurse et al., 2014). Higher rates of evapotranspiration, increased heat stress for crops and livestock, and reduced productivity are likely (Simpson et al., 2012). To address this, many of the climate strategies and action plans in the Caribbean include agricultural adaptation as a priority (Witkowski & Medina, 2016).

The Intergovernmental Panel on Climate Change, however, acknowledges that "adaptation and mitigation on small islands are not always trade-offs, but can be regarded as complementary components in the response to climate change" (Nurse et al., 2014: 1616)". This is especially true for the agricultural sector, where many practices can both enhance climate resilience and reduce emissions simultaneously. Farmers in the region must shift to more sustainable agricultural productions systems better adapted to the changing climate to maintain productivity and contribute to food security. Low emissions development pathways are also needed to ensure competitiveness and sustainability. The agricultural sector in the Caribbean – and globally – faces the challenge of finding innovative ways of balancing these multiple goals.

Triple wins with climate smart agriculture

The development of approaches aimed at simultaneously improving food security and addressing mitigation and adaptation challenges - triple wins- in agricultural systems is increasingly important (Bogdanski, 2012; Bryan et al., 2013). Most conventional agricultural and development interventions treat food security, climate change adaptation, mitigation and improved livelihoods as independent objectives (Lipper et al., 2014). This often results in a fragmentation of efforts and finance to meet the various demands placed on the sector. To address this, new integrative approaches have been developed, the most common of which is climate-smart agriculture (CSA).

CSA is an approach that seeks to develop the technical, policy, and investment conditions to achieve sustainable agricultural development for food security under climate change. CSA should enable the sector to transition towards more climate-resilient production systems and more sustainable livelihoods in the presence of increasing climate variability and change. As originally proposed by the UN Food and Agriculture Organization (FAO), the three pillars of CSA interventions are intended to:

1. Sustainably increase agricultural productivity and incomes (i.e. strengthen livelihoods and food security, especially of smallholders);
2. Adapt and build resilience to climate change;
3. Reduce and/or remove greenhouse gases emissions, where possible and appropriate.

The range of practices through which these triple wins can be achieved in agriculture are extensive and include options such as agroforestry, reduction in soil erosion, improved efficiency in synthetic agrochemical use, crop rotation, diversification, improved water management and better livestock feeding strategies (Bryan et al., 2013; FAO, 2011, 2013; Lipper et al., 2014; Smith & Olesen, 2010). While most of these practices are not new and have already been implemented by many farmers around the world, the CSA approach strives to integrate interventions at multiple scales and in multiple timeframes (Lipper et al., 2014). The novelty lies in explicitly recognizing how these practices can contribute to multiple goals and in understanding and managing the potential trade-offs at different scales (Lipper et al., 2014). This includes managing on-farm management interventions, developing institutional capacities, and designing supportive policy interventions, with the goals of all three pillars in mind (Bogdanski, 2012).

While it is unrealistic to expect that every individual intervention will alone contribute to all three pillars of CSA, it is reasonable to expect a balance – though not necessarily equal - when the group of actions taken or technologies used are considered together (Lipper et al., 2014). Depending on the context, one pillar may be prioritized over others. In the

Caribbean, where smallholder systems dominate and emission levels from production are generally low, the adaptation and resilience and food security pillars most often dominate, with mitigation co-benefits as a secondary consideration (Witkowski & Medina, 2016).

CSA, in theory, has the ability to balance multiple objectives, to contribute to improve the sustainability of agricultural systems and to support food security at a local and global scale (FAO, 2013). Nevertheless, implementing CSA in practice and providing tools to comprehensively assess its outcomes remains a major challenge (Steenwerth et al., 2014). Many efforts are labelled CSA, though robust scientific evidence regarding the ways in which they achieve multiple objectives is often lacking (Bryan et al., 2013; Rosenzweig & Tubiello, 2007).

The Caribbean Climate Smart Agriculture Forum

Mainstreaming CSA as quickly and successfully as possible in the Caribbean's agricultural sector will be facilitated by the exchange of knowledge and lessons learned both within and among countries and in the region. Given the urgency of addressing climate change in agriculture, IICA and its partners established the Caribbean Climate Smart Agriculture (CCSA) Forum in 2015 as a platform through which agricultural sector stakeholders, as well as other relevant actors, can coordinate and exchange experiences and knowledge. The Forum, which involves the 13 English speaking countries in the region, acts as a neutral space where all can share, learn, plan and promote policies, strategies and actions towards more productive, low emission, sustainable agricultural systems that are well adapted to the changing climate of the Caribbean.

The primary objectives of the Forum are to:

- Raise awareness and share knowledge of climate smart agricultural practices, policies and options for the Caribbean region.
- Build a community of interested and engaged actors at the regional and national levels that can support the integration of climate change considerations into policy, planning, research and implementation in the agricultural sector.
- Promote enhanced coordination and collaboration among actors and institutions to achieve optimal results.

To date, actors from the public and private sectors, civil society, farmers' groups, researchers, and workers in the agricultural and other related sectors (health, planning, environment, etc.) have gathered every two to three months since mid-2015 in IICA's country offices to participate in regional webinars followed by national discussions on priority topics related to climate change and agriculture. An average of 100 people has participated in each forum. In addition, a series of training workshops and other activities are organized through the Caribbean CSA Forum. This competition is one of those activities executed in the year 2016.

The competition, entitled, "Climate Smart Agriculture in the Eastern Caribbean States: Stories from Farmers," was designed to identify innovative and replicable agricultural technologies or practices that contribute to farmers' resilience and adaptation to climate change. As the CSA approach emerged fairly recently (2010), the proactive steps taken by various actors in the agri-food sector – and especially by farmers, such as the ones featured in this compendium -

are critical for strengthening the evidence base and furthering the understanding of what CSA looks like at the farm, landscape and national levels. This, in turn, is critical for enabling the scaling up of the most effective options being piloted in each context.

Thirteen cases are presented here – first the three regional level winners, then three national level winners followed by seven additional cases of merit. Each story clearly identifies the climate signals that farmers have noticed impacting their production, the measures taken in response, the impacts and positive results achieved, and the lessons learned from the process. The cases, factors for success and key next steps for the region are summarized at the end. These initiatives taking place in Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, show how the public sector, NGOs, farmers organizations and the international cooperation community are working together to make the region's agricultural sector more productive and resilient, while also decreasing emissions where possible.

Competition process: Submission and selection of entries

IICA, in partnership with the Ministries of Agriculture in the Eastern Caribbean States and others, launched the regional competition entitled "Climate Smart Agriculture (CSA): Stories from Farmers in the Eastern Caribbean States" on March 30, 2016. Detailed terms of reference, which included the evaluation criteria, were developed and disseminated to guide entries.

Eligibility

The contest was open to organizations working in the Eastern Caribbean States: Antigua and Barbuda, Dominica, Grenada, St. Lucia, St. Kitts & Nevis, St. Vincent & the Grenadines. Eligible entities included any organization or organized group (public, private or civil society) working in agriculture in the ECS. Government Ministries of Agriculture, international organizations (either for profit or non-for profit) and their employees were not eligible to participate in the competition; however, the organizations they support were eligible to submit applications.

Following the pillars of climate smart agriculture, it was required that entries focus on the resilience aspect of the story, while also indicating benefits for the productivity. Contributions to mitigation –when applicable- could be described as well. An online form was developed to facilitate the submission of the cases.

Evaluation process and criteria

Numerous entries were received from Antigua and Barbuda, Dominica, Grenada, St. Lucia, St. Kitts & Nevis, St. Vincent & the Grenadines, all highlighting the impressive steps farmers, cooperatives, local and national organizations are taking to confront the challenge of climate change in the agricultural sector.

After the competition closed, a panel of three independent judges, with expertise in agriculture, climate change, and the Caribbean region, was established to identify the winners. Each judge scored the entries received, and those scores were then averaged to arrive at the final score.

Each case had to identify the climate risk that the technology and/or practice addresses. Stories that failed to identify the climate risk were disqualified. Once it has been determined that the entry responded to a climate risk, the stories were evaluated according to the following criteria:

1. The implementation of the technology or practice has contributed to agriculture adaptation to climate change by reducing climate risk (30 points)
2. The implementation of the technology or practice has demonstrated that it improves or stabilizes agricultural productivity (10 points)
3. The implementation of the technology or practice has contributed to generating and or increasing income or food security (10 points)
4. The implementation of the technology or practice has helped to reduce emissions (5 points)
5. The implementation of the technology or practice has the potential to be replicated or scaled up (10 points)
6. The initiative is sustainable (socially, environmentally, economically) (10 points)

7. Co-benefits (water use efficiency, supports women and youth, etc.) (5 points)
8. Effective lessons learned and advice for other farmers (15 points)
9. Completion of full entry form (5 points)

The three regional winners were selected by identifying the cases that received the highest number of points overall. The national winners were then determined by grouping the cases by country and identifying the case that received the highest number of points in each group.

Recognition

A national ceremony was held in each country to disseminate results and recognize all participants in the competition. Regional and national winners received a series of prizes. A technical profile and video were produced for each of the regional winners. In addition, a representative from each of the winning organizations received an all-expenses paid trip to the Caribbean Week of Agriculture in the Cayman Islands in late October 2015. During the event, the regional winners were recognized by Minister Kurt Tibbets of the Cayman Islands and Victor Villalobos, the Director General of IICA. The winners had the opportunity to share their stories, to learn from the technical sessions, and to network with other agricultural colleagues from the region.

Various other prizes were awarded in the national ceremonies, courtesy of the generous partners listed below.

Antigua & Barbuda	Regional and National winner: ***Sir McChesney George Secondary School* -** plaque Runner Up: ***Precise Development Foundation* -** plaque
Dominica	National winner: ***4-H Local Leaders Association*-** GEF support for the project and plaque Runner up: ***Eco Balance*** - EC$300 and plaque 3rd Place: ***Giraudel/Eggleston Flower Growers Group* -** plaque Participants: ***Agriculture Women Movement – Women Farmers Group; AgroSuede Backyard Gardening* -** certificate Partners:
Grenada	Regional and National winner: ***Grenada Organic Agriculture Movement (GOAM)*** EC$2500 in farm materials/equipment, and plaque Runner up: ***Ottley's Farm*** - plaque 3rd Place: ***North East Farmers Organization (NEFO)* -** Invitation to apply to the GEF Small Grants Program for a grant of up to USD 50,000 Participants: ***Grenada Cocoa Association* -** certificate Partners:
St. Lucia	Regional and National winner: ***Belle Vue Farmers' Cooperative* -** EC$500 and plaque Runner Up - ***Millet Development Committee* –** EC$300 and plaque Partners:
St. Kitts and Nevis	National winner: ***New River Farmers' Co-operative Society* -** EC$500 voucher, EC$100, plaque Runner Up: ***Clarence Fitzroy Bryant College (CFBC)*** - EC$250 voucher, EC$150 3rd Place: ***Small Ruminant Association*** - EC$400 voucher for fencing wire Participants: ***H & H Farms; Legacy International; Gideon Force Organic Garden* -** EC$250 voucher Partners:
St. Vincent and the Grenadines	National winner: ***Richmond Vale Academy* –** plaque

Their stories are presented here, along with several other noteworthy cases that were entered in the competition.

Regional winners

1. Increasing agricultural productivity through the application of innovative technology to overcome drought and unpredictable climate conditions in Barbuda
   Sir McChesney George Secondary School, Antigua and Barbuda

2. The path to sustainability and stability of growth in a changing climate
   Belle Vue Farmers' Cooperative, St. Lucia

3. Meeting the challenges of climate change in Grenada through organic agriculture
   Grenada Organic Agriculture Movement (GOAM), Grenada

Climate smart agriculture
in the Eastern Caribbean States

Increasing agricultural productivity through the application of innovative technology to overcome drought and unpredictable climate conditions in Barbuda

Sir McChesney George Secondary School,
Codrington Village, Barbuda, Antigua and Barbuda

Contributions to climate smart agriculture

Diversification, integration and innovative technologies that enable production under extreme and unpredictable climate conditions, have increased the resilience of the farming system to climate risks.

Year round availability of locally produced poultry products, fish and fresh fruits and vegetables has enhanced the food security of the island's 1800 inhabitants and decreased reliance on food imports, which is especially important during and after tropical storms and hurricanes.

Locally produced agricultural products reduce the need for imports arriving to Barbuda by boat and air, thus decreasing greenhouse gas emissions. The use of poultry manure and compost as fertilizer, and the capture and use of rainwater, eliminating dependence on reverse osmosis and the public water supply, have reduced GHG emissions.

Climate change signals:	Climate smart practices and technologies:
Changes in precipitation patterns	Water management
Increased climate variability	Soil management
Increased temperatures	Alternative farming methods
Sea level rise	Agroforestry
	Diversification

The challenges posed by climate change

Barbuda, the smaller (62 sq mile) of the islands in the state of Antigua and Barbuda, is flat with thin soils, low rainfall (average 35 inches annually) and frequent droughts. These conditions create many challenges for conventional farming, which are now being exacerbated by climate change, thus threatening the traditional activities of fishing and slash and burn agriculture, upon which the livelihood of the island's population of 1,800 people depends.

Conventional farming methods, which are heavily dependent on predictable seasonal rainfall, have not been successful due to the changes in weather patterns as well as in the wet and dry periods. Land preparation and planting dates are no longer predictable as a result of changes in precipitation patterns. Increased climate variability, higher temperatures, drought and low rainfall periods are becoming more frequent, making traditional farming unviable.

Sea level rise has led to salt water intrusion in the ground water supply, much of which has now become unusable for crop production, while traditional crop lands in coastal areas have become unusable due to salinization. Farmers have observed an increase in the frequency of droughts, prolonged dry spells and extreme storm weather with flooding. Increased evapotranspiration and a lack of adequate water harvesting and storage have contributed to a near cessation of vegetable production on the island.

Over the years, these climate change impacts have contributed to increased crop failures and a sharp decline in agricultural production; today there are no full time farmers. The historically agriculture based economy was once able to export many agricultural products. Today, there are less than ten families that farm part time, compared to the past when almost all engaged in some form of food production. Barbuda has become a net importer of food (over 90% is imported), traditional livelihoods are threatened and food security is compromised. These impacts have been accompanied by a significant decline in the number of youth entering the agriculture sector.

The solution

Since its establishment in 2005, Sir McChesney George Secondary School has been working to reverse this trend, improve food security and address climate change impacts on agriculture. Located on the outskirts of the single village, it is the only secondary school on the island. Agricultural Science was made a key component of the school's curriculum when it opened in 2005 and a school farm was established to teach and demonstrate how agricultural production can be carried out in spite of the many challenges. The farm, which consists of poultry production (eggs and broilers), vegetables, an orchard (mango and cashew) and aquaponics (fish and vegetables), is run as a commercial entity in order to provide students with practical experiences and skills training. A strong capacity development process, involving both the students and other farmers on the island, underpins the success of the climate risk interventions.

Over time, it became clear that climate change would negatively affect the island's food security. To help address the increasing climate risks Barbuda's agricultural sector faces, new practices and technologies that help increase production in spite of the increasing climate variability were introduced as part of the school's compulsory agriculture science program. These included:

Rainwater harvesting : Water is now harvested and stored for operating the farm and the school. The roof of the school buildings were equipped with gutters and a piping system that transfers the rain to a 60,000-gallon water storage cistern, which is now the source of water available for the farm.

Mulching and composting : Grass produced on the fields of the school grounds is harvested and used for mulching the vegetable plots. This conserves water and improves the productivity of the soil over time. Hay is also used as litter in the fixed poultry pens as traditional material (sawdust/wood shavings) is not available locally. The used litter is then composted and used in the crop plots to improve the soil.

Integrated farming : The school utilizes a movable poultry pen system which allows the birds to graze on the grass in the fruit tree orchard. This reduces feed costs, decreases unpleasant odors, fertilizes the fields and increases the health of the birds. In addition, hay is produced for use as mulch and litter in poultry production and in turn, poultry manure is used as fertilizer for crop production.

Aquaponics : addresses the challenges created by low and unpredictable rainfall and extreme weather. It allows for year-round production of high value vegetables along with fish, given the conditions that prevent traditional agricultural production.

Fruit production : This helps to diversify production, thus mitigating risk and stabilizing or increasing incomes.

Each year, the Board of Education provides start-up funds for the purchase of feed and birds. Profits generated for the rest of the year, averaging EC$30,000 (US$11,112) are used to sustain and expand the program and to finance school operations.

Results and contributions to the 3 pillars of climate smart agriculture

- The successful development and operation of a farm has generated funds for sustaining production over a ten-year period. The income provided by the farm supports school operations and provides direct benefits for all 142 students, as well as indirect benefits for the community. Funds have been sufficient to permit the expansion of the program and to support the school's operations when the budget allocated from the central government has been insufficient.

- Eggs produced by the school farm and other producers who have learned from the training and demonstration provided, have made Barbuda self-sufficient in egg production since 2015. The eggs produced locally are available at a cost that is lower per dozen (EC$9.50) than those brought over by boat from Antigua (EC$12-13). The development of a tractor pen poultry rearing system suited to conditions in Barbuda has facilitated the raising of poultry in small spaces. In 2016, two new egg businesses were established using the school's production model.

- The local availability of poultry products and fresh fruits and vegetables enhances the food security of the wider community (approximately 1800 inhabitants.) In the 2011 – 2012 academic year, the school farm produced approximately 35,300 eggs and 600 pounds of chicken meat, valued at EC$26,800 (~US$10,000). For the 2015 – 2016 year, egg production has more or less doubled, which would not have been possible under the conditions that exist on Barbuda without the new climate-smart production techniques.

> *"The bottom line is we would not be able to operate the school at the standard that we do without the earnings from the farm. All therefore benefit and the lesson from this work is that even in the face of climate change, agriculture can be a credible livelihood and contribute to food security in a practical way."*
>
> - John Mussington, Principal

- Year-round production of eggs, fish and meat, as well as increased production of vegetables, has also reduced Barbuda's dependence on food imports. Reducing the dependence on food brought in via cargo boats is especially important for maintaining food security after the passage of tropical storms and hurricanes.

- Utilization of grass and byproducts from poultry production has improved barren soils and sustained vegetable production.

- Diversification beyond traditional slash and burn methods through the introduction of poultry, fruit, and aquaponic production, and the utilization of mulch and compost have improved natural resource management and made better use of the island's scarce natural resources, while improving productivity.

- Through rainwater harvesting and use, the farm and school are now self-sufficient in freshwater, which enables year-round production at lower costs. Flooding is controlled by utilizing the exposed roof area of the institution to catch the valuable and increasingly scarce resource. This has also eliminated the challenge created by the salinization of the ground water aquifers, and allows year round production.

- The introduction of aquaponics technology to successfully produce fish and high value vegetables is helping to mitigate the effects of warmer sea temperatures and acidification that have affected the area's marine resources that contribute significantly to Barbuda's economy and food security. In 2014, during the dry months of the year (March to July) aquaponics lettuce and chives were produced, supplying a local supermarket with an average of 20 heads per week. Before this, weekly imports by boat were the only means of meeting demand for such produce.

- Changing attitudes towards agriculture and providing youth with training on skills which they can later use to earn a living is contributing to the regeneration of Antigua and Barbuda's agricultural sector.

- The capacity of both students and local farmers to understand climate impacts and potential solutions has been enhanced.

- Reduction of emissions through a decreased reliance on protein and vegetable imports, and elimination of the school's need to use the public water supply, generated by reverse osmosis, have been achieved.

Lessons learned

New technologies, such as aquaponics, long term tree crops, and intensive poultry production, can be adjusted to suit to local conditions and make efficient use of scarce natural resources, thus providing viable alternatives for farmers in the face of climate change. These can be successfully applied to provide agricultural products when conditions are no longer conducive to traditional production methods, thus aiding the Barbuda community to adapt and increase its resilience to climate change. Fishers who can no longer make a living from the sea can adapt backyard aquaponics systems that meet their needs for protein and, with good marketing, can reap additional income from sale to local markets of high value vegetables and fish. Several products also have the potential to support value adding processing, such as the production of preserves and juices, which will be explored further in the near future.

Over the past ten years the school farm has demonstrated that year round production can be achieved under the extreme weather conditions that Barbuda faces as a consequence of climate change. It provides a real-life example of the need for finding and practicing adaptive measures to sustain livelihoods and food security. Given that they live on one of the most vulnerable islands in the OECS to climate change, Barbudians must find practical strategies to adapt to the changing conditions if they are to remain on their island. As the primary institution training future generations, The Sir McChesney George Secondary School has taken up this challenge, with both students and staff working to implement the programme and ensure that the wider community shares the knowledge and the benefits. ■

For more information: John Mussington, Principal / Sir McChesney George Secondary School / Codrington Village, Barbuda / Antigua and Barbuda / mgssbarbuda@gmail.com

Climate smart agriculture
in the Eastern Caribbean States

The path to sustainability and stability of growth in a changing climate

Belle Vue Farmers' Cooperative, St. Lucia

Contributions to climate smart agriculture

Adaptation and Resilience

Improved soil fertility and water use efficiency, together with the use of varieties more resilient to the local climate, are resulting in farming systems better adapted to the changing climate. Capacity development of the Cooperative's members is providing a sustainable foundation for continuous improvement.

Food Security and Productivity

A combination of diversification and climate smart practices such as mulching and water harvesting, has resulted in greater yields and stability of production for several crops, increasing locally grown produce and enhancing farmers' incomes.

Mitigation

Use of renewable energy (solar, biogas), increasing soil organic matter, tree planting, and a decrease in agrochemical use contribute to a reduction in greenhouse gas emissions from the Cooperative's members and operations.

Climate change signals:

- Increased climate variability
- Changes in precipitation patterns
- Increase in frequency and/or intensity of floods
- Increase in frequency and/or intensity of droughts

Climate smart practices and technologies:

- Water management
- Soil management
- Diversification
- Introduction of more climate resilient varieties
- Alternative farming methods
- Renewable energy
- Capacity development

Challenges posed by climate change

The Belle Vue Farmers' Cooperative, currently located at Myers Bridge in Soufriere, St. Lucia, originally started in 1984 at Belle Vue Choiseul with twelve small farmers. Prior to the formation of the Cooperative, the area's farming activities were uncoordinated and disorganized, with each individual traveling to the main market in Castries. Extension services were very poor, inputs difficult to obtain, there was a significant amount of food loss on farm and farmers' incomes were low. Today, the Cooperative has grown to three hundred farmers (30% women) from all around the island. The operations generate over two million EC dollars of business a year, and employ 25 full time of staff. Produce is bought from farmers on a weekly basis, ensuring timely payment, and the Cooperative has an open market day where the general public comes in to buy fresh goods.

Water pump powered by solar panels at Belle Vue Cooperative's office and nursery.

Climate change is proving to be a challenge for the Cooperative's members. For the past five years, farmers have suffered heavy losses on their main cash crop, tomatoes, due to unusually heavy rains as well as dry times with water scarcity which affected the traditional growing season for the commodity. Excessive rainfall had become more unpredictable and extreme events more intense, evidenced by Hurricane Tomas in 2010, and the Christmas Eve Trough of 2015 which was called a Freak Storm. The heavy rainfall over very short periods of time did direct damage to crops. This impact was compounded with extended drought periods and longer "dry season" conditions which affected not just traditionally dry areas but even those accustomed to regular rainfall. These drought conditions were observed over 2010 – 2015. Further, tomato production has also been reduced by the yellow curly leaf virus, which is transmitted by the white fly vector, that flourishes under the warmer conditions that St. Lucia is experiencing more frequently.

As a result, some farmers have stopped cultivating due to substantial losses. In addition, St. Lucia has had to import tomatoes for hotels and supermarkets, yet the high cost of fertilizer and challenging climate conditions have made it almost impossible to compete with imports, not only for tomatoes but also for bell peppers.

The solution

A combination of technologies and practices were used to combat the more unpredictable conditions and resulting impacts caused by climate change. These included:

Adopting drip irrigation: An increasing number of farmers are purchasing drip lines and water tanks. Where previously none of the member farmers from the dry belt (Southern Saint Lucia) used drip irrigation, currently some 20% of member farmers now do. The irrigation units, together with water storage and other good agricultural practices have regularized access to water, improved efficiency in water use, has allowed them to produce target commodities like tomato year-round as opposed to the limited traditional growing period of a few months.

Water harvesting and storage: A water tank to collect water from the roof of Belle Vue Farmers' Cooperative was installed. The Cooperative has also started a programme for making water tanks available to members and so far a number of them have installed tanks on their own fields to provide a more stable water supply.

Mulching: Increased awareness of the benefits of mulching, such as improving water use efficiency, improved soil moisture retention and the promotion of earthworms and nutrients in decomposition has led the Cooperative to discontinue the sale of weed killers at its input shop. To help farmers adapt, a small machine unit with weed cutters for rental was established. The Cooperative accompanies this with capacity development activities on how to make compost and use the clipping as mulch. Composting and organic pest control have also been introduced at here secondary schools in region. Capacity building efforts have resulted in farmers becoming more knowledgeable about the danger of agrochemicals for their health and the environment.

Introduction of more climate resilient varieties: The introduction of more heat and pests (especially white flies) tolerant varieties of tomato (heat master, rodeo, TX 62, improved Cariabe), has provided more resilient varieties. Similar work for heat and pest tolerance was also done for watermelon. The Cooperative is now testing a number of shorter cycle sweet potato varieties. This is important for reducing exposure to risk of weather variations by having a shorting grow-harvest period, as well as improving earnings by being able to have more harvests per year. Together with improved irrigation and use of greenhouses/protected agriculture, the Cooperative can now produce sweet potato year-round.

Protected agriculture: The Cooperative purchased a greenhouse that has enabled it to provide over fifty percent of the colored peppers consumed by households and hotels, most of the production is being pushed by organic nutrients.

Biodigester and solar power: Belle Vue has also worked to make its own operations more climate smart by installing a bio digester (on demonstration plot) and a solar electricity system. The biodigester was installed to help in the control of waste run-off from pig pens, produce liquid and solid fertilizer inputs and generate methane gas for preparing animal feed and household use. The solar electricity system is used to pump water from a rainwater collection tank to the seedling nurseries at the Cooperative's office. Altogether the solar electricity system and rainwater collection saves about EC$ 130 in bills per month.

Diversified production and food processing: The cooperative has been working with farmers to provide other on-farm income options. Production of other commodities such as watermelon, herbs, cocoa and fruit trees is promoted through a field school. The Cooperative is also holding a joint field school with a local hotel to produce mushrooms as a high value and low impact commodity that will be sold directly to hotel chefs. A similar initiative with cocoa is also being pursued. Value added activities, such as the production of smoothies by the Cooperative's youth arm, are also being promoted as an alternative form of incomes.

Good agricultural practice demonstration plots: are used to test new tomato and watermelon varieties and identify those more resilient under local conditions, pilot drip irrigation and water tanks, as well as evaluate the performance of a biodigester. The plot is managed with input from senior extension officers and technicians from the Ministry of Agriculture and is used to train both members and non-members of the Cooperative.

Field schools and training: are implemented to build members' capacity in composting, alternative pest control, use of local materials, and the adoption of more climate smart practices is provided to farmers. Youth in particular are targeted for capacity development initiatives.

Implementing these actions cost approximately EC$ 92,000 (USD34,000) from November 2014 – December 2015, with approximately 40% being used to install the solar electricity and establish demonstration and validation plots, and the rest on the water tanks.

Seedlings being watered in the nursery.

Results and contributions to the 3 pillars of climate smart agriculture

- Training on and use of natural mulching has improved soil cover thus reducing soil and moisture loss. It has added nutrients and beneficial bacteria to the soil, which reduces erosion and increases soil quality. Ten farmers, including women and youth, are demonstrating the benefits of promoting better soil management practices on their farms.

- Better soil and better water conservation has been achieved through using drip lines (anecdotal reports of users based on typical water usage and bill payments) and composting improved the health of the soils (anecdotal reports on soil texture, presence of earthworms and micro-fauna and crop growth response). The use of compost of raw manure has also helped to maintain the area's water quality by reducing run-off of waste (anecdotal reports).

- Cost saving and additional income for farmers has been achieved through different practices, such as using mulch instead of purchasing herbicides, using renewable energy and increasing quality and yields of tomatoes and other crops. Farmers report using less chemical fertilizers as a result of composting and organic mulching (e.g. most members are down to 3 bags of fertilizer from 5 bags per quarter). Direct market connections with hotels and value added activities are also helping to increase incomes. The Cooperative itself saves water and money by using its solar water pump; the Cooperative saves approximately EC$130 per month in costs for seedling production and running the office.

- Increased productivity has resulted from these efforts. In 2015, the Cooperative was able to consistently produce watermelon, tomatoes and bell peppers throughout the year – which had never been done. The country experienced its first glut of locally-produced watermelon and for the first time in many years Cooperative was able to buy and sell tomatoes throughout the year, increasing quality and volume on the local market.

- Locally sourced vegetables such as tomatoes and watermelons are now available year-round through Belle Vue's efforts, thus contributing to healthy local diets. Purchasing a greenhouse with a deposit and monthly payment has enabled the Cooperative to provide over 50% of the colored bell peppers consumed by households and hotels in 2015. Most of the production was done organically.

Compost bin at Belle Vue Organic Farm (La Fargue).

Establishing a biodigester a demonstration plot.

Farmer setting up rainwater harvesting system to store water on farm.

Use of inorganic mulch under greenhouses.

- The introduction of improved varieties and diversification of crops has helped to stabilize and even increase production and incomes. Evidence of this is in the increasing volume of seedlings of these new varieties being produced and sold through the Cooperative. As many as 10,000 seedlings are now being ordered/requested by single members.

- The use of the combination of the climate-smart practices described above has resulted in farmers buying less chemicals and fertilizers, and this lower demand led to a decrease in the agro-chemicals bought by the Cooperative itself.

- The Cocoa Field School (involving 20 farmers) and Mushroom Field School (involving 20 farmers) are creating new business opportunities for entrepreneurs - especially for youth and women. For example, the initiative is training youth to provide mushrooms spawns to mushroom farmers within the Cooperative and women farmers are being trained to manage the production system which is less strenuous than traditional crops.

- Mitigation from the reduced use of agrochemicals, the employment of solar energy and biogas and the planting of trees. At present most of the Cooperative's members have reported a significant reduction in the use of agro-chemicals as well as applications with high toxicity.

Lessons learned

The efforts described here demonstrate the value of building strategic alliances with national, regional and international organizations and businesses such as the UNDP, GEF, GIZ, and local hotels and restaurants. These alliances have helped in mobilizing resources, building technical capacity and improving access to information and knowledge on climate smart agriculture. In addition, the success in demonstrating benefits in cost savings, risk reduction and improved income of the composting, mulching and drip irrigation initiatives have convinced members and partner farmers to be willing to adjust practices and explore new production methods.

Involving youth and women farmers in climate adaptation efforts is crucial to changing the farming culture and helping new farmers to get it right early so that they are not discouraged. The need for simple investment on farms is critical; many farms lacked basic infrastructure (greenhouse/ protected structure, irrigation system, storage shed). Prior to this work, most farms lacked the basic knowledge on good agricultural practices to improve water use and better care for soils. This resulted in high financial costs for obtaining sufficient water.

Farmers are now receiving training and support to help them identify, adapt and finance equipment to enhance the resilience of their farms with items such as water tanks, drip lines and weed cutters, water harvesting and storage. Adaptation to the changing climate is an ongoing process that requires additional skills for success. An example of this is the need to improve record keeping, and the cooperative is building partnerships with other organizations to address this with information and communication technology. ■

Belle Vue initiated a pilot action to supply community schools with fresh fruit in 2014/2015 to promote health and consumption of local foods.

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Climate smart agriculture
in the Eastern Caribbean States

Meeting the challenges of climate change in Grenada through organic agriculture

Grenada Organic Agriculture Movement (GOAM)

Contributions to climate smart agriculture

Adaptation and Resilience

By implementing practices that are suitable to adapt to the increase in temperatures and climate variability and the change in precipitation, the farmers have made both their farming systems and their livelihoods more resilient. Improving water management and soil quality, incorporating multi-storied intercropping, and protective structures are some of the adaptation measures implemented.

Food Security and Productivity

Diversification, improved soil health, and better water and landscape management to address the climate changes have resulted in an increase in yields, a reduction in losses, and an overall increase in production, leading to enhanced incomes and food security for the farmers.

Mitigation

Reduced tillage, incorporation of perennial crops, and the use of biochar help reduce greenhouse emissions by maintaining soil carbon and enhancing carbon sequestration.

Climate change signals:	Climate smart practices and technologies:
Changes in precipitation patterns	Soil management
Increased climate variability	Diversification
Increased temperatures	Agroforestry
Sea level rise	Water management
	Alternative farming methods
	Capacity development

The challenges posed by climate change

This story focuses on two farms owned and managed by members of GOAM, one in Belvidere, St. John and the other at DeBlandeau in St. Andrew. The DeBlandeau farm is on 15 acres in the middle agricultural belt and receives less rainfall (~100 mm/year). The 25 acre Belvidere farm is located in the center of Grenada, the upper agricultural belt which experiences the highest rainfall (180mm/year) on the island. In the 1990's, during a governmental drive to increase banana production, farmers there were encouraged to cut nutmeg trees to establish pure stand bananas. When the moko disease and black sigatoka emerged, banana production was no longer viable. Farmers in Belvidere have since been testing alternative production systems – tree crops, vegetables, root crops, and livestock – with encouraging results.

Hurricanes Ivan (2004) and Emily (2005) destroyed the production base of most farmers in Grenada. Recognizing that extreme events might increase in intensity and frequency with climate change, in 2008 Belvidere made the decision to adopt a sustainable approach to farming by introducing a multi cropping system based on permaculture principles and organic farming. In 2011, the Grenada Organic Agriculture Movement (GOAM) formed, and its members began farming organically to respond to climate change and to produce safe and healthy foods.

The areas of Belvidere and DeBlandeau have historically had a very predictable climate with a wet season extending from late May through January followed by a marked dry season. Today, the rains and dry season come at any time with great intensity resulting significant soil and crop loss. The historical rainfall pattern ensured that soils did not dry out. Plants were able to reach water even in the dry season which allowed the vegetation remain green throughout the year without irrigation. Today with the long dry spells, the soils dry out and irrigation is a necessity for maintaining production levels. Heavier downpours not only break down the soil structure, but also cause nutrient leaching and flower loss. Strong winds are more common, especially in Belvidere, resulting in tree toppling, especially bananas.

Higher night temperatures have been reducing production of certain vegetable and tree crops, such as cauliflower, broccoli, cabbages and nutmeg. Belvidere previously enjoyed low night temperatures, giving the region an advantage for growing cole crops that has since disappeared because of elevated night temperatures, which have impacts like reducing the size of nutmeg pods. This has, however, opened new opportunities as higher night temperatures permit enhanced fruiting and reduction of disease in certain crops such as mangoes (fruiting) and avocadoes (reduced fungal disease).

The solution

Given the climatic changes experienced and anticipated, the farm managers began to adopt practices to address soil and nutrient loss, better manage their landscape and water, and adjust to the higher temperatures and increasing climate variability. The practices and technologies implemented include:

Mulching and composting: Where annual crops are planted, both plastic and dry mulch are used to protect the soil from direct impact of rain, reducing runoff, soil loss and evapotranspiration. In the areas where plastic much was used, the land was first plowed and composted manure from chickens, rabbits and cattle was integrated. The four-foot wide beds were then covered with plastic mulch with four to six inch holes to accommodate the crops planted. Dry mulching is now used in the dry season. Lands are ploughed and manure is incorporated before the land is covered by four inches of dry shredded mulch made from trimmings from farms and public road works along rural roads.

Intercropping, wind breaks and diversification: To help manage the more intense and frequent winds that were damaging crops, old windbreaks were restored and new ones planted. A permaculture design was utilized, dividing the farm into zones delimited by blue mahoe *(Talipariti elatum)*, which is used for farm building and sold to furniture makers. Any gaps in the windbreaks were filled with other tree crops, especially cloves and cinnamon. Crops were selected to form different layers/levels so that at maturity the plants would be stacked. For instance, bananas provided shade for nutmeg when the latter is first planted, then as the nutmeg matures it shades the bananas. The wind break formed the highest layer, followed by nutmeg, then citrus, then bananas and finally dasheen (taro) or sorrel.

Biochar: Biochar is being incorporated with pen manure in the vegetable beds. The process of mixing the two, called charging, allows for the soil organisms from the manure to inhabit the pores in the char thus providing a home for the organisms that will provide the nutrients that are needed for plant growth. It is produced using a kiln that allows for the gasification of biomass at 700 degrees Fahrenheit. Charging biochar allows for greater moisture retention in the soil, thus making the plant more resilient to dry spells, while also providing nutrients to enhance plant growth and development. Initial results with peppers show that plants grown with charged biochar have higher yields.

Improved water management: The farm's contour drainage was remodeled using an A frame to design a system of swales and weirs for enhanced water control. The gradient of the drains was improved to water flow and allow for greater water infiltration. Controlled run-off was achieved by the creating of weirs by blocking one end of the swale with stones and organic matter. Gravity fed irrigation, using water collected in a nearby dam, was added to help address the fluctuations in precipitation and water availability.

Protected agriculture: The farm has been experimenting with mini covered protective structures of approximately four feet in height. Bamboo and plastic are used to cover the beds, protecting the crops from the direct impact of the heavy rains as well as permitting water to enter the beds through the nearby drains.

Reduced tillage: On both farms, land preparation for short term crops historically involved annual land plowing. A decision was made to reduce plowing and to adopt the practice of digging holes only to accommodate the crops, leaving the rest of the bed undisturbed. This has helped reduce the impact of both drought and heavy downpours.

Capacity building: GOAM has an outreach programme that uses farmer field schools to train and build capacity of our stakeholders. For instance, of the six compost units we have established we organized a rotational training programme to have training on each site – beginning on the first and completing on the last site. GOAM has also developed plans to work with two schools through the 4H group.

Results and contributions to the 3 pillars of climate smart agriculture

- On both farms, there has been a great improvement in soil health. A decrease in soil loss has been evidenced by the colour of the runoff and reduction in sediment load. The protective structures and mulch help prevent nutrient leaching and the breakdown of the soil structure caused by heavy rains. The mulching and compost also add nutrients and organic matter into the soil; while the incorporation of biochar enhances the water holding capacity and nutrient supply.

- Enhanced management and efficient use of water was achieved on both farms. The swales and weirs prevent runoff and allow water to infiltrate into the soil. Increased infiltration helps restore groundwater supplies and allows higher soil moisture levels increase resilience to drought. Plants located in beds with mulch and or biochar incorporated withstand drought conditions better than those without.

- Increased resilience to more intense droughts and winds has been observed on both farms. Plants that were grown on mulched beds withstood the drought better than those that were not mulched. The plastic mulch without irrigation in the wet season helped plants to grow well and eliminated the need for weeding, thus reducing on the cost of labor which is significant on the principal farm. On the principal farm, the farmers have observed a noticeable reduction in the toppling of bananas due to the wind breaks installed.

- Intercropping and stacking have permitted the farm to incorporate additional crops and increase production, as more food can be grown in the same space. The impacts of the combination of practices described above that have helped to reduce the impacts of higher temperatures, provided additional nutrients to plants (mulching, biochar); allow for continuous water supply without excessive leaching (swales and weirs); protected crops from rotting and flower loss (mini covered protective structures), reduced waste, helped maintain produce quality, and minimized losses from drought. Farmers have noted that this has helped increase yields and maintain production, as well as reduced the risk of relying on one crop.

- Crop diversification has allowed for the harvesting of different crops at different times of the month, providing stability and diversity in food availability. The production and sale of different commodities has increased the amount of disposable income for the families so they can supplement what they grow, thus enhancing the food security of the farming families.

- Healthier soils have helped to increase yields and therefore income. Intercropping using the stacking principle allows for marketable crops throughout the year, enabling a regular cash flow. Lower losses from droughts and heavy rains have also helped to maintain incomes. Adoption of these practices has made the farms more viable, and as such, is increasing job opportunities for others. Nine people are employed full time, and in the summers, additional youth are employed. It is also helping youth to see that farming can in fact be profitable and make a suitable career.

- Reduced tillage, perennial crops, and the use of biochar help reduce greenhouse emissions by helping to maintain or sequester carbon in the soil.

The principal beneficiaries of these efforts have been the farm families and workers. The environment, improving both human and agro-ecosystem health. Other consumers of the farm's produce also benefit from the safe, nutritious and healthy goods grown without the use of synthetic fertilizers or toxic pesticides. The broader community benefits because the organic practices reduce contamination and help maintain water quality. Finally, Grenada benefits as the island moves towards more sustainable production practices that creates positive synergies between land and marine based systems to support food security.

Lessons learned

Longer time frames are required to observe the true impact of climate smart agricultural practices. Observation and both quantitative and qualitative data collection are important to be able to demonstrate costs and benefits. In addition, farmers should be prepared to adjust the practice as what works in one situation may not always work in another. Technologies and practices need to be adapted for the local context. Some of the interventions have hidden or unanticipated costs over time. For instance, the costs of operating the biochar unit were not contemplated, only the cost of the unit itself was considered.

Working together and learning from the experiences, achievements, and errors of others will facilitate success. Exchange between farmers and outreach from extension officers are critical. Finally, it is very important to involve all those with implementation responsibilities (paid workers, volunteers, etc.) in the trainings so that they not only understand what to do, but also why it is being done. ■

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National winners

4. The model 4-H agricultural project as a training and demonstration centre for young 4-H clubites to gain practical experience in sustainable agriculture and contribute to the conservation of our environment
National 4-H Local Leaders Association, Dominica

5. Climate smart agriculture in St. Vincent and the Grenadines: A brain-stormed organic approach to agriculture
Richmond Vale Academy, St. Vincent and the Grenadines

6. Implementing an integrated approach to reduce the effects of drought on farming in the New River area
New River Farmers' Co-operative Society, St. Kitts and Nevis

Climate smart agriculture
in the Eastern Caribbean States

The model 4-H agricultural project as a training and demonstration centre for young 4-H clubites to gain practical experience in sustainable agriculture and contribute to the conservation of our environment

National 4-H Local Leaders Association
Roseau, Dominica

Contributions to climate smart agriculture

Adaptation and Resilience

Terracing, improved drainage and crop diversification have helped to decrease soil erosion and manage the more intense rains Dominica experiences. Mulching, composting and the incorporation of leguminous plants enrich the soil and help retain soil moisture. Exposing students at a young age to the challenges and solutions to climate change helps to ensure that the future farmers of Dominica have the knowledge and skills to adapt.

Food Security and Productivity

Mixed planting methods were promoted to enhance food diversity and educate students about the importance of diversity for food security. The project strengthened the interest, motivation, and capacity of students to engage in sustainable food production that supports both a healthy environment and a healthy diet.

Mitigation

The rearing of poultry, rabbit and goats eliminates the need to utilize agro-chemical fertilizers during food production. The planting of tree crops as windbreaks and for fruit production enhance carbon sequestration.

Climate change signals:

- Increased climate variability
- Increased temperatures
- Changes in precipitation patterns

Climate smart practices and technologies:

- Water management
- Soil management
- Diversification
- Alternative farming methods
- Agroforestry
- Capacity development
- Landscape management

The challenges posed by climate change

The Caribbean islands are and will continue to be considerably affected by climate change impacts. Dominica, a 750 square mile island with a population of roughly 72,000, is no exception. Increased climate variability and higher temperatures are causing crop wilting and intensifying soil degradation. Agricultural systems are increasingly impacted by more frequent periods of intense drought interspersed by periods of intense rainfall and flooding. Vulnerability to the impacts is amplified due to deforestation and unsustainable tree harvesting, which has led to soil erosion, sedimentation in rivers, and a reduction of the soil's water holding capacity.

The 4-H Clubs at six primary schools in the Southern District of Dominica, including Bagatelle, Grandbay, Petite Savanne, Pichelin and Tete Morne recognized the impacts of climate change, and wanted to conduct awareness-raising and training to encourage the agricultural sector to begin to adapt. The area had a high dependence on fishing, and lower catches caused people to begin to seek additional sources of food. A lack of funding for appropriate technologies, capacity development, and community education on climate change in agriculture, combined with scarce technical support and limited inputs (animals, seedlings, etc.), were inhibiting action and innovation towards more resilient production systems in the district.

The solution

To help respond proactively to community needs for climate smart agriculture, the 4-H Clubs, led by the National 4-H Local Leaders Association, which serves students between ages eight and 12, joined forces with the Youth Development Division. In collaboration with the Agricultural Extension Unit and the Parent-Teachers Associations of the participating schools, they worked together to implement sustainable, climate-resilient agricultural practices, including and build in this area, including:

Crop diversification: Students have been taught the importance of crop diversification in agricultural systems and also for food security and soil health. A wide range of crops – vegetables, fruits, herbs, root crops and greens - is being used to minimize soil erosion, boost soil nutrients and attract a multitude of beneficial insects. Crop diversification has inspired youth involved in the School Feeding Program to think about balanced diets, food security and nutrition.

Improved water management and land terracing: A system to improve field drainage was adopted to redirect rainwater and prevent the loss of fertile top soil. Rocky hillsides that were previously unusable for agricultural purposes are now thriving agricultural land. In school feeding programs, elevated garden beds were designed with side drainage made of renewable resources such as logs, bamboo, and stones to educate students on the importance of soil health and proper field drainage.

Infrastructure improvements: To address higher temperatures, tree crops were planted and netting and greenhouses used to provide shading for small vegetable crops. Irrigation (water lines and hoses) also played a major role in some of the schools involved with a focus on water conservation.

Boosting soil health: Dried grass was used as mulch to reduce soil temperatures, minimize irrigation, and increase soil moisture retention in school gardens. Leguminous plants such as string beans and red beans, as well as pen manure, were incorporated to improve soil fertility. The construction of a compost shed has created an excellent learning environment to teach young clubites the importance of compost and technical composting techniques.

Poultry production: Availability of chicken manure for compost and soil fertilizer contributed to decreased dependence on chemical fertilizers, thus by extension, a reduction in greenhouse gas emissions, as well as increased soil fertility to facilitate the production of higher quality produce. This activity also benefitted the school feeding program. Rabbits and small ruminants have also been raised in several areas.

Capacity building: 39 adults were trained to guide these efforts, half of whom are women. These leaders then went on to teach over 300 elementary school children about land preparation and planting techniques to increase youth awareness of climate change and environmental concerns

Results and contributions to the 3 pillars of climate smart agriculture

- Terracing of land for crop production has increased the area available for production of fruit trees and other crops, while providing erosion control and enabling proper drainage, thus helping to address some of the impacts of the more intense rains.

- Improved soil fertility and moisture levels were achieved through a combination of the interventions, and helped to lift productivity at five of the six schools involved.

- Intercropping and diversifying crop production, as well as the use of fruit trees as wind breaks to reduce the stress on plant growth, have also contributed to increased productivity and minimizing losses due to climate variability. The latter also provides a habitat for pollinator and other wildlife species.

- Poultry, rabbits and goats provided additional sources of protein for students' diets. The use of organic animal fertilizers significantly contributes to the health of the farm ecosystem, and also reduces the dependence on chemical fertilizers which must be shipped from other islands.

- The School Feeding Program and residents of the village benefit from the increase in production and sustainable practices mentioned as the availability of nutritious products rose. The broader community is also learning from the project and interventions and thus is more aware of the impacts of climate change.

- A generation of young leaders have received skills and knowledge about climate change and sustainable agriculture. As a result of the many projects the 4-H has spearheaded, participation in backyard gardening at the sites has increased by 25%.

Prior to this effort, resources were not available to fund sustainable agriculture education projects in this region of Dominica. Through this experience, the 4-H clubs in the southern districts were able to gain practical skills in sustainable agriculture. As a result, over 330 youth (57% female) and adults have been trained, many of whom continue working to make Dominica's production systems more resilient to climate change and other risks.

Lessons learned

Through these educational experiences for youth, much has been learned by all those who participated. Sustainable agriculture education provides an excellent avenue for involving youth in climate change and sustainability issues, not only because of the importance of the sector but also because it provides a hands-on, visible way for the youth to make a positive impact on their communities.

The grant funding provided great motivation and incentive for the Youth Officers and Leaders to both generate support for their club projects and upgrade their agricultural plots at school and at home. This kind of practical approach to youth involvement in agriculture serves as a catalyst for stimulating the interest of the youth, not only in agriculture, but also in climate change and broader environmental issues. ■

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Climate smart agriculture
in the Eastern Caribbean States

Climate smart agriculture in St. Vincent and the Grenadines: A brain-stormed organic approach to agriculture

Richmond Vale Academy
Kingstown, St. Vincent and the Grenadines, W.I

Contributions to climate smart agriculture

Organic farming and permaculture practices make efficient use of natural resources, enhancing soil fertility and composition. Gray water recycling and landscape management have increased water use efficiency. Capacity development efforts have increased human capacity for resilience in the broader community.

Diversified production, extension of the growing season through protected agriculture, cost savings, and organic practices contribute to enhancing the food and nutrition of the students and community members.

Reforestation efforts, mulching, agroforestry, use of renewable energy, and the elimination of agro-chemicals during production minimize greenhouse gas emissions and enhance carbon sequestration, thus contributing to mitigation efforts.

Climate change signals:

- Increased climate variability
- Increased temperatures
- Changes in precipitation patterns
- Increase in frequency and/or intensity of floods

Climate smart practices and technologies:

- Diversification
- Alternative farming methods
- Renewable energy
- Landscape management
- Soil management
- Water management
- Agroforestry
- Capacity development

The challenges posed by Climate Change

Over the past several decades, multiple climate changes have occurred across the islands of Saint Vincent and the Grenadines (SVG), located in the Lesser Antilles, including increasing temperatures, changes in water availability and precipitation, and increasing instances of floods. The December 2013 floods, for example, adversely affected many agricultural zones across SVG and several regions are still recovering.

These changing climatic conditions, especially over the last twenty years, have presented multiple risks to the country's agricultural sector, affecting the productivity and quality of crops. Marked changes in rainfall dynamics, with more frequent and intense precipitation events, and more frequent and pronounced drought events that disrupt farming and other economic activities, have presented new challenges for farmers. Farmers are now forced to respond to these adverse changes that affect the way they are accustomed to farming and threaten to destabilize the economic viability of many farming communities.

These changes, along with increasing climate variability, have influenced soil fertility, crop selection, and harvesting times. The emerging challenges have prompted a need for change in agricultural practices and technologies on the islands. Innovators in the community of farmers in SVG have realized that to tackle these issues, both mitigation and adaptation measures need to be implemented, and have thus committed to working towards creating more resilient agricultural systems.

The solution

Located on 30 acres of farmland on the Leeward coast of St. Vincent, beyond the town of Chateaubelair, Richmond Vale Academy is a non-profit educational institution that seeks to train local and international youth in climate change, food security and poverty reduction through on-farm education. Established

in 2002, women and youth represent over 70% of the current student body, which consists of both local (1/3) and foreign (2/3) individuals.

The Academy's philosophy embraces environmental sustainability, as an initial assessment by the institution indicated a need to transition from the widely practiced conventional approach to farming, to the use of practices that foment a food, energy and disaster secure production system. Now focused on organic crop and livestock production, composting and water harvesting techniques, the Academy leads on-farm capacity building programmes, environmental education drives and awareness raising efforts to encourage resilient crop production, improved livelihoods and a healthy environment. The Richmond Vale Academy has employed multiple climate-smart techniques including:

Organic production: Organic production is promoted to help enhance the resilience of production while decreasing greenhouse gas emissions through the use of non-fossil fuel based inputs. In the intensive permaculture garden, a variety of herbs and flowers including rosemary, thyme, chives, aloe, marigolds and others are planted along the borders of the beds to deter pests. Bio repellents, such as cayenne and garlic, are also applied to plants with a spray can. On the farm, some crops are introduced as pest repellants, while other crops are cultivated to assist in nitrogen fixation of soil and pollination.

Permaculture and integrated farming: On the farm there are large, designated areas for rearing animals and spaces allocated more exclusively to crop production. Livestock are grazed in strategic areas to aid in weed removal and allow for the spread of manure as organic fertilizer to revitalize and maintain the pH balance of the soil. Within the intensive garden, a system of continuous intercropping is used, mixing up to nine plant families within each bed. These are planted in a guild system that takes into account plant growth characteristics and root structure. Outside of the intensive system a traditional fruit, leaf, root, legume rotation cycle corn/legume system is also being developed.

Protected agriculture: There are now three greenhouses where vegetables and herbs are grown. This helps to ensure optimum conditions for growth throughout the distinct wet and dry seasons. By extending the growing season, these vegetables help to auto-sustain the group of persons living at the institution, improving food security and accessibility to fresh local produce.

Energy efficiency: The use of solar water heaters and a new solar panel system will contribute to greater energy efficiency on the farm and reduce the fossil fuel footprint of the Academy. They have been installed in each of the dormitory and administrative sections of the farm and will be connected in September 2016.

Erosion control: New swales are constructed in the areas prone to the most erosion damage. The swale has a number of benefits as it slows run-off whilst recharging ground water and providing extra nutrients and water for trees and other productive and support species planted along the swale line.

Water recycling and management: A system was designed to enable the reuse of gray water for irrigation purposes, thus addressing water availability issues. Four gravity-fed mega tanks were constructed to allow for the reuse of water from showers, washing machines and sinks. Water is recycled and channelled to irrigate specific crops. From an educational standpoint, the system facilitates education on the water cycle and raises awareness of how individuals can actively contribute to reducing pollution of water bodies.

Agroforestry: Trees have been incorporated into the farming system to help sequester carbon and other nutrients, such as nitrogen, to improve soil health. The orchard is being converted to a thriving food forest by increasing diversification in layers and enhancing productivity. After several failures in cultivating bananas using chemicals, an experimental organic banana patch on half an acre, in which a grove of gliricidia trees existed, was established. The gliricidia branches are periodically cut and dropped to enhance the soil around the bananas. A plan is in place to add vanilla and cocoa, together with other support species. There are also ongoing reforestation projects in strategic areas that increase in the sequestration of carbon.

Mulching and composting: Dry leaves and other organic matter (gliricidia leaves and vetiver grass) are left to decompose on agricultural beds, and help to increase soil fertility, composition and, combined with other practices, optimize nutrient flow through the production system. This helps ensure that the crops cultivated can grow and be nurtured without the use of chemicals, while the continuous enrichment of the humus layer creates a buffer against harsh climatic conditions. Erosion from heavy rainfall is avoided and soil moisture is maintained during dry conditions.

Capacity building: Farmers and other persons who come to visit are given the experience and opportunity to participate within the framework of the academy. Different methods are used, including field discussions and practical sessions that seek to incorporate Good Agricultural Practices, climate compliance, school outreach, hikes, tree planting and workshops. Among the topics taught are climate adaptation, pest and disease management, recycling, greenhouse management, composting, and diversification. Leadership development and other soft skills complement the technical topics. Members of the North Leeward community, including schools and community groups, actively participate in open day sessions and outings.

The key beneficiaries of the work of the Academy are the 500+ students, farmers and persons who come to the institution to be engaged in organic farming, permaculture and climate change resilience activities. Several local families also benefit. Many women within the neighbouring communities have benefited from the investigative and direct approaches of these technologies. Schools and communities have learned about climate risk and how they can play their role in reduction of chemicals, food security, improvement of their livelihoods and contributing holistically to the agricultural sector.

Results and contributions to the 3 pillars of climate smart agriculture

When its efforts began, there was limited knowledge of these climate-smart practices in the area, and varying perceptions of their feasibility. The implementation of these practices has helped to address various climate risks and has had positive socio- economic impacts on production and farmers, while fostering broader awareness of sustainability and environmental issues.

- Organic farming practices and permaculture are contributing to climate resilience by maximizing the effectiveness of natural resource use, while minimizing the use of agro-chemicals and fossil fuel intensive techniques. By promoting the use of organic production on the island, RVA is promoting the health and longevity of agro-ecosystems and the sustainable use of natural resources.

- Integration of sustainable practices has become more common around the island, as awareness has been raised and people now realize that climate change is real and the risks affect all community members. Increased knowledge of climate smart practices has led people to improve their production as they better understand the benefits of organic and climate smart agriculture, both for the environment, human health, and production. The community of North Leeward has advanced its production and many people have also begun to diversify and expand their levels of production.

- Enhanced carbon storage and sequestration were achieved through the appropriate management of livestock (preventing damage to native grasslands and avoiding deforestation), as well as agroforestry and reforestation activities.

- Since the inception 500 + persons, primarily youth and women, improved their knowledge of sustainable agriculture. Schools and communities have learned about climate risk and how they can play a role in improving food security, livelihoods and contribute holistically to the agricultural sector.

- Minimal soil compaction as a result of low impact agricultural techniques has helped maintain soil fertility and soil composition while reducing runoff, damage to soil ecosystems and nutrient leaching.

- Many women and youth have been empowered to become part of the solution. Many previously thought it impossible to cultivate and practice farming without a viable income/ start-up to buy tractors and other chemicals etc. This initiative has helped persons to learn how to increase their income in a sustainable manner; while at the same time protecting and conserving their environment.

- Economic savings have been achieved through the use of renewable energy sources, reuse of gray water, elimination of agro-chemical use and utilization of organic inputs. On a yearly basis, approximately $400-$700 is saved through reductions in consumption of agrochemicals and in public water supply usage.

- Diversification and integrated farming has improved farm management, enhanced productivity and enabled more efficient use of both land and capital. Permaculture and mixed farming have helped to provide diverse foods and nutritional benefits for the students and farmers at the institution.

Lessons learned

One of the primary lessons learned on which RVA will build future efforts is that climatic risks have serious implications, especially for SVG's farmers. Understanding the risks and how to address them is key to enhancing the resilience of production systems, and sustainable development must always be considered in efforts to mitigate and adapt to climate change. It is imperative to create a strong link with the 17 newly reformulated Sustainable Development Goals agreed upon in 2015.

Education on and promotion of sustainable agricultural practices with youth is an important step in ensuring the future of food security in local communities, and proactively responding to actual and anticipated climate change impacts enhances the effectiveness of action. As the population grows and more food is required, farmers must be encouraged to continue to work in the sector, and not be afraid to be innovative and creative in their approaches. While climate change can be seen as a frightening phenomenon, it must be acknowledged that it is here to stay, and the positive opportunities must also be considered. Farmers must advance amidst the challenges to achieve a more viable and sustainable agricultural sector and world.

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Climate smart agriculture
in the Eastern Caribbean States

Implementing an integrated approach to reduce the effects of drought on farming in the New River area

New River Farmers' Co-operative Society,
New River Estate, St. James, Nevis

Contributions to climate smart agriculture

Adaptation and Resilience

Diversification, integration, and innovative technologies that enable production under extreme and unpredictable climate conditions, have increased the resilience of the farming system to climate risks.

Food Security and Productivity

Farmers were able to diversify their crops which in turn allowed for increased productivity and food security for the area. By making water available to producers during the dry season, farmers were able to expand production to multiple crops and varieties, thus increasing productivity and food security.

Climate change signals:	Climate smart practices and technologies:
Changes in precipitation patterns	Water management
Increased climate variability	Soil management
Increased temperatures	Diversification
Sea level rise	Landscape management

The challenges posed by climate change

The New River Farmers' Cooperative Society operates on government owned lands on the eastern side of the island. The New River Estate extends from sea level on the east and rises to nearly 800 feet at the western extremities. Comprised of 790 acres, approximately 300 are pasture, 10 are irrigated cropland, 25 are rain-fed cropland, and the remaining acreage is covered by scrub woodland and forest at higher elevations.

New River, once a thriving agricultural community, has experienced great setbacks as a result of changing climatic conditions. The issue of water has been a growing concern for the farmers in the area for decades due to the ongoing reduction in precipitation that has limited their ability to produce. A Devere, Inc. study of precipitation over 47 years revealed that droughts extending three to four months are relatively common in Nevis. Even during the wet season (July through December), extended periods of two or three weeks with no rainfall now occur.

Over the past 20 years, increasing water scarcity has been a growing concern for the New River area farmers. Changes in rainfall patterns and a noticeable decline in precipitation, as well as more intense and frequent drought conditions have been experienced by farmers. As rainfall patterns became less predictable, farmers experienced substantial losses in yield, and witnessing the unprecedented deformation of fruits, dropping of blossoms, reduced fruit set and deteriorating plant health. This has been particularly apparent in traditionally rain-fed crops such as sweet potato, peanuts, yam, cassava, and corn. Increasing temperatures and a lack of water led to a faster rate of soil moisture loss, and resulted in soil cracking and reduced soil fertility. Farmers lost income and some were forced to abandon planting. Some farmers turned to hand watering and using water stored in drums on their land. Innovative solutions were needed to ensure farmers' livelihoods and restore thriving agricultural systems. The increase in sea levels, coupled with more windy conditions, caused salt spray to be blown on plants leaves, thus causing further damage to farmers' crops and a reduction in crop yield.

Overhead view of the New River Estate ruins with a view of a farm with plastic mulch.

The solution

The farmers decided to investigate the harvesting and storage of water from the New River Spring. With support from the British Development Division,[1] the New River irrigation project was established to supply the farmers with irrigation water to be used- for year-round crop production.

Design and construction of an irrigation and water storage system: Ten acres of irrigation area were surveyed by an engineering firm to determine an appropriate design of the irrigation system that will enable farmers to have a constant supply of water. A water supply and irrigation system were then installed by the Department of Agriculture on Nevis to allocate water to 17 farmer's plots, ranging from 0.25-2 acres in size. A 25,200-gallon storage reservoir, made of reinforced concrete blocks, holds water from the spring so farmers can access water during dry periods or drought. The reservoir, with two outflow pipes, was placed 100 feet west of the high point of the farming area, thus allowing water to be gravity fed to the farmers' plots. Another reservoir and two additional Ferro-cement tanks were also constructed in the New River Estate area at different locations to further increase the storage capacity of water for the New River farmers. Using technology from Germany, the Ferro-cement tanks were designed similar to an egg, with a thin, reinforced shell, able to withstand the evenly distributed pressure of the water inside without bursting at any point.

Mulching: In an effort to reduce water usage, farmers began to use a dried grass mulch in the mid 1980's as a water saving technique that was introduced by the Nevis Agriculture Department. The mulch is applied in a matted form over the land surface prior to the establishment of their crops with the aim of protecting the roots from drying out and the plant from moisture stress. Plastic mulch is now being used as a more modern technique to further reduce soil moisture loss. Farmers place the white surface of the mulch facing the sun which help to reflect the heat and keep soils cool.

Drip-irrigation: Drip irrigation systems were introduced by the Nevis Agriculture Department in order to allow farmers to conserve water in the catchment reservoirs and to produce crops during periods of drought. All farmers in the New River farming area now use drip irrigation as the best technique to conserve water while providing for the crops' needs. More recently, the New River Farmers' Cooperative Society secured funding from the Global Environmental Facility (GEF) to upgrade and improve the pipe system to transport water to various farms because of the increase in the number of farmers who operate in the New River Estate area. The upgrade and improvement was necessary to enable farmers to become more competitive in terms of the quantity, quality and consistency of produce demanded by the market place.

1 BDD is a group of collaborators from around the world who generate ideas and actions for social change through research and identify and implement alternative approaches to promote sustainable social change.

Greater variety of crops: Additional commodities such as limes, passion fruit, mango, plantain and bananas were planted to increase production and enhance the quality of produce from the area. Farmers are now producing commodities such as onions, yams, sweet potato, carrots, water melon, honey dew, cantaloupe, peanuts, tomatoes, sweet pepper, string beans and pumpkins on a wider scale, which they were unable to do before.

Landscape management: Planting fruit trees such as mangos and limes, as windbreaks and for erosion control, has also expanded the availability of additional products to sell.

Funding for the implementation of the project at New River Estate was provide by the British Development Division but, as recent as February 2015, improvements have been funded through a US$50,000 grant from the Global Environmental Facility (GEF). A total of 6,810 feet of pipeline was installed to take water to farmers' plots and old leaky valves were replaced. Each farm was connected using one-inch lines in order to ensure there was a better supply of water for farmers.

Backhoe dropping fill material to cover pipe line in the trench.

One of the Co-operative's female farmers Ms. Alana Leitch busy levelling off fill material along the trench.

Results and contributions to the 3 pillars of climate smart agriculture

The technology and climate smart practices implemented have provided benefits not only for the farmers who were directly involved, but also for their families and the wider community.

- Over 30 crop farmers, 10 livestock (sheep, goats, cows, pigs) farmers, and over 10 women farmers benefited from the implementation of this technology.

- Increased water storage capacity and increased agricultural production through innovative technologies has had a lasting impact on the New River farming community, which currently encompasses over 40 farmers. Farmers are now able to effectively irrigate not only their short cycle crops (for example, watermelons, cucumbers, sweet pepper etc.), but also their perennials (for example, mango, avocado, banana, limes), which had been suffering from high fruit drop due to drought conditions.

Installing a valve to ensure good control of water system.

- Efficiency measures such as drip irrigation systems, which were introduced to farmers by the Nevis Agricultural Department, combined with mulching, have been integrated by farmers in the New River community to reduce evapotranspiration and soil temperatures, improve soil moisture, and to use the water supply more sustainably. As a result of workshops and farmers' meetings that were hosted by the Agriculture Department, farmers are much more aware of the importance of water conservation and efficient use.

- Due to the availability of supplemental irrigation, farmers have been able to increase their production (for example, an increase in the production of watermelons from 10,000 pounds per acre to 15,000 pounds), enhance quality, and extend their planting seasons into the dry season. This has raised their incomes, making them more consistent throughout the year and enabling these farming families to decrease their dependence on the savings generated during the wet season. Farmers reported that their current income far exceeds what they were earning before. Other farmers commented on how satisfied they were in being able to put more food on their family table.

- Diversification to a wider array of crops than those traditionally grown by the crop farmers has contributed to food and livelihood security, as well as self-sufficiency. By capitalizing on the water now available during the dry season, farmers are able to produce a wide variety of fruits and vegetables to reliably supply local markets as well as a new hotel, which offered gave the New River farmers a year-round contract. Having a wider variety of crops to sell has mitigated the risks of dramatic income loss in the case of failure of one crop, and higher quality produce means that the price commanded is also higher. This has helped to increase the food security of the farming families, and of the island as a whole. Farmers were also able to take produce to the marketing division; it was then distributed to hotels and restaurants around the island.

- Impacts such as unhealthy crops, blossoms dropping, plant stress and fruit deformation have been minimized.

- A farmers' co-operative was formed to facilitate knowledge exchange and improve access to innovations. Enhanced co-operation between farmers has enabled progress towards the common goal of a consistent, well-maintained, clean water supply. This also helped to instill a sense of pride in their work, resulting in the organization of a farmer's day at New River Estate where they showcased their produce to the public and were able to generate many sales. Bonded together as a group, the 40 farmers in New River continue to build on their strategies to develop a vibrant farming industry in the area. They even secured a USD 50,000 from the Global Environmental Facility to upgrade their water distribution line from the storage tanks to the farming area.

- Farmers are now more receptive to new innovations and are more aware of the effect that changes in climate can have on agriculture, as well as what they can do to respond.

Flushing of pipe line to remove any debris before releasing water to farmers.

Lessons learned

There are many lessons learned from implementing practices to improve water use efficiency and distribution, and to reduce climate risks to production. The adaptation of new technology is a difficult and often daunting task, especially for farmers who are traditionally accustomed to employing particular methods of production, and who depend on farming for their livelihood. Farmers must be open-minded and receptive to testing new technologies, as innovations can make an important contribution to combatting the climate risks being faced by farmers. Integrated approaches using multiple technologies are important. In this case, farmers have successfully employed methods that continue to have significant positive impacts on their farms and farming livelihoods by developing and expanding their farms while becoming more competitive and capitalizing on new markets when they become available. Farmers were able to supply the Four Seasons Hotel, through the marketing division, with produce such as honey dew, water melon, tomatoes and cabbage, among other fruits and vegetables.

Participating in co-operatives and better coordination can increase the chances of acquiring funding and technical support to assist farmers to manage the impacts of climate change. These networks allow for information, knowledge, and adaptation techniques to be shared, and help some farmers to learn from the errors or successes of others. Climate change is real and farmers need to arm themselves with the necessary information to understand and anticipate what is happening, identify the climate risks and take action to place themselves in a better position to manage those risks.

My fruit trees can now be well watered which will help them to have better fruit set. I am very grateful and heartened that the New River Farmers' Co-operative bonded together and pulled off such a project. I will be able to produce more quality produce that will help me to be more competitive in the market place.

Mrs. Coreena Liburd, farmer

We are truly grateful for the flow and adequate supply of water coming to our farm now. My plants are fully watered in a shorter time and much needed time is saved. Special thanks to the New River Farmers' Co-operative Society for this innovative project.

Trevis and Grace Leitch, farmers

I have been struggling with the issue of a good supply of water for a long time now. The struggles are over as this project proved to have really made a difference in not only how I plant now, but also what I plant. Increased water supply means an increase in my farm output, which will ultimately lead to an increase in my earnings.

Clive Maynard, farmer

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Additional CSA experiences

7. Rebuilding Grenada's soil for sustainable production
Ottley's Farm, Grenada

8. Building a resources centre for food security and managing scarce water
Precise Development Foundation Inc., Antigua and Barbuda

9. Introduction of drought resistant grass and improved grazing management for resilient small ruminant production
Small Ruminant Association, St. Kitts and Nevis

10. Protecting the Molinière-Beauséjour Marine Protected Area and adapting to climate change risks using climate smart agriculture technologies
North East Farmers Organization, Grenada

11. My farming experience: Learning to produce under challenging climatic conditions
H&H Farms, St. Kitts and Nevis

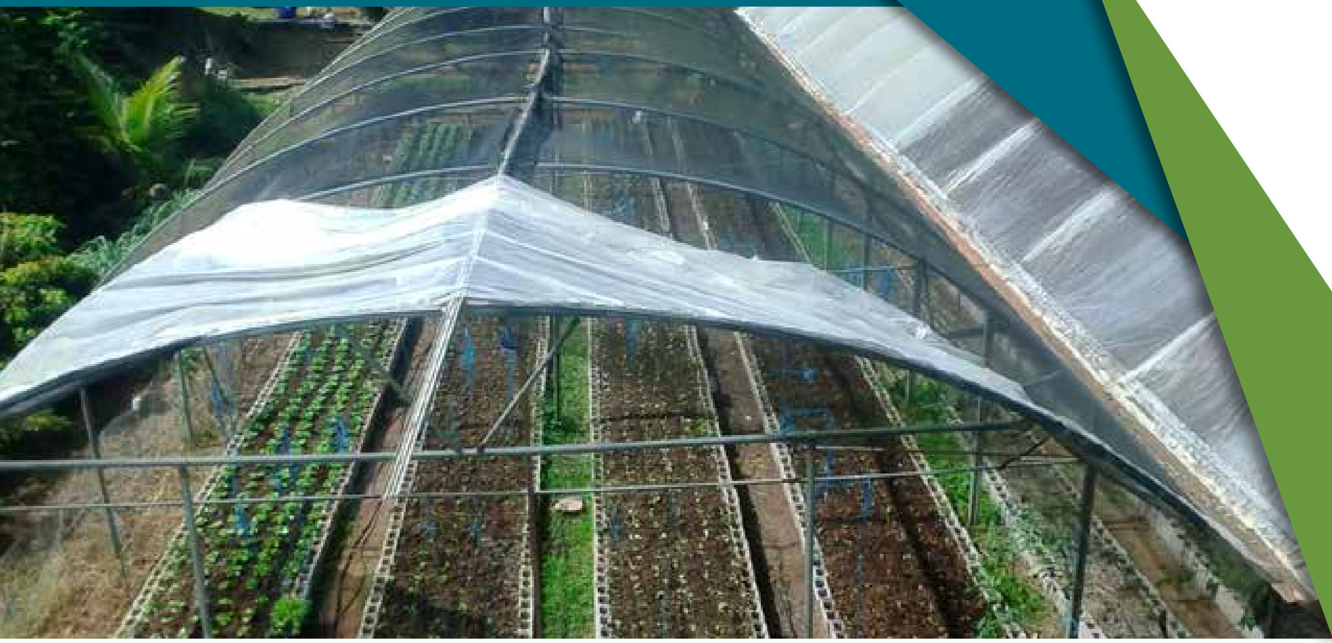
12. Solar crop dryer for climate resilience
Grenada Cocoa Association, Grenada

13. Climate smart hydroponics: Growing more with less
Clarence Fitzroy Bryant College, St. Kitts and Nevis

Climate smart agriculture
in the Eastern Caribbean States

Rebuilding Grenada's soil for sustainable production

Ottley's Farm
St. Andrew, Grenada



Contributions to climate smart agriculture

Integrating organic matter into the farming system and enhancing resource use efficiency has helped to reduce production costs and augment the resilience of the farm. The owners and workers strive to continually enhance their knowledge of climate smart innovations.

Restoring soil health has helped enhance production and productivity on the farm. Crop loss has been reduced with improved water, soil and landscape management and the introduction of new varieties.

Eliminating the use of synthetic pesticides and other agrochemicals has reduced the greenhouse gas emissions produced by the farm.

Climate change signals:	Climate smart practices and technologies:
Extended heat waves	Water management
Increased climate variability	Soil management
Increased temperatures	Alternative farming methods
Changes in water availability or precipitation	Capacity development
	Introduction of more climate resilient varieties

The challenges posed by climate change

St. Andrew, the largest parish in Grenada, houses the vast majority of both the island's rainforest and its farms. Mr. Winston Ottley is one of the producers who works on 150 acres with four employees there in the rural Mt. Cassell area. Various vegetables, including peppers, red cabbage, and tree crops including avocados, mangoes, are grown. These crops are primarily sold to supermarkets, restaurants, hotels and the National Marketing and Importing Board. It is an important source of locally grown and fresh food. A small volume is also exported.

Traditionally, the area has been quite productive, though soil erosion has posed a challenge for farmers. Climate change has contributed to changes in the local weather patterns, leaving farmers unsure of when the rainy and dry seasons will start and end. Heavy rains, which are typical in the area, are exacerbating the erosion of top soil and resulting in nutrient leaching and decreased soil fertility. Extended periods of increased temperatures and more frequent heat waves pose a threat to Ottley's Farm and Grenada's agricultural industry as a whole. At the Farm, even the plants grown under shade within the confines of the green house are affected by the extreme heat.

Producers have experienced a decrease in crop production, with water stress, higher plant mortality and lower productivity. This also contributed to a rise in expenditure on fertilizer to replace the important nutrients that were leached from the soil due to unexpected heavy rainfall and high temperatures. In 2015, a number of plants grown in the shade house were lost due to infiltration of water from unusually heavy rains, which ultimately resulted in a significant reduction in their commercial value. Ottley's Farm lost as much as EC8000.00 as a result of such heavy rains. The water also removed a large quantity of the top soil from some farms thus rendering the land less productive. Combined, these factors have left the farmers with no choice but to adapt to the changing environment and alter their typical way of doing things.

The solution

Ottley's Farm is taking a variety of proactive measures to confront the current and potential impacts of climate change.

Utilization of sargassum seaweed to improve soils: Taking advantage of the Sargassum invasion the Caribbean experienced, due in part to the warming oceans, the farm has integrated the seaweed collected from the coastal area of Hope beach two and a half miles away. Mulching with the Sargassum seaweed has helped combat the loss of soil moisture. In addition, in 2015, the farm started using the seaweed, which was placed in a drum to create a liquid fertilizer for the farm's crops. Sargassum seaweed is also used in combination with nutmeg waste, green grass for nitrogen, dry grass for carbon, and chicken litter to create a well-balanced compost that increases beneficial micro-organisms and other nutrients in the soil.

Installation of irrigation systems: Both drip and overhead irrigation systems were installed on the farm depending on the crop to be irrigated. From approximately a quarter mile into the valley of Mt. Cassell, water from a stream is gravity fed through water pipes and stored in various ponds located on the farm. From there, water is pumped to various areas as needed, using a controlled system with timers.

Drainage system: Contour drains have been created throughout the farm to channel rainwater to the ponds, thus removing excess water after heavy rain falls. This capture of runoff also helps to ensure water availability in the ponds for irrigation.

Participation in training: Those working on the farm took advantage of various trainings and opportunities for learning that were offered in their area, especially by the German international cooperation agency, GIZ. Extension agents from the Ministry of Agriculture also provided support. The workers gained knowledge and practical skills to help them implement climate smart agricultural techniques. The farm also helped to raise awareness of others through inviting primary school students to learn about the different measures being implemented at the farm and participating in news casts to tell others about the practices.

Improved crop varieties: The farm is changing practices to adjust to the changing climate by using improved hybrid crop varieties of peppers and tomatoes. These crops are specially developed to withstand the harsher climatic conditions – in particular heat and water stress but also various plant diseases. Increases in yields of as much as 30% were obtained with a concomitant level of profitability.

Organic pest control: Natural insecticides, fungicides and nematicides are created from the neem plant. Neem leaves are crushed, soaked in water, strained and applied into the soil at the base of the plant. These pesticides are used in conjunction with cultural field practices to ensure that pests and diseases are kept in check.

Crop rotation: The practice of letting certain fields rest for two to three cycles to help restore soil fertility is now used. Rows in which the vegetables are planted are shifted to make use of the areas that have been rested. This helps to reduce the buildup of soil nematodes and other pests, and diversification with different tree crops and vegetable crops grown in open fields and under shade house is also helping to restore different soil nutrients.

Results and contributions to the 3 pillars of climate smart agriculture

- The seaweed and other readily available organic materials for composting and mulch have had many positive impacts on soil health: increasing nutrient and soil moisture content and enhancing soil fertility. In areas where production had not been possible, the rehabilitation of soils through the practices described above enabled growth of cauliflowers and cabbages.

- Production increases were reported on the farm, in part, due to the use of tomato and pepper hybrids which produced larger fruits and reduced crop loss due to heat and water stress. Farm workers noted an increase in productivity by 30% on the farm, with greater yields being obtained and greater income from the sale of the produce. For example, after the use of the compost in place of synthetic chemical fertilizers in a crop cycle of peppers, the workers reported a significant increase in pepper production. With such positive response from the compost, less synthetic chemical fertilizers are being used on the farm and more compost bins are being installed to produce more compost for use on the farm. The increases in crop production have contributed to local food security.

- Water use efficiency improved through the timed irrigation system. Before, a hose or bucket was used. The irrigation system allows for the release of a specific amount of water to meet the necessary requirements so that there is no major wastage.

- The improved capture of rainwater using the drainage system, and the irrigation systems installed helped to increase the stability of the water supply, ensuring timely availability for production. This also helped to even out production through the dry season.

- By utilizing organic materials on the farm for compost, mulch and pest control, the farm was able to decrease its greenhouse gas emissions and eliminate the costs of purchasing synthetic fertilizers, thus resulting in increased farm income. Other financial savings have also been achieved through these measures. Collection of Sargassum on the nearby beaches reduced the need to buy inputs, collection of water in ponds decreased dependence on water lines, and the time saved with the irrigation system reduced labor costs.

Lessons learned

Farmers in the area are used to changing conditions on their farms, but some of the changes in variability that are being experienced are more than the farm can bear and require different practices to facilitate production. These kinds of measures include natural interventions, for example, the production of compost to help restore soil health; engineering options, for example, building shade houses and water harvesting systems; and finally, capacity building measures to enhance the training and knowledge farmers have.

Many of the of the adaptation measures, such as rebuilding soil health, are critical for enabling the crops grown by Grenada's farmers to thrive in the changing and more unpredictable climatic conditions. There are some costs involved with implementing these measures, but ways must be found to cover them. Those involved with the implementation of these practices should advise other farmers to practise smart agriculture, and to take advantage of the natural materials that are available to them on their farms. This work has shown that synthetic fertilizers are not required for good productivity, and that positive impacts on the environment can be achieved without the use of synthetic chemical inputs, while also saving costs. ■

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Climate smart agriculture
in the Eastern Caribbean States

Building a resources centre for food security and managing scarce water

Precise Development Foundation Inc.
Paynters Industrial Park, Antigua, Antigua and Barbuda

Contributions to climate smart agriculture

Hydroponics allows for the production of consistent quality and quantity of lettuce even during periods of reduced rain and high temperatures, allowing people access to a local food source rather than imports. It has also helped with the control of pests and water usage.

The new production techniques have resulted in stronger and healthier plants, which in turn extends the shelf life and reduces waste. Higher productivity has also been achieved, increasing income stability.

The Precision Centre installed photovoltaic panels which are expected to reduce greenhouse gas emissions by 395 metric tons over the next 25 years. Use of natural pesticides and fertilizers in place of chemical products also reduces emissions.

Climate change signals:	Climate smart practices and technologies:
Changes in water availability or precipitation	Water management
Increased climate variability	Alternative farming methods
Increased temperatures	Capacity development
	Renewable energy

The challenges posed by climate change

The island experiences low humidity and is prone to recurrent drought. Climate change has caused both increased temperatures and decreased levels of precipitation in Antigua and Barbuda. The country has experienced an unusually prolonged dry season starting in 2013 and continuing to present day (late 2016). The typical annual rainfall of 40 inches has not been attained throughout this period. The current drought is being labelled by meteorologists as the worst since 2002-2003.

The main surface water resource was completely depleted by the middle of 2015, and ground water sources are no longer being used for fear of damaging aquifers. Higher temperatures have led to an increase in evapotranspiration rates, and the increased water needs by crops have depleted the limited water that remains in the supplementary pools used to service the central and eastern parts of the country.

These conditions have severely impacted farmers and the agriculture sector of Antigua as a whole. Agricultural activity is generally located near the surface water catchments, which have completely dried up. Farmers have been forced to limit production of crops that have high water demands, increasing the needs for imports, especially for lettuce and other vegetables. The demand for lettuce is high among the hospitality sector, which is the mainstay of Antigua and Barbuda's economy. Lettuce needs to be watered regularly during the dry season to ensure the best quality produce. Farmers are struggling to meet the water demands in the prevailing drought conditions.

The solution

Precise Development Foundation (PDF) Inc. is a volunteer-run national non-profit organization, committed to nation building through the promotion of ethical, values-based initiatives. It designs and executes programmes focused on sustainability, including managing an orchard to maintain the country's plant biodiversity and a hydroponics farm.

Established in 2014 through a grant from the Global Environment Fund (GEF) Small Grants Program, the Hydroponics Farm is located on 4900 sq. ft. of land in the Parish of St. George, Antigua.

Hydroponics: This system was implemented as an alternative to the traditional way of farming. Growing plants in a water based, nutrient rich solution helps to increase productivity in a small space.

Knowledge exchange and training: An expert from Trinidad and Tobago was identified and consulted to guide the building of the system and capitalize on the lessons learned during prior experiences in the region. Volunteers participated in the installation of the technology and were fully trained in hydroponic techniques and the grafting of plants. These people now serve as resource persons for others looking to establish similar operations. The Farm itself was designed to be a living knowledge management site for farmers and students of Agricultural Science, as they visit to obtain first-hand information and experience of the hydroponics operations. The Foundation provides free advice to other interested groups/organizations interested in setting up similar projects.

Solar energy: Photovoltaic panels have been installed at the Precision Centre, which will help reduce energy costs over time as Antigua and Barbuda has one of the highest energy rates in the Caribbean. The use of renewable energy is important for decreasing emissions as well – savings are estimated to be 40% over the next 25 years.

Natural pesticide use: As weeds do not have space to grow, the application of synthetic agro-chemicals is reduced. Natural pesticides (primarily Neem) and fertilizers are now used.

Results and contributions to the 3 pillars of climate smart agriculture

Combined with other measures, hydroponic production has helped to adapt production to the reduction in available water and to the increase in temperatures that have been experienced. It has demonstrated multiple positive benefits:

- Precise hydroponic production allows for increased production compared to traditional cultivation methods. The plants are stronger and healthier, yields are higher, and susceptibility to attacks by pests has decreased. Hydroponic lettuce reaches maturity in a shorter time compared to traditional growing methods, and the use of bays allows for the production of more lettuce per square foot.
- At the end of 2015, data collected show imported lettuce sold for US$2.04 per head, while the hydroponically grown lettuce sold for US$1.48 per head. The hydroponic lettuces were also twice the size, and the heads weighed 1.25 pounds while the imported green leaf weighed 0.75 pounds.
- The Hydroponics Farm provides a consistent quality and quantity of lettuce to its customers, even during periods of intense that farmers experience intense heat and droughts between June and September. This was very difficult to accomplish using traditional production methods. The farm has the capacity to produce approximately 5,712 heads of lettuce at one time.
- Hydroponic lettuce also has demonstrated a shelf life of roughly two weeks longer than traditional cultivation methods, enhancing economic returns and contributing to a more resilient food system by the reduction of food waste.
- This system has been proven to reduce labor and make more efficient use of water – estimated at up to 90% - in its daily operations as compared to traditional farming. There is no weeding or spraying required.
- Lettuce is now part of the average Antiguan diet, as evidenced in the increase in supermarket sales.
- A reduction in the use of synthetic pesticides and the use of solar energy have contributed to a reduction in GHG emissions from the farm operations While the full realization will occur incrementally, the photovoltaic panels installed at Precision Centre will reduce GHG emissions by 395 metric tons over the next 25 years.

- The farm has also inspired new entrepreneurs and prospective farmers; several persons have approached PDF for technical assistance with starting their own hydroponics farm and renewable energy projects. In addition, technicians in the Environment Division and the Ministry of Agriculture, as well as a hotel gardener and students of both secondary and primary schools have benefitted from this knowledge. Many of the volunteers involved with the Hydroponics Project had never been involved in farming before, but the experience has ignited an interest in setting up and expanding back yard gardens.

Lessons learned

This initiative has been successful not only in enhancing the resilience of production, but also in increasing productivity while contributing to greenhouse gas reductions. The benefits realized were greater than anticipated. For instance, after the passage of Tropical Storm Gonzalo in October 2014, farmers utilizing traditional soil production techniques were unable to produce lettuce for some time. However, the hydroponics system was dismantled and secured during the storm and then reassembled two days afterwards, producing lettuce at full capacity three weeks later.

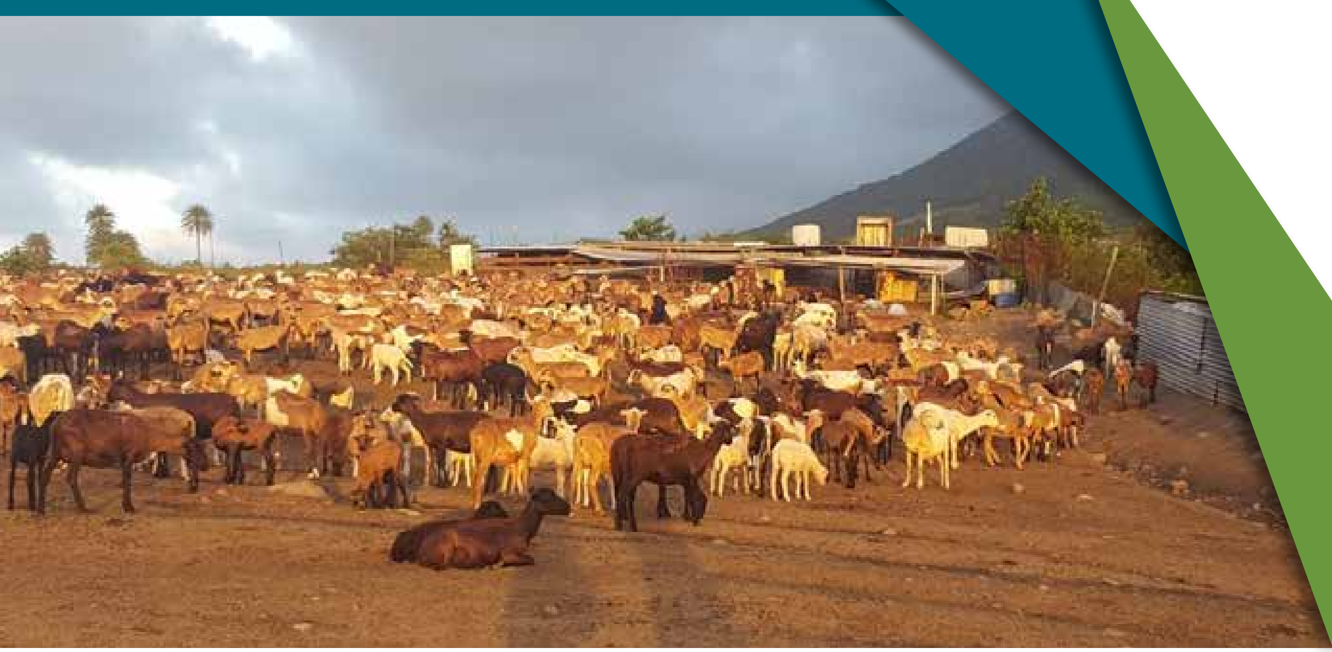
The system has been proven to save labor, water and some costs when compared to traditional farming. However, attention to detail and constant monitoring are needed to ensure the free flow of water and correct balance of the nutrients for the plants to flourish. Any farmer who wants to invest in a Hydroponics Farm will find that the start-up costs can be substantial; however, the benefits far outweigh the challenges over time especially as the climate continues to change.

For more information: Mrs. Alicia Cornelius, Administrator, Precision Centre
alicia.cornelius@precisioncentre.org
See: https://goo.gl/2NmUaz

Climate smart agriculture
in the Eastern Caribbean States

Introduction of drought resistant grass and improved grazing management for resilient small ruminant production

Small Ruminant Association, St. Kitts
St. Kitts and Nevis



Contributions to climate smart agriculture

Adaptation and Resilience

Improving the capacity of small ruminant systems to produce under drought conditions provides farmers with steady incomes throughout the year and reduces sudden losses due to production decreases and increased mortality of the animals.

Food Security and Productivity

Using grazing management strategies and improved grass varieties raises the productivity of the system by increasing the grazing capacity of the land. Animals that have access to better and readily available feed, in addition to protection from high temperatures and low availability of water, show lower mortality rates, higher gain weight and improved reproductive cycles.

Mitigation

Increased quality of forage and greater forage biomass production reduce absolute emissions from enteric fermentation and decrease emission intensities. The introduction of trees in pasturelands intensifies soil carbon storage and carbon absorption.

Climate change signals:	Climate smart practices and technologies:
Changes in water availability or precipitation	Agroforestry
Increased temperatures	Alternative farming methods
	Capacity development
	Capacity building

The challenges posed by climate change

Livestock production systems are particularly sensitive to climate signals. Increased temperatures and changes in water availability, for instance, reduce the quality and availability of feed and fodder for the animals. Nevertheless, quantifying the direct and indirect negative impacts of climate change on livestock production is a difficult task for many reasons. Livestock systems often overlap with crop systems and natural landscapes. Small ruminants often represent a fundamental component of the livelihoods and food security of small farmers, providing stability and coping capacity for farming systems. Hence, in order to adequately quantify the impacts of climate change on animal production and attain the three main goals of climate smart agriculture, it is necessary to analyze livestock systems as part of a broader system.

Mr. Wilmoth Thomas raises a flock of sheep on a 15-acre lot in the village of St. Pauls on the island of St. Kitts. Mr. Thomas initially shepherded a flock of approximately 1000 sheep, but experienced high rates of mortality amongst lambs. This was because he continued to employ traditional shepherding techniques - taking sheep out to various pastures to graze and consume water - though temperatures have been rising over the years. This led to dehydration, overheating, a decrease in grazing times, and poor overall health of the sheep. In turn, poor mothering ability and a decrease in the overall fertility of the animals negatively affected the herd.

Higher temperatures have also increased grazing pressure on local pastures. Combined, these factors degrade the land, forcing shepherds to take sheep further away from farms to graze. Due to the longer distances that the animals have had to travel to get good quality grass, mortality has increased as the likelihood of sheep straying from the flock to tend to lambs has increased and it was difficult for farmers to accurately determine which lambs belonged to which mothers. Water availability has also been decreasing. These challenges often resulted in high lamb mortality as well as loss of sheep. The negative impacts prompted Mr. Thomas to seek assistance from the Ministry of Agriculture in finding a solution.

The solution

Technicians from the Ministry of Agriculture who intervened suggested trying to plant Mulato grass II, a drought resistant variety of the Brachiaria genus, and guided the farmers through the process.

Establishment and management of Mulato II grass: The Ministry of Agriculture demonstrated to farmers how to establish the new grass. Mr. Thomas planted five acres of Mulato II grass (Brachiaria hybrid CIAT 36087; Tropical Seeds Coral Springs FL) in three different pastures. He also established an additional plot to graze his breeding flock. The land was harrowed with a tractor drawn trail harrow and levelled. The stones and boulders on the soil were removed to avoid breaking the harvester blades. In rows two feet apart, 8-10 pounds of seed were sown per acre.

Use of specialized maternity pastures: Provision of maternity pastures, in which better, easily accessible food is available for the ewes reduces the need for vulnerable animals to travel long distances. The maternity pastures also provide a confined area in which sheep can be separated from the rest of the flock to tend their lambs in conditions safer than those found out in the open where they traditionally would have remained. Pregnant sheep are separated for one month after giving birth. At the last stage of pregnancy, sheep graze entirely on the maternity pasture reducing the strain and stress they experience. This also facilitates management activities for the farmers, who are able to better observe the animals.

Increase in forest cover in pastures: In order to reduce heat stress for particularly vulnerable animals, Mr. Thomas selected strategic locations to plant trees to provide shade to the animal during the hottest hours of the day as well as during heat waves. This reduces heat stress and water consumption needs. In addition, trees increase the above and below ground biomass, enhancing soil carbon storage and carbon absorption.

In the case of this particular project, the approximate cost to establish five acres of Mulato grass in 2014 was 11,327 XCD.

Results and contributions to the 3 pillars of climate smart agriculture

- The successful establishment of Mulato grass in the dry season shows promising results and production potential to feed ruminant species in St. Kitts. With the potential to produce 54.7 tons of forage per ha, 20 hectares of Mulato Grass will cover the forage needs for all the small ruminants in St. Kitts.

- Use of specialized maternity pastures has decreased the mortality of lambs and sheep on Mr. Thomas' farm. Grazing sheep on maternity pastures results in healthier animals as they do not have to travel long distances for sustenance. When sheep give birth while segregated, it is easier to identify to which mother each lamb belongs, thus decreasing mortality rates due to rejection. After applying this management technique, the survival rate of lambs has reached up to 95%.

- During hot weather, it was observed that the sheep flocked under the shade provided by the trees incorporated into pastures. The farmers reported seeing a decrease in the signs of dehydration. By establishing multiple pastures with Mulato grass, Mr. Thomas has reserve pastures onto which he can transfer his maternity flock to avoid overgrazing.

- The decreased quality of forage under the hotter, drier conditions being experienced not only has a direct impact on productive and reproductive parameters, but is also linked to absolute emissions of greenhouse gases and emission intensities. Therefore, improving grazing systems results both in positive gains in terms of productivity and in the mitigation of emissions from ruminant livestock production.

Lessons learned

The grass was successfully established during the dry season, covering 98% of the soil in only 20 weeks. Forage biomass production effectively increased its yields during the wet season.

Due to the positive results obtained by Mr. Thomas, more farmers were encouraged to join the project. They participated in all training and harvesting processes which increased their interest and motivation to try the forage on their own farms. As a result of the pilot experiences of the project, five other farms have decided to establish a total of 20 acres of Mulato II on their own.■

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Climate smart agriculture
in the Eastern Caribbean States

Protecting the Molinière-Beauséjour Marine Protected Area and adapting to climate change risks using climate smart agriculture technologies

North East Farmers Organization
St. George, Grenada

Contributions to climate smart agriculture

Adaptation and Resilience

Reducing contamination in the waterways and integrating compost resulted in healthier agroecosystems to support production and decrease negative impacts on the adjacent marine protected area. Soils were rehabilitated, decreasing the quantity of water needed for irrigation during the dry season.

Food Security and Productivity

The use of biogas digesters and a reduction in synthetic agrochemical use will contribute to a reduction in emissions from these farms.

Mitigation

Farmers reported an increase in yields and quality of produce as soil fertility was enhanced through composting.

Climate change signals:

- Changes in water availability or precipitation
- Increased climate variability
- Increased temperatures
- Sea level rise/salinization of soils

Climate smart practices and technologies:

- Capacity development
- Soil management
- Renewable energy

The challenges posed by climate change

The North East Farmers Organization (NEFO) is a not for profit farmers' organization whose members operate small to medium size holdings in the northeast St. George area of Grenada. Established in 2005, its 19 female and 27 male farmers come from five different communities. The NEFO farmers primarily grow roots and tubers, vegetables and herbs. A few members also rear pigs and small ruminants. For the most part, these products are destined for local markets, supermarkets, hotels, restaurants and to the Marketing and National Importing Board (MNIB). NEFO farmers believe that 10-15% of their production is consumed by their households. Very little is exported.

The members of the NEFO operate within the Beauséjour watershed whose rivers and tributaries empty into the Molinière Bay, where the Molinière-Beauséjour Marine Protected Area (MPA) is located. Over the years, the MPA has been negatively impacted by the activities that take place on the land above, many of which are linked to agriculture.

Climate change and increased climate variability have impacted the farmers of the North East noticeably, in particular over the last ten years. Precipitation during the rainy season has not been as consistent as in the past; more intense rainfall over short periods of time has become the norm. This has resulted in an increase in nutrient leaching, runoff of agrochemicals, and soil erosion all of which end up in the rivers and streams and ultimately in the MPA, leading to disastrous results for coral and other aquatic life. The increased temperatures experienced during the dry season have also had negative impacts on the farmers of NEFO, who have noticed more frequent incidences of pest and disease, increases in soil moisture loss, lower yields, inferior quality and crop failure. Sea level rise and the salinization of soils have also affected producers across Grenada and neighboring islands. The ultimate end of these impacts was a reduction in earnings which threatened their livelihoods.

In an effort to enhance resilience to the impacts of climate variability and change, while reducing negative impacts on the MPA, the Ministry of Agriculture, the Inter-American Institute for Cooperation on Agriculture (IICA) and the GIZ Caribbean Aqua Terrestrial Solutions (CATS) Project supported NEFO in the development of a project to promote climate smart agriculture in the areas.

The solution

To address the challenges described above, the project focused on training and implementing several basic climate smart innovations, including:

Demonstration of useful technologies: The project focused on raising awareness of and training farmers about different technologies and practices that had the potential to improve productivity while supporting adaptation. Many training sessions were held and funding was provided to permit the piloting of several technologies to facilitate CSA practices, including shredders, biodigestors and others. One farm has also been used as a demonstration site where young persons from schools in the North East St. George area visit to observe the innovations being employed to improve the sustainability of production. The project did not undertake work to address the issues of salt water intrusion and sea level rise as the NEFO farmers were not directly affected by them. There was however discussion and awareness raising by the project among the NEFO farmers on said issues, so as to further build their knowledge and capacity.

Composting: Creation and utilization of compost was promoted to improve overall soil management and soil water retention. Two shredders were purchased, enabling the farmers to process dry materials - grass, branches, plant matter - into smaller particles that break down easily, thus decreasing the time it takes to produce the compost. Incorporating animal waste from the piggeries into the compost was encouraged. The use of compost allowed better crop nutrition and improved soil structure.

Installation of biogas digesters/renewable energy: Biogas digesters were installed on the piggeries of four farmers to help reduce greenhouse gas emissions as well as the amount of animal waste entering the waterways. The bio-gas digesters would enable farmers to reduce their use of conventional cooking fuels on the farm or in the household where possible. Extension officers from the Livestock Division of the Ministry of Agriculture as well as certain NEFO farmers were trained in biogas digester building and management.

Mulching: Mulching was promulgated as one of the tools to tackle the increased water loss and crop failure due to increased temperatures.

Results and contributions to the 3 pillars of climate smart agriculture

The results obtained through the implementation of this project are significant and the true impact will be seen in the years to come once the practices learned by the NEFO farmers are sustained and replicated across the North East St. George area and across the country. Amongst the observed impacts are:

- Many farmers observe improved water retention in their soils as a result of incorporating compost. The quantity of water used for irrigation was reduced, and farmers noted less negative impact on the plants during the dry season as a result of using compost as mulch around the base of the plants.

- While the soils were not tested for nutrient levels or improvements in structure, many of the farmers noted more robust growth of the crops - especially vegetables- as a result of incorporating organic matter into the soils. Increases in yields and quality of the produce were observed, and the reduction in agrochemical usage contributes to providing a consistent supply of healthier food for local consumers. While members have been reporting increased production and productivity, adequately documenting these changes with solid data has not yet been accomplished.

- Farmers have reported experiencing various savings and increases in incomes. Reduced financial outlay on inorganic fertilizers and chemicals for pest and disease control were required. This, combined with the increased yields of improved quality that have been reported will contribute to higher profits for farmers. The production of the methane gas for households that received biogas-digesters is still low and NEFO expects them to have a greater impact in the future. As the gas output is increased, farmers will be able to proportionally reduce their use of conventional cooking energy sources (liquefied petroleum gas, electricity, firewood, etc.).

- The installation of the biogas digesters and the use of manure in compost have contributed to the reduction of inorganic fertilizer use and have decreased the amount of organic and inorganic materials entering the waterways. Water quality tests will be conducted to quantify the impact in the areas surrounding the farming areas. It is expected that the reduction in siltation and pollution will help safeguard the health of the coral reefs and other aquatic life, as well as the livelihoods of the people who depend on a healthy marine environment.

- These pilot actions have strengthened the capacity of NEFO members and better positioned them to adapt to the impacts of climate change and other risks. They have also generated interest from other farmers in the St. George North East Area and the country as a whole.

Through the CATS project, GIZ invested US$90,000 over a period of three years to finance these efforts. An additional US$50,000 was contributed in technical assistance and labour by the Ministry of Agriculture, IICA and the NEFO farmers. These efforts directly benefited almost 200 people - NEFO members and their immediate families - in a direct way. Many others will also benefit from the food produced, the reduction in agrochemical use, increase in the health of the area's soils and the MPA.

Lessons learned

The NEFO farmers learned invaluable lessons during the implementation of this project and to date all of the farmers engaged continue to implement some of the climate smart agriculture practices learned. They obtained a greater understanding of the impacts which activities on the land can have on the marine environment and how climate smart agriculture can not only significantly reduce those impacts but also increase their resilience to the risks that climate change and variability pose to agricultural production.

Farmers realized that they can proactively take some measures to adapt to climate change with the knowledge and technology available at a relatively low cost. Simple, inexpensive technologies can bring significant returns, not just to the farmers themselves but to the surrounding environment. For instance, material that was usually burned or otherwise discarded can be useful inputs for composting. This compost can fertilize and help retain soil moisture. The producers also recognized that composting and natural pest and disease control can be a substitute for the chemical alternatives which contribute to contaminating the waterways and diminishing soil microorganism populations that are critical to soil and plant health and nutrition.

There is a great need to establish baselines to enable concrete measurement of the impacts of the climate smart measures being implemented on members' farms. NEFO is currently taking steps to properly document the members' data on gains in yield and income as a result of these interventions. Water quality tests also need to be conducted to measure the impact on the MPA.

NEFO members would advise other farmers within their area and across Grenada to adopt some of these climate smart agriculture measures because in addition to being better for the environment, they are also economically beneficial. The NEFO farmers have vowed to work with other farmers in the area and throughout the country in passing on the know-how that they have acquired from the project and will seek to engage with other efforts to continue this work.■

For more information: For more information see: https://goo.gl/n8RKmM
• https://goo.gl/JWNMUi or contact northeastfarmersgrenada@gmail.com

Climate smart agriculture
in the Eastern Caribbean States

My farming experience: Learning to produce under challenging climatic conditions

H&H Farms, Nevis, St. Kitts and Nevis

Contributions to climate smart agriculture

Adaptation and Resilience

The use of driplines and plastic mulch allows for more stable and reliable production during periods of dry weather. The drip irrigation system ensures the consistent availability of water for crops in an efficient manner that also reduces soil erosion. In addition to controlling weeds, the plastic mulch increases water retention in the soil, reducing evaporation and protecting the topsoils from water and wind erosion, which has been exacerbated by increasing sea blasts. Natural barriers also help protect crops from these blasts.

Food Security and Productivity

Using technologies that are less labour intensive has enabled the farm to expand its acreage, and thus the agricultural production and productivity of the system. This in turn, has created greater job opportunities and increased the local food availability. Additional crops have been cultivated, and production of some – like tomatoes – is now possible year round. This effort also contributes towards maintaining a steady supply of fresh produce on the island. The farmers also recognized the need for improved, consistent and timely management of the farm to enable success under more challenging conditions and are building capacity to accomplish this.

Climate change signals:	Climate smart practices and technologies:
Changes in water availability or precipitation	Water management
Increased climate variability	Soil management
Increased temperatures	

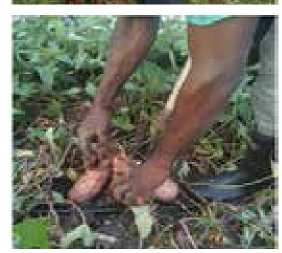
The solution

Driplines: To combat increased temperatures and dry weather conditions, driplines were installed for all the crops – melons, butternut squash, cucumbers, cabbage, okra, lettuce, eggplant, tomato, peppers, sweet potato, string beans, celery, and herbs. This system maximizes water use efficiency, thus lowering production costs while helping to control erosion.

Plastic mulch: This was installed in the vegetable beds to help control weeds that were stunting crop growth and to help maintain soil moisture. The driplines are placed under plastic and four inch holes are cut out for the plants. Applied manually, it stays in place in windy conditions and lasts for two years if done well.

For more information: Grace and Trevis Leitch, gracegreenproduce@hotmail.com






Climate smart agriculture
in the Eastern Caribbean States

Solar crop dryer for climate resilience

Grenada Cocoa Association, Grenada

Contributions to climate smart agriculture

Adaptation and Resilience

Solar technology is much more efficient in terms of the time and space (50 kg of fermented cocoa beans/m2 compared with 5 - 10 kg/m2 using traditional methods) required for drying. This has helped reduce the loss of the cocoa while improving the flavor and quality of the cocoa produced as a result of homogenous drying with little or no contamination or astringent flavors. This allows the GCA to obtain higher prices on the market. The investment of time and labor also decreases as there is no need to move the beans at night or during rainy days.

Running the active drying facilities using diesel-powered burners gas had a high cost - $30,000 XCD per high season – and contributed to air pollution. The GCA has been able to save on energy costs and these savings are passed on to the producers as the GCA is able to pay higher prices.

Food Security and Productivity

To reduce the climate risk of increasing variability, the GCA is now offering its 2,000 members an alternative to the traditional direct sunlight drying method which is still the most dominant at the moment. This system can dry more beans, thus providing enhanced services to the Association's members, even in the absence of sunlight. The faster drying time prevents over fermentation and reduces contamination from mold, ensuring a higher quality product able to be sold at a good price. The Association is now advising its farmers and their agents to adopt the solar drying technologies to reduce their exposure to climate risks, with the goal of enabling all farmers to dry their own beans in a cost-effective manner. If they can reduce their reliance on the GCA for drying, the Association will channel its resources into other areas such as improving its value addition enterprises to help enhance farmers' livelihoods.

Mitigation

Using clean, solar energy to power the cocoa drying process has reduced the dependence of the GCA on diesel fuel for producing the heat necessary to dry the beans, resulting in a reduction of greenhouse gas emissions.

Climate change signals:	Climate smart practices and technologies:
Increased climate variability	Capacity development Renewable energy

The solution

Solar crop dyer: Heavy rains during traditionally dry seasons have forced Grenada's cocoa farmers to consider alternatives to passively drying the beans outdoors. The Grenada Cocoa Association (GCA) thus began using diesel powered facilities to dry the beans indoors; however, the costs ($30,000) and environmental impact were unsustainably high. With funds from the GEF Small Grants Programme, a pilot solar drying system at Mt. Horne, the largest drying station in the country, is helping them to manage the unpredictability of local climatic conditions in a clean, cost effective manner.

Capacity development: Local workers were trained in solar technology installation, and have held workshops to train the employees of the cocoa drying stations to both run the system and monitor its success. This pilot will inform future efforts for different agricultural commodities throughout the Grenada, Carriacou and Petite Martinique.

For more information: Mr. Andrew Hastick, General Manager, GCNA Complex, Kirani James Boulevard, St. George's, Grenada, gca@spiceisle.com

Climate smart agriculture
in the Eastern Caribbean States

Climate smart hydroponics: Growing more with less

Clarence Fitzroy Bryant College,
St. Kitts, St. Kitts and Nevis

Contributions to climate smart agriculture

Adaptation and Resilience

More frequent and extended dry spells in St. Kitts have resulted in island wide water rationing, making it a challenge for farms to produce food consistently. Using this system, which recycles both water and nutrients and utilizes an energy efficient pump, helps maximize the efficiency of resource use. It is enclosed in a shade house with suran mesh (a nylon synthetic) to allow full ventilation, and covered with a film to block ultra violet light from entering the green house, thus protecting the farmers as well. This system also uses harvested rain water.

Food Security and Productivity

This climate smart hydroponics model provides a means of producing high quality produce more quickly, all year round and in small spaces at maximum yields. The model has shown impressive yields for 20 crop types above ground, which include broccoli, kale, spinach, corn, eggplant, okra, cucumber, strawberries, melons, lettuce, cabbage, peppers, string bean, soy bean, tomato, basil, sage, cauliflower, brussel sprouts and parsley. For some vine varieties such as cucumber and tomato, yields have almost tripled. As plants are germinated and grown in the same spot, no transplanting is needed, thus avoiding losses. This model allows people to diversify their income or even develop this as a side business. It also demonstrates the ability to produce in a shorter time using less water as compared to traditional means.

Climate change signals:	Climate smart practices and technologies:
Changes in water availability or precipitation	Capacity development
Increased climate variability	Water management
	Alternative farming methods

The solution

Hydroponics system: Combining three different hydroponics designs, this system allows for a wide range of crop types to be grown in a small space in a water efficient manner. A small, successful home pilot was scaled into a semi-commercial, 24 square foot unit at the local college, which can house up to 300 individual crops or up to 900 individual vines (tomatoes, cucumbers, string beans, squash) per cycle. This model allows for crops to be produced consistently throughout the year. This is important given the growing population living on the 65 square mile island.

Rainwater harvesting: Rainwater is collected from the roof of the greenhouse and delivered to a holding tank. From there, the water is sent to the reservoir containing the nutrient solution, which is regulated using a float value. When the water in the reservoir drops, it is automatically refilled from the holding tank, maintaining the hydroponics system in an efficient manner with captured water.

Capacity building: Training which includes technical support, installation and operation on this technology has been conducted for secondary school students in Guyana, St. Kitts & Nevis, Dominica Department of Agriculture, Barbados SJPP College, and the Trinidad Holy Faith Convent. Teens on the Dutch island of St. Eustatius and farmers at the Department of Agriculture of both St. Kitts and Nevis have been exposed to and are now using this technology. These training sessions were done in the individual countries for periods of one to three weeks depending on the scale and the need.

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Conclusions

While the global community has been mobilizing in response to the challenge of climate change, realizing the commitments made at the international and national levels will not be possible without action on the ground. That is where the farmers, farmers' organizations, extension agents, ministries, and others that support them come in. It is clear that many of these actors are taking proactive steps to help address climate change in the Eastern Caribbean States. The cases detailed here showcase examples of how farmers are working to enhance their resilience and adapt to the climatic changes being experienced while seeking to contribute to the food security of their communities and, where possible, reducing greenhouse gas emissions.

These stories demonstrate that while many of the technologies and practices considered "climate smart" in the region are not necessarily new, they are now being applied specifically to reduce the impact of climate change on production. A combination of multiple measures is required to achieve the best results. Most initiatives featured here were able to contribute to all three pillars of climate smart agriculture, though several did not directly focus on mitigation efforts. The reductions in greenhouse gas emissions that did occur were not quantified; rather, general contributions were determined by the implementation of technologies known to produce lower emissions when compared to the baseline or traditional practice. Enhancing resilience and contributing to food security are clearly the priorities in the region, which is not surprising given the low levels of agricultural greenhouse gases generated in the Caribbean. None of the stories here mention any negative trade-off with productivity.

Most of the efforts in the stories presented here have been implemented in response to greater climate variability, changes in water availability or changing precipitation patterns, and increasing temperatures, which appear to be the climate signals of most concern to the farmers in the region. The most common practices currently used in the region are driplines, rainwater harvesting, composting, mulching, agroforestry and hydroponics. The installation of renewable energy sources and diversification are also utilized frequently. Many of these are general sustainable agriculture practices, also known as low regret measures, that tend to be lower cost and require little climate information. These practices will provide benefits to the farmers even in the absence of climate change. Other technologies and practices respond more directly to the climate signals farmers are experiencing, such as the changes in varieties. These, however, are not yet as prevalent, as there is a greater possibility that farmers will lose out if climate change signals do not continue to follow the observed trends.

Factors for success

Leadership, commitment, and ownership from the farmer or farmers' group is critical for success, especially since many of the positive impacts are not often visible within traditional project cycles. Involving farmers from the start, in identifying the problems to determining preferences for action is key for realizing the desired impacts, as even the best technical solutions are of little use if farmers are unwilling to put them into practice.

Capacity development efforts also contributed greatly in many of the cases featured here. Increased awareness of climate change and its impacts, trainings on improved agricultural practices, such as water harvesting or composting, and efforts to educate youth are prevalent in the ECS. Several cases noted exchanges with other countries in the region to source technologies or knowledge. Working in groups so farmers can learn from and support each other and seeking additional partners – from extension agents to international cooperation to potential buyers – has also proved to be essential.

Environmental co-benefits were produced by most of the practices implemented, whether it was enhanced soil-fertility, water use efficiency, or a reduction in agrochemical use. Many of the practices applied provided economic benefits for those farmers or farmers' organizations that implemented them, in addition to supporting those involved in achieving more consistent production of high quality goods. In several cases, this helped the producers to access additional markets.

Finally, shifts in technologies and practices often imply costs for farmers, and the positive impacts of the investments made by organizations such as the Global Environmental Facility (GEF) Small Grants Program and the German cooperation (GIZ), and others in enabling many farmers in the region to take action are noteworthy. The demonstrations implemented with donor funds should help to catalyze action among those reluctant to take action until they witnessed the successes achieved. The road ahead towards a sustainable agriculture sector adapted to the changing climate and capable of underpinning food security in the ECS will be challenging.

Keys for the future

Further research is necessary to determine the synergies and trade-offs of each set of practices and technologies in terms of their contribution to each of the three pillars of CSA. At the farm level, little concrete data is currently available to determine impacts, and thus farmers and extension agents rely on observations and subjective reports from those involved. More rigorous data collection, monitoring and evaluation are therefore required, as are cost-benefit and impact analyses. This will enable science based decision-making to provide valuable evidence to inform the necessary policies and investments by both the public and private sectors to scale up action.

The measures featured here are those implemented on-farm, many of which are providing incremental benefits to help producers cope in the short term. Clearly these actions will need to be complemented by more transformative measures in the future; ministries of agriculture and others working at the national level will need to create an enabling policy environment for this. Institutional frameworks to incentivize and scale action and encourage innovative adaptation technologies or practices along with low carbon development are required. This highlights the different roles that actors at different scales have and the importance of each taking proactive leadership in contributing to the solutions.

Capacity must be built at different levels to raise awareness, to enhance adoption of climate smart practices, and to integrate climate change considerations into planning processes. Continued exchange to disseminate experiences and lessons learned at both the national and regional levels is critical to increasing the pace of implementation. Additional financing is likely to be needed to upscale current initiatives and as such, each country will have to determine how to make best use of the Green Climate Fund, multi-lateral and bi-lateral funding, as well as their own domestic investments to make the most effective transition towards a more sustainable, climate resilient, low emissions sector.

The organizations featured in this compendium are innovators and despite uncertainty, are leading the way towards a more climate smart agriculture sector in their respective countries. Hopefully, these stories will inspire their fellow farmers, agricultural researchers, extension agents and politicians to take immediate, concrete actions as well.

Annex 1: Official entry form

Story name: Give a name to the story that you are submitting including the name of the country. Make the title as short and attractive as possible. For example: New technologies for nutmeg production in Grenada empowers women farmers.

Organization submitting the story: clearly indicate the name of the organization submitting the story, and the type of organization it is (NGO, marketing platform, producers group, etc.).

Contact person: clearly indicate the name and title of the person submitting the story, his/her address, phone and email address.

Location: (75 words) where did the story happen (country, district, city, region, other important information, map if available).

Background: (150 words) please provide a short account of the initial situation that the story documents.

Climate change risk being addressed: (350 words) Clearly indicate the climate risk that the farmers were facing that prompted the implementation of the technology and or practice.

Climate change related risk	**Check if applicable**	**Please describe what was happening.** How has this risk increased in the area over the last several decades? What were the impacts of this risk or how was it affecting production?
Increased climate variability		
Increased temperaturaes		
Sea level rise /salinization of soils		
Changes in water availability or precipitation		
Increased floods		
Other (please name)		

Describe the technology and or practice implemented: (450 words) describe clearly the technologies and or practices that were implemented to address the climate risk. What motivated the introduction of the technology and for how long has it been implemented? Who implemented it? (how many people are using it, of these how many are women, support received, etc.).

How does the practice contribute to the 3 pillars of climate smart agriculture? (450 words)

Adaptation/resilience:

Productivity/food security:

Reduction of greenhouse gas emissions (if applicable):

Costs to implement: (100 words) provide an indication of the funding, labor, time and knowledge required to implement the practice or technology.

Results obtained: (500 words) clearly indicate the results or impact that have been obtained by implementing the technology and or practice and how this changed the initial situation described in the background section and climate risk sections.

Please check the column if the technology or practice has additional benefits.

Benefit	**Check if applicable**	**Please describe**
Maintained or increased productivity or production		
Mitigation or a reduction in greenhouse gases		
Diversification		
More efficient natural resource use		
Increased income		
Improved food security		
Supports women and youth		

Beneficiaries: (225 words) clearly indicate and describe the beneficiaries of this technology and or practice, indicate the number of people or families, including the number of women and youth, and specify how they benefit from the technology and or practice.

Lessons learned: (300 words) describe the lessons learned from implementing the technology and or practice in terms of adapting agriculture to the climate risks identified. What advice would you give to other farmers?

Links – Please put the link to any websites available for further information.

Photos: Please include 2 or 3 photos if available, of the technologies, farms or beneficiaries.

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