Civil Society Organisations (CSO)

Enhancing CSOs' contribution to governance and development processes in Barbados and the Eastern Caribbean

"Promoting sustainable livelihoods among Eastern Caribbean farmers"

This project is funded by
The European Union

ProNGO!
CPDC
Caribbean Policy Development Centre
A project implemented by Pro NGO! Germany and CPDC, Barbados

This project is funded by The European Union

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Cologne, December 2018

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About the Project

The project “Promoting sustainable livelihoods among Eastern Caribbean farmers” is implemented in partnership between Pro NGO! e.V., Koeln, Germany and the Caribbean Policy Development Centre (CPDC), Bridgetown, Barbados.

Overall objective of the action is to enhance opportunities for sustainable livelihoods amongst rural agricultural farmers in Barbados, St. Vincent & the Grenadines, and Grenada.

In particular, it aims:

- to improve the financial and operational sustainability of small-scale farmer operations;
- to ensure the implementation of sustainable/cost effective farming practices among rural farmers
- to improve the opportunities for access to finance to support the implementation of sustainable agricultural practices in agricultural production
- to enhance the enabling policy environment for sustainable agriculture

Main target groups of the action include small scale rural farmers, with a special focus on women and youth farmers; representatives of farmers’ organization; and private sector agencies working in the renewable energy sector.

The action has three main components:

- Capacity building: composed of workshops on marketing, financial management, and record keeping; mentoring and individual coaching; workshops on climate smart agriculture; and implementation of a sustainability SWOT analysis with clear options for actions for more sustainable farming practices.
- Financing: offering financial support and technical assistance to 10 rural women and young farmers (mini-grants).
- Enabling policy framework: developing a model policy framework on sustainable agriculture to guide national policy development.

Short-term impacts will include improved operational and financial sustainability of farmer operations; Strengthened capacity of small-scale farmers in the application of climate smart agricultural practices; Enhanced opportunities via CSR for the establishment and financing of sustainable farming practices by designing CSR roadmaps; Enhanced policy environment to support sustainable agricultural production.

Medium & long-term impacts will include more sustainable small-scale farmer’ operations and sustainable farming practices; improved management of small-scale farms; increased farm income, improved livelihood security; adoption of climate smart approaches and technologies on farms; increased participation of women and youth in the agricultural sector; improved policy environment for sustainable agricultural approaches; and improved private investment in the agriculture sector.

The project was launched in February 2017 and will last until July 2019.

Contents

List of abbreviations

CA - Conservation agriculture

CC - Climate change

CSA - Climate-smart agriculture

EU - European Union

FAO - Food and Agriculture Organization of the United Nations

GHG - Greenhouse gas

ICT - Information and communication technology

MoA - Ministry of Agriculture, Forestry and Fisheries

REDD+ - Reduction of Emissions from Deforestation and Degradation of Forests

SI - Sustainable intensification

SLM - Sustainable land management

SVG - St. Vincent and the Grenadines

UNFCCC - United Nations Framework Convention on Climate Change

i. Executive Summary

Agriculture's role in climate change is twofold: it is a sector that contributes to climate change, yet it is also one of the first sectors to suffer from the consequences of climate change. Therefor amongst the most vulnerable groups to climate change impacts are farmers on small islands developing states.

In response, the international community came up with the concept of climate-smart agriculture an approach that addresses three goals simultaneously: to increase productivity and incomes sustainably, to adapt and build resilience to climate change from farm to national level, and to mitigate the effects of climate change by reducing greenhouse gas emissions or, where possible, by increasing carbon sequestration in agriculture.

The concept has earned a lot of criticism at grassroots level due to missing guidelines that clarify what is considered as CSA and what is not. In most cases CSA differs from other agricultural concepts by explicitly addressing climate change, although it uses techniques and practices that extend over to other established agricultural practices such as sustainable land management, organic farming or conservation agriculture.

This study focusses on the challenges that agriculture due to climate change such as uneven rainfall patterns, droughts, increasing intensity of hurricanes and heavy rains. Therefor the discussed agricultural techniques center feasible technologies (climate-smart and others) that address biodiversity and resilience increase, the reduction of soil erosion, improved pest management as well practices that are efficient on scarce resources such as land, water, agricultural input. Since the agricultural situation slightly differs between the three project islands the study presents five different measures that represents possible scenarios for the agricultural development of the islands.

1. Introduction into climate-smart agriculture

Agricultural development and food security are high on the global policy agenda. The adverse effects of climate change on food production prospects are felt most by the rural poor and farming communities. While amongst the most vulnerable groups to climate change impacts are farmers on small islands developing states. Agriculture's role in climate change is twofold: it is a sector that contributes to climate change, yet it is also one of the first sectors to suffer from the consequences of climate change. Globally seen agriculture is directly contributing 14 % of anthropogenic greenhouse gas (GHG) emissions and 17% through land use change. While industrialized countries must dramatically reduce current levels of GHG emissions, the majority of future increase in emissions from agriculture is expected to take place in low- to middle-income countries. Therefore, these countries face the challenge of finding alternative ways into less climate impact agriculture (Smiths et al. 2007, Birnholz et al. 2017).

In response, the international community came up with the concept of climate-smart agriculture (hereafter: CSA), an approach that aims to achieve three goals simultaneously, in line with the three concept pillars: **productivity, adaptation** and **mitigation**. To increase productivity and incomes sustainably, to adapt and build resilience to climate change from farm to national level, and to mitigate the effects of climate change by reducing GHG emissions or, where possible, by increasing carbon sequestration in agriculture. While the concept is new and still developing many of the practices that are considered in CSA already exist and are applied by farmers to cope with agricultural production risks (FAO 2013a). Although CSA aims at improving food security, resilience and mitigation, it does not imply that every recommended practice should necessarily be a 'triple win'. Food security and resilience are main priority while mitigation should be a co-benefit (Birnholz et al. 2017).

"Climate-smart agriculture (CSA), as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, contributes to the achievement of sustainable development goals.
It integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. It is composed of three main pillars:
1. sustainably increasing agricultural productivity and incomes;
2. adapting and building resilience to climate change;
3. reducing and/or removing greenhouse gases emissions, where possible.

CSA is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The magnitude, immediacy and broad scope of the effects of climate change on agricultural systems create a compelling need to ensure comprehensive
integration of these effects into national agricultural planning, investments and programs.
The CSA approach is designed to identify and operationalize sustainable agricultural development within the explicit parameters of climate change".

Box 1: Concept defined by FAO (FAO 2013a: ix)

The concept has earned a lot of criticism at grassroots level due to missing definitions, guidelines, safeguards and standards that clarify what is considered as CSA and what is not. A joint statement issued by a consortium of over 260 national and international organizations and civil society movement in advance of the COP21 highlighted the risk that in the context of smallholder farmers the lacking guidelines the concept of CSA can lead to confusion in its limits to other agricultural systems.

In the first edition of the FAO Sourcebook (2013) 3 Sections (A, B, C) with a total of 18 modules were defined.

• **Section A: The case for climate-smart agriculture**
(Module 1) Explains the rationale for CSA
(Module 2) Adoption of a landscape approach.

• **Section B: Improved technologies and approaches for sustainable farm management**
(Module 3) Water
(Module 4) Soils
(Module 5) Energy
(Module 6) Genetic resources
(Module 7) Up-scaling of practices of crop production
(Module 7) Livestock
(Module 9) Forestry
(Module 10) Fisheries and aquaculture
(Module 11) Sustainable and inclusive food value chains

• **Section C: Enabling frameworks**
(Module 12) Institutional options
(Module 13) Policy
(Module 14) Finance
(Module 15) Disaster risk reduction
(Module 16) Utilization of safety nets
(Module 17) Capacity development
(Module 18) Assessments and monitoring

The revised digital CSA Sourcebook contains five new modules:

- Climate change adaptation and mitigation;
- Integrated production systems;
- Supporting rural producers with knowledge of CSA;
- The role of gender in CSA; and
- The theory of change for CSA approach: a guide to evidence-based implementation at the country level
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Box 2: Key modules of the concept by FAO. (http://www.fao.org/climate-smart-agriculture-sourcebook/about/new-content/en/)

In most cases CSA differs from other agricultural concepts by explicitly addressing climate change, although it uses techniques and practices that extend over to e.g. Sustainable Land Management (SLM)[1], Sustainable Intensification (SI)[2], Conservation Agriculture (CA)[3]. Numerous techniques that fall under SLM, CA or SI, such as soil conservation practices, reduced tillage and water harvesting are nowadays equally regarded as CSA techniques, which makes an exact demarcation between these concepts challenging. In general, CSA comprises all farming techniques and practices that simultaneously contribute to at least two of the three pillars (FAO 2013a).

Figure 1: CSA Pillars (CaICAN 2010; http://calclimateag.org/what-is-climate-smart-agriculture/)

An universal definition whether a farm or farm system can be called climate-smart has yet to be developed. Different actors approach the question differently but it is important to note that CSA is not a single specific agricultural technology or practice that can be universally applied. Williams et al. (2015: i) present this suitable summary: “There is no such thing as an agricultural practice that is climate-smart per se. Whether or not a particular practice or production system is climate smart depends upon the particular local climatic, biophysical, socio-economic and development context, which determines how far a particular practice or system can deliver on productivity increase, resilience and mitigation benefits”.

2. An overview on agriculture in the Caribbean

Two agricultural systems shape the way agriculture is done in the Caribbean. Historically, agriculture in the Caribbean was dominated by colonial plantation systems, which prevail until today in commercial plantations directed at producing goods like sugarcane (Barbados), banana (Granada and SVG), coconut, rice, and coffee for the export market, addressing the US and Europe. These large farms are the more mechanized, more often monoculture planting systems, often still owned by foreign companies. On the other hand, small subsistence farming has

[1] Sustainable Land Management (EthiOCAT 2010)

[2] Sustainable Intensification describes a system that “looks at whole landscapes, territories and ecosystems to optimize resource utilization and management.” (FAO online). And in which yields are increased without adverse environmental impact and without the cultivation of more land.” (Baulcombe et al., 2009).

[3] Conservation Agriculture follows clear guidelines and covers soil conservation practices in crop production such as minimum soil disturbance, minimum tillage, mulching and minimal burning of crop residues, mixing and rotating crops, timely implementation, precise operations, efficient use of inputs and following clear guidelines.

developed mostly in the rough terrain of the hills, and is usually done on less than 2 hectares in disconnected plots. These small farming systems focus on fruits and vegetables like yams, cocoa, potatoes and mangoes for the local consume (Tandon 2015).

Conditions for agriculture are not perfect on the islands, where usually only ⅓ of the terrain is usable for agriculture, with especially the not windward portions of the land in strong need for irrigation. Extreme natural events like hurricanes, erosion, landslides and/or floods keep impacting agricultural production. Tandon 2015 even states that "over the past two decades, agriculture in the Caribbean has been in a state of decline, in terms of both productivity and competitiveness. With the removal of preferential access based on quotas for traditional crops and other reforms to the EU's trading policies, as well as the increased pressure of globalization, Caribbean agriculture has struggled to compete internationally, and has experienced considerable reductions in the production of crops for local consumption as well (Tandon, 2015)". The reduction in the production of crops for local consumption as well the drop of working population in livestock and farming lead to increasing imports.

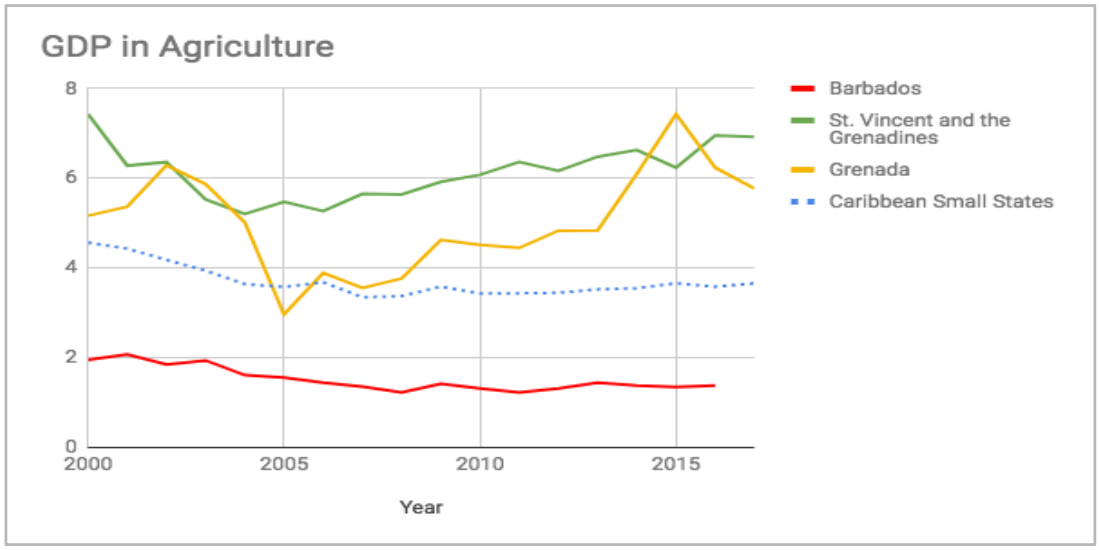


Figure 2: Percentage of GDP in Agriculture, Fishing and Forestry (Worldbank 2018)

The impact of agriculture on the national GDP differs between the three countries in focus of this study (see figure 2), Barbados shows quite low rates (2%) while St. Vincent and the Grenadines and Grenada range between 5% and 8%. Agriculture accounts for roughly 16% of the overall employment in the region, among them the poorest parts of the population.

Key facts on agriculture and climate change in the Caribbean

All Eastern Caribbean states, as SIDS are among the most at-risk countries for climate change, especially regarding sea level rise. Although projections for future developments of sea temperature and level rise differ, climate change is perceivable in the three countries already today: sea salt is entering water systems near the costs, hurricanes, heavy rains and droughts threaten agricultural production and life on the islands (World Bank, CIAT & CATIE 2014,

UNFCCC 2005). Looking more into climate change impacts on agriculture, rain patterns are already changing on the East Caribbean islands. Climate models predict in general warmer and drier conditions, mainly resulting in irregular and shorter rainfalls. Barbados is already classified as a water scarce country, and further change in precipitation could cause health impacts as well as competition between the different economic sectors for freshwater. In addition, the rising sea level leads to saline intrusions into coastal fresh water systems, a serious problem for agricultural activities near the coast lines. Being located within the Atlantic storm zone, Barbados suffered a rising number of tropical storms in recent years, which destroyed agricultural production and fostered erosion (WHO 2018).

As this data shows, CSA techniques and practices on the islands should focus on climate change mitigation and measures to make agriculture more resilient especially regarding water availability since most of the agricultural production is done under rainfed conditions GHG emission from agriculture is neglect able (World Bank, CIAT & CATIE 2014).

Agriculture in the three project countries - a short overview

Key facts on agriculture and climate change in Grenada

Agriculture in Grenada is dominated by small-scale, family-run farms cultivating nutmeg and mace for export, spices like cinnamon, ginger and cloves and tropical fruits on subsistence level or for occasional market sale. Lately, cocoa beans production is a dynamic sector, with a strong focus on the tourist market. Overall, 13% of Grenada's population is engaged in agriculture and fishing, producing 5% of the country's GDP while the major source of monetary value production in Grenada comes from tourism.

Map 1: Grenada (https://legacy.lib.utexas.edu/maps/americas/grenada.gif).

Small-scale farmers represent 80% of the farming households working usually on 0,5-1 hectare, cocoa and tropical fruits are grown on larger, extensive farms. Farmers are 68% male, and as per the CIAT country profile, worked about 30 years in farming but nowadays it is not their principal economic activity anymore (Interim narrative report 2016)[4]. This also shows in the fact that 61% of Grenada's population lives in rural areas, but only 13% is engaged in agriculture and fishing. Interestingly, Grenada has large areas of abandoned cropland or shrub lands at disposal. Other land cover forms include forest (50%) and perennial crop plantations (fruits and spices, 21%) (World Bank, CIAT & CATIE 2014).

[4] This is an important point for further investigation. Livestock is mentioned as second activity (in report #9), but studies in other regions also show that for many people sharing their time between a paid job in the city and part-time farming activities becomes more and more normal (see e.g. Inta Plostins 2008), which might change the scenario if also the case in Grenada.

Key facts on agriculture and climate change in Barbados

Barbados is the wealthiest and most developed country of the entire Eastern Caribbean region. Its economy was long dependent on sugarcane production, and has now shifted towards tourism and service provision - especially offshore finance and information services (CARDI 2011a). Agricultural production is mainly based on sugar and vegetables such as yams, sweet potatoes, cassava, and beans as well corn. In drier areas cotton is cultivated. Most of the small-scale farmers on Barbados have more than 20 years of experience in farming, cultivate 0.5-1 hectare on predominantly owner operated land. For small scale farmers livestock rearing and works in the cottage industry, along with vegetable production and flower cutting are their main agricultural activities. Still about half of the farmers depend solely on agriculture for their annual income. Agriculture overall contributed 3% to the GDP per capita, while offering occupation for 10% of the population in 2009 (Rawling 2003).

Map 2: Barbados (https://legacy.lib.utexas.edu/maps/americas/barbados.gif).

While there were policies aiming at developing the non-sugar agricultural sector through Agricultural Policy packages, the movement of the economy away from agriculture in the 1960s could not be prevented. Due to FAO reports, agriculture is today still a declining sector in Barbados, which also represents in a drop of greenhouse gas emission due to agriculture.

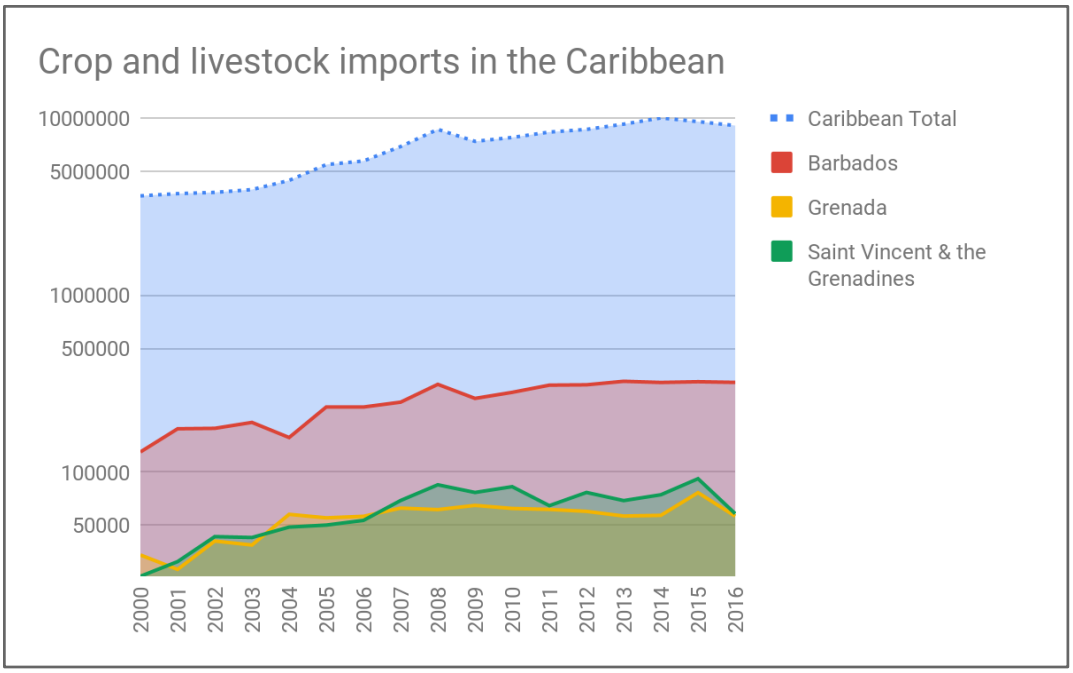
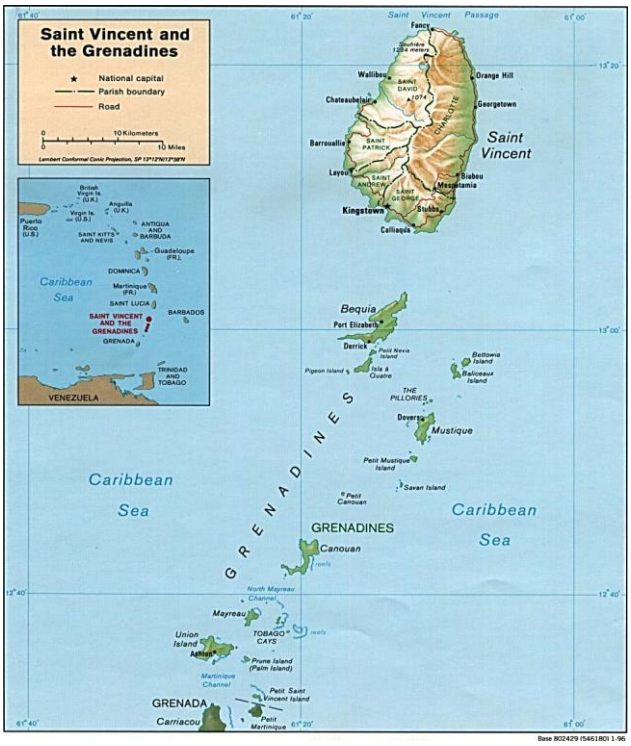


Figure 3: Crop and livestock imports in the Caribbean (FAOSTAT 2018)

Imports of food have increased significantly over the last ten years, due to the lack of produce being cultivated on the island plus the increasing food demand from tourism (Figure 3 and FAO 2009). This makes the country very vulnerable to changes in international food prices caused by climate change (e.g. wheat currently being imported from the US or Canada), a situation that can threaten food security and financial stability on Barbados (ECLAC 2011).



Map 3: Saint Vincent and the Grenadines. https://legacy.lib.utexas.edu/maps/islands_oceans_poles/st_vincent_rel96.jpg

Key facts on agriculture and climate change in St. Vincent and the Grenadines

The economy in St. Vincent and the other small islands of the Grenadines is relying heavily on agriculture (see figure 2 above), almost 30% of the local labour force is working in this sector. Farmers have an average of 35 years of experience in farming, predominantly cultivating 0.5-2 hectares on predominantly owner operated land. Most farmers depend on agricultural production for the vast majority of their income (Interim narrative report 2016). The main crop still is banana, which cultivation is recently being

incentivized by the government, CARDI also states a growing cultivation of cultivation of root crops such as cassava, eddoe, dasheen yam and sweet potato (CARDI 2011b).
Other key agricultural products are: coconuts, spices, as well as small numbers of cattle, sheep, pigs and goats. Fishing activity is rising. Fruits and vegetables are also increasingly grown on the islands.

3. Project Country Analysis

3.1 Grenada

3.1.1 Challenges for farming in climate change conditions in Grenada

Different factors hamper agricultural production on Grenada. First of all, extreme weather events like hurricanes and cyclones regularly destroy harvests and agricultural infrastructures.
Hurricanes represent a major external threat to agricultural production on Grenada - in 2004/5, 90% of the nutmeg production was destroyed by hurricanes and plantations are only slowly being rebuilt. In general, one of the major challenges for agriculture on the islands are extreme weather events: On the one hand, water scarcity is a huge problem especially for fruit and vegetable farmers, irrigation equipment is hard to import, and measures for water security are mostly affordable only for commercial farmers, a minority on Grenada. On the other hand, heavy rains increasing fertilizer runoff also represent a serious problem for agricultural production.
Besides extreme weather conditions, **landscape formation and high energy** costs reduce options for mechanization in livestock production as well in agriculture and food processing.
High input costs and lack of credit in Grenada make it hard for small scale business to survive economically, especially in front of low capacities for management and administration. Farms are not run and monitored like businesses and opportunities for growth and good practices are lost.
In addition, **marketing** is difficult since local markets are limited and commercialization focuses on exportation of raw produce instead of value-added products.
Last but not least **informal and fragmented land tenancy** is an issue on Granada. Like many of the Caribbean islands Granada is structured by large colonial plantations - and the general tendency of young people leaving the rural areas due to bad income perspectives provide a difficult background to innovate and build profitable and environmentally sustainable agricultural businesses (World Bank, CIAT & CATIE 2014)[5]. Most of the small-scale farmers have no land titles and lease the land where their production relies on.

[5] Studies as e.g. the one by Diederen et al 2003 state that “Older farmers on average have a lower level of education, which may be correlated with the ability to judge opportunities to innovate. Also, they may have a shorter time horizon and be less inclined to invest in novelties. Schnitkey et al. (1992) argued that age is related to farm expertise. They will rely less on external information, and therefore do not get in touch with innovations in the market as early as their younger colleagues”.

3.1.2 What are current practices & local perceptions of problems in Grenada

Information on current practices can be drawn from existing country reports (e.g. the CSA country profile for Grenada published by World Bank, CIAT and CATIE 2014) as well as from the project's prior meeting and research protocols.

In general, farmers respond to the vulnerability of the nutmeg and spice production by hurricanes with diversification: cash crops such as banana as well as beekeeping or aquaponic projects are currently dynamic sectors with which farmers try to become more environmentally and economically resilient. Burning of crop residues is a widespread practice despite the problematic effects on soil erosion, fertilizer runoff and wildfires (World Bank, CIAT & CATIE 2014).

Apart from these points, the project's workshops where farmers that run conventional farms, as well as farmers that focus on organic agriculture attended (reports #3 and #5) and 5 in-depth interviews with fruit and vegetable farmers (Internal Project Questionnaire) give interesting insights into the specific needs and practices of farmers in Grenada:

While some standard climate-smart techniques are applied (such as crop rotation, mulching, use of manure, and to some extend intercropping), **water management stays an explicit topic to improve as well as planting techniques, soil management, push and pull techniques and organic agricultural measures** (Questionnaire).

Farmers as well as the Ministry of Agriculture, Forestry and Fisheries (MoA) have stated that rural extension needs to be strengthened, and that new pathways for this shall be explored. Educative TV programs are mentioned as one way to scale agronomic information, and actors call almost unanimously for **information and communication technologies (ICTs)** to do this, also because one major problem is the absence of young people as agricultural entrepreneurs. ICT is expected to attract this group back and to be part of a general movement towards connecting farmers, building lobbying and sharing groups that support each other with information, support and build strength to influence policies in their interest.

Another factor to attract youth could be the **organic farming** movement, that all over the world attracts young people with ideals and deep knowledge on qualities, scientific value and value-added properties of crops (report #3 and #5).

As another important factor to build trust and attract (young) people to farming, **model farms** are discussed among farmers, youth initiatives as well as the Inter-American Institute for Cooperation on Agriculture (IICA) (report #3). They picture model farms as an important instrument to show to farmers how CSA techniques actually lead to improved harvests, build trust into these measures and promote them.

On the market side, farmers perceive the local markets threatened by imports with which they are not able to compete, and ask to strengthen the inter-island trade (report #3).

Farmers are aware of the high costs of energy for storage, transport and or processing, and first projects with biogas systems are being piloted on Grenada. Farmers show interest in new ways to integrate renewable energy sources into their production systems, but need the necessary infrastructure and technology. Already for irrigation, the necessary equipment is imported and costly, so that in most cases only the wealthier commercial farmers are able to use these (report

#3). On the policy level, credits need to support financing for CSA projects as e.g. renewable energy projects.
As a general problem, larceny is mentioned (report #3) to be an expression of the low profitability of farming on Grenada, while at the same time of course pushing people away from it.

Agricultural measures that are being practiced currently in Grenada:

- Diversification of cash crops
- Widening of the activities in the sector with e.g. beekeeping and aquaponics.
- Implementation of good agricultural practices such as crop rotation
- And application of animal manure and in parts intercropping

3.2 Barbados

3.2.1 Challenges for farming in climate change conditions on Barbados

Main problems stated in the literature include the **lack of policies and links to other industries**, making agriculture a viable business. In every analysis of the situation, it is called for programs to attract youth to agriculture in order to prevent it from becoming a totally “dying” sector. The main entrance barrier for youth into agriculture is mainly the lack of **access to land**, which is costly and scarce (report #6).
Another recurring problem is **praedial larceny**, an FAO study states that 98% of all producers participating in a survey have been robbed and that state that this is the single greatest disincentive to investment in the sector. Praedial larceny involves the theft of produce, but also machinery and materials. The FAO states that 18% of the value of regional farm output in the region is taken by thieves (FAO 2013b).
As a natural challenge for agriculture on Barbados, it is important to consider the **soil type** - limestone - which allows only for very **shallow top soils**. In addition, reports mention the pressure from other sectors to **convert land used by agriculture into areas by tourism and housing** (ECLAC 2011). Regarding climate change conditions Barbados is considered to be a **water scarce** country and rain patterns are increasingly uneven distributed. Barbados has been named the 10th country in the world in terms of **high energy cost**. When it comes to irrigation systems or land machinery farmers are affected by these conditions.

3.2.2. What are current practices & local perceptions of problems on Barbados

Information on current practices and local perceptions stem from the protocols of the project’s meetings and interview material collected during the project term so far. In interviews, farmers stated the same practices to be common then registered for Grenada: **Composting, application of animal manure, crop rotation and mulching** are practiced (Questionnaire). In a workshop

organized by the project, a representative of the Ministry of Agriculture, forestry and fishery (MoA) acknowledged that farmers start to move to **mulch instead of overusing herbicides**, but adds that most **use plastic sheets**, while the MoA recommends the use of organic material and cites the case of Jamaica, where guinea grass as mulching material against weeds and moisture loss. **Sprinkler irrigation** is still quite common, but the MoA is heavily incentivizing the installation of drip irrigation systems with a 50% rebate and recommends solar powered ones (report #6). In the discussion of that meeting, farmers named **storage and packing** badly done being a recurring problem for the quality of their products and ask for information and support. **The lack of youth in agriculture** is perceived as a big problem by the farmers, it contributes in their point of view to the lack of innovation and interest to develop the sector in what would be needed: **value chain management, cooperation networks of farmer cooperatives, a financing and insurance system** steered at supporting agricultural businesses, and in general more business model development. Agriculture in Barbados is perceived to be based on a low input - low output level with gains primarily gained on the retailer side (report #1 and #6). Farmers expressed explicit **interest in push-pull techniques for pest control and in general for organic agriculture techniques**, while claiming that state extension informs them insufficiently (report #6, Questionnaire). They also expressed interest in innovative measures to deal with the soil conditions and on soil preparation like **terracing, swales, pothole planting** (Questionnaire).

Agricultural measures that are being practiced currently in Barbados:

- Implementation of good agricultural practices such as crop rotation, composting, application of animal manure.
- Mulching (sheet mulching) is gaining importance in order to decrease herbicide application.
- Investments for drip irrigation are being made along with solar power systems.

3.3 St. Vincent and the Grenadines

3.3.1. Challenges for farming in climate change conditions on St. Vincent and the Grenadines

Among the challenges for agriculture on St. Vincent and the Grenadines, farmers named **praedial larceny, an aging farming community without young people, and access to water and machinery** (report #2). Beyond that, the **lack of structures and consistent marketing** available to most farmers leads to a part of the produce being sold to traffickers and also leads to a low degree of planning on the farmer's side (report #2). An FAO country program framework supports this perspective, adding climate change and the lack of an organizational structure for the farming as well the fishing sector to the picture (FAO 2011). Farmers support the latter, expressing explicitly the need for an information exchange platform to inform themselves and create networks among producers (report #7). Radio is suggested as the carrier medium but has to be critically

scrutinized in its ability for connecting people. In general, farmer groups have reported to perceive a **lack of IT infrastructure to facilitate their farming and planning** (ICTs and/or computers) as well as to be one mean to attract youth to agriculture. Further challenges include dealing with **increasing drought** times caused by **climatic changes**, **water harvesting and pumps** are needed for this. Farmers asked for **organic farming** techniques to be taught and in general expressed their need for continuous engagement, be it in the form of projects growing into **reliable partners or in the form of continuous information flow** as e.g. in a planting calendar. Farmers face as well challenges with the **provision of seeds and the provision of suitable planting material** (e.g. for sweet potato).

3.3.2. Current practices & local perceptions of problems in St. Vincent and the Grenadines

CARDI runs pioneer centres for undercover and protected agriculture systems development for vegetable production, and the Richmond Vale Academy already trains students on CSA techniques and facilitates workshops. On the islands, several farmers already practice **CSA techniques on the energy** production side through biogas or solar panels, as well in **water harvesting**. The government's climate change mitigation programs finance the **installation of tanks and pumps on demonstration farms and water** harvesting is entering the schedule of the extension trainings (report #2). Public laboratories of the Ministry of Agriculture also started to offer **gratis soil testing** for farmers, which is not yet widely used. As a result, fertilization of St. Vincent and the Grenadines is based mostly not on the soil properties, farmers mainly apply urea, ammonia and manure, composting is only starting to be known as an **adequate fertilization measure** (report #13). As for pest and disease control, pesticides and manual weeding are common techniques, as well as push planting.

Agricultural measures that are being practiced currently in SVG:

- Implementation and training on CSA techniques on energy production such as biogas or solar panels.
- Water harvesting techniques are being practiced on demonstration farms and introduced into extension training.
- Soil testing, resulting in appropriate nutrient management
- Good agricultural fertilization practices such as composting are starting to be known.

4. Discussion on farming technologies and practices

Based on the agricultural situation analysis, the current challenges faced by farmers because of climate change as well the socio-economic position where farmers at in the following abstract some suitable farming techniques will be discussed in further detail. Hereby it is important to mention that techniques out of different agricultural concepts will be presented.

4.1. Feasible farming technologies and their benefits

An agricultural technology can be climate-smart in many places but is definitely unlikely to be climate-smart everywhere. Therefore, as stated initially whether or not a particular practice or production system is climate smart depends upon the particular local climatic, biophysical, socio-economic and development context" (Williams et al. 2015) that will determine how far a farming technology or particular practice can contribute to an increase in productivity, resilience and mitigation.

A Organic agriculture

When applicable:
Over the last decades in response to the shortcomings of mainstream agriculture organic agriculture became one role model in the spectrum of alternative agricultural systems. Although many practices are likely to increase the cost of production organic agriculture aims to minimize the environmental impacts. Organic farming requires reliable and credible standards like certification schemes and policies. In comparison to conventional farming products consumers demand high standards of animal welfare, provision of ecological services such as system resilience and less residues of chemical products in food and the environment.
Expected benefits:
Organic agriculture is defined by the method of production (no use of synthetic pesticides or fertilisers). Compared to conventional agriculture organic agriculture offers a system that can reduce environmental impacts. While climate change mitigation is not the primary objective of organic agriculture it can contribute to the reduction of GHG emissions, improve system resilience through maintenance and improvement of biodiversity, conserving soil fertility and reducing water pollution due to less fertilizer run-off. Organic agriculture can be seen as a role model for low farm external nitrogen input systems since the methods applied focus on establishing closed nutrient cycles. The key factor in reducing methane and nitrous oxide emissions lies in how the manure is handled. Therefore, a focus should be laid on better storage and treatment of animal manure (IFOAM EU and FibL 2016).

Especially in Granada the reports showed that organic agriculture is better known and partly being conducted than on the other two project islands. Organic mixed cocoa plantations produce quality certified cocoa for export. The incorporation of diverse fruit species make the system more stable and resistant to extreme weather events, and therefore provide more economic security due to diversification. Wide crop rotations, the implementation of organic material like farmyard manure, compost and green manures is mandatory in organic agriculture in order to keep soil fertility high.

B Soil testing

When applicable: Uncertainty about required fertilization scheme, tight financial resources for fertilizers, lack of nutrients are visible in crops with deficiencies.
Expected benefits: Provides insights and knowledge about soil fertility. Adequate amounts of nutrients, early discovery of primary and secondary lacks in fertilization, early adoption of fertilization schemes, early establishment of more feasible crop rotations, as well usage of adopted varieties. It may increase yields.

C Conservation agriculture

When applicable: Uneven rain patterns, dry-spells, heavy rain or floods, strong wind and storms, high temperatures and raised moisture lack.
Expected benefits: The benefits of conservation agriculture are that this technique might improve the soil fertility and in consequence yields, retains soil moisture during dry periods, protects soil from high temperatures, reduces logging of crops since the plants are growing from deeper level than before, soil erosion through heavy rains or wind erosion can be reduced. Reduces the amount of labour required e.g. for weeding (when herbicide are used), reduces labour needs and costs for field preparation e.g. ploughing, harrowing, planking.

D Water harvesting

When applicable: Uneven rain pattern, little rain, dry spells, heavy rains and floods.
Expected benefits: Practices that slow down, capture and conserve as well as store water are crucial for responding to more intense droughts and irregular rainfall patterns. Priority options include efficient irrigation systems. Water harvesting system provide water during dry-spells and droughts, can support a widening of the production periods, may allow production for niche markets.
Cut-and-carry stabling systems for dairy goats in order to decrease the overgrazing and land degradation. This goes along with landscape restoration and watershed protection. The maintenance of a carpet of vegetation and the adoption of no-burn agricultural practices is essential for protection of soils against extreme climate events such as extreme rainfalls.

E Earthworks: Terracing, swales and well pothole planting

When applicable: Uneven rain patterns, heavy rains and floods, low vegetative cover.
Expected benefit: On a bigger scale structural land management measures capture rainfall and retain it to enrich the ground water levels. Stone terrace are build from stone-faced bunds constructed on a cultivated land following the contour. Land terracing will reduce soil erosion, the runoff of nutrients, improves soil moisture, trap rainwater and increase the filtration of such, as well control concentrated runoff. Earthworks therefor may have the benefit of improving yields and maintaining the soil fertility.

F Certified seeds

When applicable: Uneven rain pattern, little or late rain.
Expected benefit: Seed quality plays an important role in the production of agronomic and horticultural crops. Farmers should always use good seed for different reasons: Reduced seeding rate due to higher germination rate. Purity and more uniform stand (free of other seeds or weeds). Reduce the need for replanting, give more uniform plant stand per square unit area, thus make harvesting easier and decrease labour requirement. Give more vigorous early plant growth, which helps plants compete better with weeds. They have early maturity and might be pest/disease/drought-tolerant or resistant. They give higher yields and better quality due to less cross-contamination with other varieties. They result in fewer immature seeds leading to higher milling. Therefor certified seeds can increase food security.

G Push and pull agricultural pest management

When applicable: The push and pull technology is a strategy for controlling agricultural pests by using repellent "push" plants and trap “pull” plants. Although diseases and pests are part of an agricultural system they can be devastating for a farmer’s production once the system gets out of balance. Push and pull technology are most efficient when used from the start and are crucial in farming communities with limited access to chemical pesticides.
Expected benefit: Push and pull technology involves intercropping a repellent crop with the main crop for production purposes. It is mainly used in cereals production systems.
Further the agricultural practice of companion planting in gardening and agriculture is the planting of different crops in proximity providing a habitat for beneficial insects and therefore possibly contribute to control pests. Companion planting is a form of polyculture where the growth of the main crop is supported by the provision of shade and nutrients. Knowledge about plant companions helps to improve growth, increase natural pest and disease control, and allows higher production from your land.
In general push and pull is expected to create benefits on pests and weeds, to improve biodiversity and nutrient availability. Grasses as a green fodder improve fodder availability and may have positive effects on dairy production.

H Agroforestry

When applicable: Uneven rain patterns, little or late rain, dry-spells, heavy rain and floods, strong winds, high temperatures, inclination towards soil erosion. Especial high applicability within agricultural systems with low mechanization rate.
Expected benefit: The implementation of agroforestry systems provides maximum protection from soil erosion and improved land productivity. Woody species intercept water, protect soils and ground cover crops against heavy rains through given ground cover and widespread roots. Allows beekeeping activities due to abundance of bee fodder. Tree leaves create biomass that is needed for soil fertility increase as well as mulch for soil moisture retention. Mulches have several advantages. They help retain soil moisture in the summer and protect the roots of plants in winter. They also keep the soil at a relatively constant temperature and suppress weeds. Depending on

the type of mulch used, they can also break the life cycle of some pests or encourage beneficial organisms. As the mulch material breaks down, nutrients are release into the ground, which helps to enhance its quality. Agroforestry can provide fodder for livestock. Microclimate that are created due to agroforestry attract rainfalls. An agroforest might protect crops from too much sunlight as well function as a windbreak.

Farming technologies	When applicable	Expected benefits
Organic agriculture	Minimization of the environmental impacts, reliable and credible standards like certification schemes and policies are required to insure the payoff of extra labour and different inputs, consumers demand high standards of animal welfare, provision of ecological services such as system resilience and less residues of chemical products in food and the environment	Less environmental impacts, less nutrient loss, due to establishment of high closed nutrient cycles, improvement of biodiversity, conserving soil fertility and reduced water pollution due to no mineral fertilizer and chemical pesticides run-off, diversification of production and often direct marketing selling strategies may lead to more economic stability and resilience.
Soil Testing	Uncertainty about required fertilization scheme, tight financial resources for fertilizers, lack of nutrients are visible in crops with deficiencies.	Provides insights and knowledge about soil fertility, application of adequate amounts of nutrients, early discovery of primary and secondary lacks in fertilization, early adoption of fertilization schemes, early establishment of more feasible crop rotations, as well usage of adopted varieties, may increase yields and may reduce costs of inadequate dosages of fertilizers.
Conservation agriculture	Uneven rain patterns, dry-spells, heavy rain or floods, strong wind and storms, high temperatures and raised moisture lack	Increases soil fertility, positive effect on yields, retains soil moisture during dry periods, protects soil from high temperatures, reduces logging of crops, protection of soil erosion, reduces the amount of labour required e.g. for weeding (when herbicide are used) as well for field preparation e.g. ploughing, harrowing, planking.

Water harvesting	Uneven rain pattern, little rain, dry spells, heavy rains and floods	Increased availability of water, higher resilience against droughts and yield loss, possible installation of irrigation systems, opportunity for production of irrigated crops, entrance to niche markets, widening of agricultural seasons.
Earthworks: Terracing, swales and well pothole planting	Uneven rain patterns, heavy rains and floods, low vegetative cover	Rainfall capture and enrichment of ground water levels, reduce soil erosion, the runoff of nutrients, improves soil moisture, as well control concentrated runoff, possible yield improve and maintenance of soil fertility.
Certified seeds	Uneven rain patterns	Good germination qualities, vigorous early plant growth, reduced weed competition, reduced needs for replanting/ gap filling, uniform plant stand, possible early maturity and might be pest/disease/drought-tolerant or resistant
Push and pull agricultural pest management	Knowledge intensive, limited access to chemical pesticides	Creation of a habitat for beneficial insects, improved diseases and pest control, nutrient availability and better growth, fodder improvement and effects on dairy production
Agroforestry	Uneven rain patterns, little or late rain, dry-spells, heavy rain and floods, strong winds, high temperatures, inclination towards soil erosion.	Protection from soil erosion, nutrient run off, retain soil moisture, fodder for livestock, windbreak, production stacking, higher biodiversity

Table 1: Overview on feasible farming technologies and their benefits

4.1.1 What are opportunities for adopted farming technologies that address key challenges to the agricultural sector and climate change in Grenada?

Interestingly, Grenada's main production sectors - nutmeg and spices - are in many aspects already climate-smart: arboreal crops sequester carbon, protect the soil and watersheds from erosion and nutrient run off and are relatively drought-resistant. Nevertheless, the shallow roots of the trees don't stand the increasing power of hurricanes on the islands.

That's why **root and tuber cultivation** could be another climate-smart approach, they are resilient to extreme rains and hurricanes and - as staple food - contribute to food security. This introduction of new crops should go hand in hand with **rehabilitating the damaged nutmeg-fields**, which would put nowadays abandoned land into productive use and at the same time foster high-quality export products while reinstalling the above-named ecological advantages (World Bank, CIAT & CATIE 2014).

Another measure recommended in Grenada's CSA country profile is **intercropping**, partially implemented already by good practice farmers and organic farmers. Crops to be combined could be deep rooted trees (e.g. cocoa) with shade trees (e.g. banana), using organic mulch to create a system that's at the same time resistant against extreme weather and hurricanes as it is economically secure through diversification of produce. Grenada's CSA profile presents a case study on the Grenada Organic Cocoa Farmers Cooperative Society which could be scaled to other parts of the islands (World Bank, CIAT & CATIE 2014).

As measures not directly improving profits from farming but midterm and long term improving the water management, improved **control on use of agrochemicals** as well as invest in non-timber forest products such as **honey (beekeeping)** is recommended (ibid.). Also, further intensification of shredding, composting and mulching could **abolish the practice of burning**, which also would protect forests and thus watersheds.

Since networking, sharing information on agricultural best practices as well as market opportunities and policies were mentioned as primary challenges, all the above-named measures could be promoted through the use of **ICTs**. Smartphone applications, radio and TV programs could be used to promote, inform and receive feedback on the above-mentioned package of actions addressing extreme weather events. In addition, ICTs could provide decision support not only on the individual farmer level but also to support decision makers to build their policies on integrated climatic, agronomic and market data.

Improved market size and access could be achieved through **developing local food processing industry**, e.g. chocolate production, or value-added products through **certification** to open the organic as well as touristic market for local products.

Not only for any processing industry, but also on an individual level of local production, energy is a big issue for climate-smart agriculture in Grenada. As stated above, prices are high and volatile since electricity production is built on diesel and heavy fuel oil. Farmers state heightened interest in **exploring renewable energy sources** as long as they come with an end-to end solution that really addresses their needs (e.g. fitting nozzles for biogas use). It would be an interesting option to explore the use case for photovoltaic energy, biogas generation (first pilots in place) as well as solar pumps for irrigation and dryers for food-processing. Of course, these options have to be part

of a directed set of action, as e.g. solar pumps make much more sense in combination with water harvesting methods.

Summary Grenada:
The already existing arboreal cropping systems in nutmeg and spices of Grenada are addressing key challenges in the context of Climate Change such as uneven rainfall patterns, droughts. Systems with elements from agroforestry and intercropping (including roots and tuber vegetables, ground covers, arboreal structures as windbreaks) are more likely to withstand the rising power of hurricanes and heavy rains. Via ICT these knowledge intensive agricultural practices can get shared among the farming communities and alternatives to less beneficial practices such as burning or over usage of chemical agricultural inputs spread.

4.1.2 What are opportunities for adopted farming technologies that address key challenges to the agricultural sector and climate change in Barbados?

Information on opportunities for CSA techniques are taken from the project's meeting reports protocoling recommendations from local experts of the MoA/ IICA (Inter-American Institute for Cooperation on Agriculture). As measures for improving agricultural productivity on Barbados, the Ministry of Agriculture and IICA alike recommend the use of **protected agricultural structures** like shade houses or greenhouses to improve output on small plots and deal with the heat through ventilation systems. (Report #6).

As a means to deal with the soil conditions, both MoA and IICA recommend **soilless farming**, like vertical farming or aquaponics (Report 6), the latter being presented as a means to be able to use the scarce water resources more efficiently. On the other side, the MoA also states the opportunity to increase productivity and reduce costs by improved fertilization techniques and more directed usage supported by soil testing. Most of the interviewed farmers showed interest in realizing these tests.

High energy costs could be cut by **wind turbines, solar systems or solar panels, e.g. powering irrigation systems.** To avoid water shortage, the MoA recommends **water storage** in tanks or ponds, and a farm visit realized during the project showed these techniques being in place but not widely promoted. **Model farms** could promote sustainable and climate-smart information among farmers, together with increased support for farmers through extension. If this cannot be taken on by the state, **digital solutions for extension** could be considered (Report #6).

Last but not least, the financial entry barriers could be smoothened through **micro-financing or funds**, or even through **farmer-organized credit systems**, to increase investment and finally

income generated through agriculture, and in return start to attract more young people to the sector (Report #6).

Summary Barbados:

Soilless farming activities, greenhouses and protected farming structures combined with ICT could lead to higher involvement of youth in the agricultural sector as well to less usage of restricted resources such as water and land. High energy costs could be tackled with climate-smart irrigation systems, water storage structures as well alternative energy production technologies. Due to the islands focus on tourism, a strategy for entering niche products, such as organic agricultural products into the touristic structures could be set up.

4.1.3 What are opportunities for adopted farming technologies that address key challenges to the agricultural sector and climate change in SVG?

On the irrigation side, more efficient irrigation system like drip irrigation could be installed and combined with the ongoing subsidies on alternative energy production.
Since composting and **proper manure management** are only starting to be known fertigation as a method of fertilizer application through drip irrigation could be applied. The further development of water collection systems needs to get further emphasis on all the three islands.
Since at St. Vincent and the Grenadines **demonstration farms** are already established a further focus could be laid on training farmers in push and pull techniques, organic pesticides production and application, simple soil testing measures and fertilization options to decrease the use of urea in the region. The widespread application of **organic fertilization and pest management techniques** have the potential to increase the sovereignty of farmers and the rural communities. Locally already tested techniques need to be shown and trained to farmers in order to be able to adapt them. On the livestock management side, the island needs to lay a focus on restricted pasture areas in order to decrease land degradation. **Living fences** can have positive effects on erosion and land degradation, water retention and biodiversity.

Summary St. Vincent and the Grenadines:

The interlinkage between efficient irrigation and fertilization scheme can tackle challenges such as limited access to fertilizers, high nutrient run-off and uneven rain patterns. The overall benefit of SVG are demonstration farms that conduce a vast variety of good agricultural practices that need to be spread amongst famers and extension officers. The implementation of climate-smart practices such as earthworks, intercropping and agroforestry structures should be continued.

4.2 Scenarios for measures in the agricultural sector in the three project islands

Based on the current situation in the project islands, farmers' practices and feasible farming technologies, four scenarios emerge that are interlink able but will face different challenges in their implementation.

Scenario 1: Improved agricultural technologies in cultivation of the current crops and introduction of roots/tuber, maybe certification

As mentioned above, the introduction of roots and tubers could be an approach to the hurricane destruction that threatens Grenada's most profitable value chains. Roots grown in the Caribbean include turmeric, yams, cassava, and sweet potato (Agricarib 2016). At the project islands St. Vincent & the Grenadines this production is already established and currently growing. While root vegetables and tubers production contribute to the food and nutrition security needs of the islands (IICA & CARDI 2013), the combination of root vegetables and different layers of trees, shrubs and groundcover could provide the protection against soil and wind erosion that is needed (Richmond Vale Academy online). Studies from 2013 show that the production of cassava and sweet potato at Barbados as well in SVG already meet the needs of local processors. While a focus could be laid on the production of root vegetables and tubers organic farming methods and further good agricultural practices such as improved crop rotation, increased diversification in crops, cultivars or even polyculture systems, intercropping and push- and pull measures should be considered.

Certification for organically produced roots and tubers could be considered if the demand of processed roots vegetables and tubers is rising.
A stronger focus on these crops would imply severe steps towards value chain development on the regional and national level. Steps could include public purchase mechanisms to guarantee income for smallholder farmers or other public financing mechanisms. FAO also recommends improving food and quality standards to meet international requirements (FAO 2017). In addition, roots and tubers could be the basis for developing new, processed products and the related local food processing industry - examples from other cases include flour, chips, sweetener, or malt replacement in beer (FAO 2017). A CSA approach in root vegetables and tubers could therefore be taken at the post-harvest stage in the improvement of on farm storage, drying techniques and improved productivity.

Scenario 2: Focus on agroforestry (in possible combination with REDD+)

Surely agroforestry is not exclusively an CSA practice although it may include many practices that can be counted under the roof of agroforestry such as land restoration, intercropping, boundary planting, silvopasture, multi-strata agroforestry and improved tree management. These agricultural practices may contribute to increasing productivity, climate adaptation and mitigation and therefore become climate-smart. Model farms take a crucial role in the acceptance of agroforestry production systems.

Due to the history of the project island most of the primary forests have been deforested nevertheless secondary forests as well cultivations are important elements in the landscape. The implementation of agroforestry structures would consider the relevant categories of CSA technologies such as carbon, nitrogen, water, weather and energy. Within an agroforestry system other resilience enhancing activities such as beekeeping could be integrated. As stated above one of the most important responses to climate change in agriculture is the increase of biodiversity. The absence of wide areas of monocultures in the project's islands provide good conditions for niche agricultural activities such as beekeeping. Pollinators like honeybees are highly affected by pesticides like insecticides or herbicides. Especially the use of agrochemicals close to apiaries may lead to absconding of bees and possible deaths of colonies. A further concern mentioned above is the high rate of deforestation and the possible lack of bee fodder.

Besides the many challenges the beekeeping industry in Grenada is still considered one of the strongest in the OECS. Beekeeping and the various products of beekeeping have created a significant linkage between Agriculture and Agri-business and the other major economic sectors, especially Health and Tourism. Better beekeeping techniques led to higher yields although the overall amounts of bee hives dropped. A focus could be laid on the implementation of multipurpose plants that enhance the availability of bee fodder along with the increase in food security. Experienced beekeepers could get involved in other areas along the value chain of honey production such as queen rearing, hive production, provision of pollination services and development of secondary hive products, such as pollen, wax, cosmetics, medicine. The diversification of beekeeping products is a much more sensible approach than having all beekeepers on the islands involved only in pure honey production (Bees for development 2016).

Bee keeping and other agroforestry activities could be combined with a look at opportunities for generating carbon credits and thus increasing income through agroforestry. REDD+ has introduced a strong focus on sustainable management of forests to the UNFCCC since 2008. Much has been written about the pros and cons of the REDD+ regime, but all reports from practice stress the necessity for clear policy frameworks and REDD-readiness, the institutional and technical capacities to show measured and verified results of REDD+ activities while securing social & environmental safeguard mechanisms preventing leakage[6]. Of the Caribbean countries, only the Dominican Republic so far takes place in one of the UN/ Forest Carbon Partnership funds to enter the process of creating national REDD+ frameworks (Forest Carbon Partnership Facility 2017). In order to prepare for the official emission trade scheme still being set up, Grenada would need a national REDD strategy or action plan, a baseline and monitoring scheme for forest emissions as well as a proven safeguard monitoring and reporting system to account for the impact and effect of any future REDD+ program. Beyond the official UNFCCC trading scheme, there exists the subnational voluntary carbon market, where project-based emissions credits are traded.
Here, local capacity building and support from legal experts is very important to ensure that any contract actually plays out in favor of the communities it claims to benefit. One example for a REDD+ project including beekeeping activities is the KARIBA project implemented in Zimbabwe

[6] Leakage means detrimental effects outside of the project area attributable to project activities.

(REDD Monitor 2018). The project started in 2011 and aims to generate 52 million carbon credits in the 30-year project time. Its certified under the verified carbon standard as well as climate community and biodiversity standard systems. Reports from researcher and civil society actors report the usual problems with REDD+ projects: Local livelihoods run the risk of being undermined by non-participatory project goals and implementation, lack of understanding of the purpose and scope of REDD+ projects by local populations as well as lack of consultation, and problems to sell the generated credits on an unstructured, unofficial market (Redd Monitor 2018).

Scenario 3: Improvements in water management

On the agronomy level water management plays a crucial role for increasing productivity, resilience against droughts, uneven rain pattern and devastating effects by heavy rains. Although agricultural systems have to be analyzed as a whole the aligned introduction of water storage and management elements could improve the primary mentioned challenges. Together with water storage elements practices such as mulching, tillage practices and organic input management should be addressed. Practices that could be feasible for the project countries are zai pits, which are small planting pots that collect rainfall or run over, efficient water use techniques such as drip irrigation, alternate partial root zone irrigation and deficit irrigation as well stone rows, grass strips, swales and the increase installation of basins and water harvest ponds. If water storage elements are installed and managed badly negative effects such as the rise of mosquito breeding places may lead to even higher rates of tropical diseases. Considering that Barbados already has one of the highest rates of Dengue fever in the Americas. Therefore, guidelines and standards for the safe use of wastewater for irrigation and agricultural purposes needs to be developed (WHO 2015).

Scenario 4: Focus on sustainable energy production

Due to high import rates and therefore high importation costs the introduction of renewable energy technology should be supported in all three project countries. From a climate-smart agriculture perspective the practices that could be focused are biogas from anaerobic and bio-digesters, improved cook stoves as well solar systems for irrigation systems.

Scenario 5: Invest in ICTs

The investment in ICT could address the mentioned problem of shortage of extension services for farmers. Digital communication possibilities could spread know-how on good agricultural practices as well sustainable intensification practices. Internet based technologies could offer farmers decision support tools and provide climate relevant data. Since most of the project countries population has mobile description as well there is a good coverage of smartphones and internet connection with 4G is strong ICT could be a good option to emphasize the above stated good agricultural practices at the farm level especially in Grenada and SVG where extension services are received irregularly. ICT's could be integrated in all aspects of farming such as crop guidance and disease warnings, record keeping and marketing,

5. Recommendations

A. Making a farm climate-smart obviously requires more than to simply choose and integrate one of the agricultural practices and technologies described above. Farmers should choose and integrate a smart combination of practices in order to shift their whole agricultural system into a more productive and resilient one. While a smart combination of techniques is desirable for all farmers at the projects islands it is evident that their investment decisions are based on land rights, available materials and inputs, know-how, labour availability and individual needs.

B. Improve stakeholder cooperation in research, policy making and organizations of national scale as well farmers cooperatives in order to develop a vision for the agricultural sector. The lack of strategy and direction combined with the absence of agricultural science and technology research creates a high dependency on donors and external stakeholders. In order to determine what is being produced and for which market the project countries need a structural approach in the agricultural sector.

C. Awareness of the wider importance of sustainable agriculture needs to be raised in order to increase productivity, resilience and adaptation rather than mitigation to climate change in the project countries agricultural sector.

D. Numerous feasible agricultural practices that are considered to be climate-smart are seen as an intensive approach that includes trainings and capacity development. Therefore, there should be trainings on feasible sustainable agricultural practices based on the needs that were addressed by farmers on a higher frequency.

E. Most of the recommended agricultural practices for the three project countries require mid- to long term perspectives for farmers therefore addressing land rights and tenures are a key to enhance the adoption of sustainable and climate-smart technologies. This is especially important in Grenada where farmers predominantly lease the land.

F. Development of sustainable agricultural value chains should be developed that correspond to REDD+ goals. Taking into account the small size of the countries high-value niche products are more likely to be competitive than traditional commodity crops.

G. To address praedial larceny approaches from SVG such as community-based networking and farmer watch group could be spread. The FAO recommends traceability systems for proof of ownership under the law, information sharing for deterrence and for capacity building, networking and intelligence gathering.

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