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SUSTAINABLE PRODUCTION PRACTICES AT THE COMMUNITY LEVEL IN BARBADOS AND THE EASTERN CARIBBEAN

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ABSTRACT: The Sub-Regional Office of the Caribbean of the Food and Agriculture Organization (FAO-SLC) facilitated the collation of information on sustainable production practices in Barbados, Antigua and Barbuda, Dominica, St. Kitts/Nevis, St. Vincent and the Grenadines, Grenada and St. Lucia. The study, carried out by the Caribbean Agricultural Development and Research Institute (CARDI) on behalf of the FAO, aimed to identify the use of some of the ‘tried-and-tested’ methods in order to promote them by making them available to the wider agricultural community in the Region. This is in keeping with FAO’s sustainable crop production intensification (SCPI) objective, which aims to increase crop production per unit area, taking into consideration all relevant factors affecting productivity and sustainability, including social, political, economic and environmental impact. In the current study, ‘sustainability’ included environmental, financial and socio-economic elements. Current practices were determined via on-farm observation and inquiry, as well as by reviewing marketing and legislative protocols. Activities of over 2000 producers were drawn from individual interviews, field inspections, Extension Officer reviews, and structured group sessions. Whilst several practices were seen to be endemic and common to all seven countries, there were subtle inter- and intra-island differences. Results indicate that in all countries, sustainability was more commonly defined in terms of environmental aspects by way of soil and water conservation, and ‘sustainable’ practices dealt with land clearing, erosion reduction and soil improvement. Additionally, water conservation as opposed to rainwater harvesting and storage was a central pursuit. Appropriate cropping patterns and other farming practices were largely determined by geography. There was a reasonable level of understanding of the benefits of biodiversity as related to sustainability. Interestingly, there were some practices which were not as widespread that could be expanded, and others that were widespread but not effectively executed. Several recommendations are presented based on the amalgam of practices recorded, on the areas of land use, soil quality, water use and reuse, environmental sustainability, and financial sustainability.

Keywords: sustainable crop production practices, environmental sustainability, financial sustainability

BACKGROUND

One of FAO’s Organizational Results in the 2010-11 biennium was the promotion of strategies for Sustainable Crop Production Intensification (SCPI)¹ in countries of Latin America and the Caribbean. In addition, at several workshops and meetings, FAO (and other organizations) were

¹ SCPI – increase in crop production per unit area, taking into consideration all relevant factors affecting productivity and sustainability, including social, political, economic & environmental impact.

requested to capture existing practices, technologies and models of sustainability, and to make these available to the wider agricultural community. As a result, FAO facilitated a survey in seven countries under a Letter of Agreement (LOA) with the Caribbean Agricultural Development and Research Institute (CARDI). The baseline survey collated information on sustainable agricultural practices at the community level in Barbados, Antigua and Barbuda, Dominica, St. Kitts/Nevis, St. Vincent and the Grenadines, Grenada and St. Lucia. It was recognized that sustainability in the context of Small-Island Developing States (SIDS) needed to consider Climate Change and in this regard, agriculture must be ‘climate-start’, i.e. it must minimize agriculture’s contribution to greenhouse gases, and/or it must increase carbon sequestration.

Farmers and producers in the Caribbean Region have long been practicing conservation agriculture and integrated farming systems, including both crop and pest management. Sustainable, as it refers to agriculture, involves more than the study of relationships between organisms and their environment. It has been defined as "an integrated system of plant and animal production practices having a site-specific application that will last over the long term whilst satisfying human needs efficiently using natural resources, demonstrating financial viability and enhancing the quality of life for farmers and society as a whole." The Conceptual Model therefore took into consideration environmental sustainability, financial sustainability and economic sustainability.

MATERIALS AND METHODS

Information for the baseline survey was gathered in a number of ways. On-farm data was collected via structured interviews conducted by trained and experienced Field Assessors, using standardized survey instruments. The selection process was guided by interviews with a number of stakeholders: the Ministries of Agriculture, Producer organizations, NGOs, and Environmental Management officials. Meetings with focus groups were organized, and the following was undertaken

- a review of the documented holdings/producers in the administrative district
- determination of the major types of potential/actual environmental degradation to which the area is prone with regard to:
 - soil (quality/quantity)
 - water (quality/quantity)
 - air-borne pollutants
 - flora/fauna interaction (biodiversity)
- assessment of the economic importance of the major products emanating from the district – to select the success factors (financial sustainability)
- integration of the enterprises within the community

The overall aim was not to determine the prevalence or statistical significance of the practices but rather to seek out even isolated cases of sustainable operation. Sampling was guided by the question “what are the tried-and-tested practices, models and technologies used by producers?” By focusing on the answers to the question, the inquiry resulted in a more thorough “analysis of the current situation to identify the starting points for a program/project” or baseline study. Since the natural environment is critical to sustainability issues, the farms / agribusinesses surveyed were initially categorized by districts; and by covering all the districts, all geographic scenarios were captured. Further segregation was based on geographic features that affected the likely conservation practices.

All of the seven assessors had over 20 year field experience within their respective countries of operation, and augmented the data gathered during the selection process. The selected interviewees within each district reflected the range of product mixes, tenure patterns and marketing arrangements. Discussions with the producer groups (crop/livestock farmers, fisher-folk), district extension officers, and produce buyers/consignees, supplemented by the assessor's familiarity with the sector, directed the selection process.

A field assessor in each of the seven countries alerted the respective Ministries of Agriculture and interacted with key Extension staff and Producer Organizations to launch the project. Activities of over 2000 producers were recorded, drawn from individual interviews, field inspections, Extension Officers reviews and structured group sessions. Discussions with the producer groups (crop/livestock farmers, fisher-folk), district extension officers, and produce buyers/consignees; supplemented by the assessor's familiarity with the sector provided the following details.

RESULTS

The findings of the survey are reported in line with the Conceptual Model, specifically Environmental Sustainability (Soil and water management, Crop selection, Carbon footprint), Financial Sustainability (GAP training, Marketing, Land tenure) and Economic Sustainability (Farmers and their communities; Policy level support). It is noteworthy that there were instances where the Assessors' "production sites" did not meet the "sustainability criteria" agreed to by the team. Common examples involved instances of terracing or composting that were not technically correct and thus were not deemed to be sustainable.

Environmental Sustainability

There were several practices that are common throughout the seven countries constituting the baseline territories.

Soil Management

Soil management was a common feature on farms. Most of the farmers, Extension Officers and Ministry Officials equated sustainability with land quality and quantity, so there was a heavy concentration on soil conservation and improvement. Soil management was analyzed by using eighteen interrelated criteria (Table 1).

Table 1. Sustainable practices involving soil management across seven countries

1. SOIL MANAGEMENT (Soil quantity, quality)	Perceived Frequency ²
1.1 Appropriate Land clearing technique used (to maintain biodiversity, conserve soil)	2
1.2 Appropriate Building site selection	1
1.3 Building layout	2
1.4 Terracing	1
1.5 Contour ploughing	1
1.6 Crop cover	2
1.7 Direct planting (reduced on slopes to reduce soil loss by erosion)	1
1.9 Drainage (soil conservation, reduced runoff rate)	1
1.10 Ameliorant/incorporate	0
1.12 Green manure	1
1.13 Nutrient recycling	1
1.14 Composting	2
1.15 Crop rotation	3
1.16 Appropriate tillage (minimum soil disturbance)	2
1.17 Vermiculture	0
1.18 Soil fauna/flora (increased soil micro flora and fauna)	0

Unlike the continental CARICOM States and the larger islands, the Eastern Caribbean States were not engaged in significant farmland expansion. Hence the land-clearing techniques considered were related to seasonal land clearing. There were, nonetheless, isolated instances of the unsustainable use of bulldozers and subsequent burning. Land clearing methods ranged from the use of hand tools, grazing sheep, and selective thinning to motorized cutting machines. The multiplicity of methods was evident between and within countries.

Conservation practices included low soil exposure by selective tree cutting and understory slashing. Burning was avoided and the cut material windrowed. In Grenada and the mountainous Windward Islands, there was selective thinning and the planting of spreading crops, green cover, windrowing and using the cut vegetation to reinforce contour-protective bunds. Subsequently, the protection of cleared land included practices such as terracing, contour ploughing, crop cover and direct planting. Contour ploughing and terracing were listed as practices in St. Kitts and Barbados, but there are significant variations in terms of technical correctness and efficacy. Contour ploughing, independent of bed preparation on the contours, and subsequent good crop cover, reduce the efficacy of the practice. In St Vincent, of the 35 producers with recordable soil sustainability features, 19 practiced contour ploughing and planting. Soil management in the less mountainous islands was primarily about holding moisture, avoiding wind erosion and improving fertility.

Soil loss through erosion by water was the most prevalent concern. Many of the contour beds were not properly drained and subsequently developed weak bunds that broke free long streams of

² Legend: perceived frequency of occurrence, 0 = absolutely no evidence of practice/technology, 1 = 1-25%, 2= 26-50%, 3=51-75%, 4 =76-100%

muddy water. In St. Kitts, one farmer was forced to adjust his contours to allow water flow to a nearby ghaut/ravine, which allowed the water to flow in a specified direction rather than filling and breaking the banks during heavy rains. In the Scotland District of Barbados, contour planting and the use of fruit trees for soil stabilization was evident.

Improved drainage was a common practice recorded. Apart from the traditional drainage procedures (box drains, furrows, and trenches), some producers avoided the same wheel tract on unpaved roads, which somewhat mitigated erosion from fast-flowing miniature streams.

Soil protection was augmented with soil quality improvement through the use of ameliorants. Green manures (e.g. guinea grass) were used in all the countries. Nutrient recycling by incorporating animal and green manures was extensively reported. Manure incorporation varied from on-farm collection and subsequent spreading to animal droppings whilst grazing. Field grazing by livestock was also used for weed control.

Composting was listed as an activity but only a small percentage of the farmers carried out composting using proper technical execution. There was deviation from the actual practice leading to the use of green manures and mulch from material that was listed as composted. The most comprehensive composting operations were recorded from Grenada, where true compost (*friable organic material that can be used as a soil amendment or as a medium to grow plants*) and compost teas were prepared to nutrient-rich specifications.

There were instances of appropriate crop rotation with crop choice reflecting different nutrient uptake regimes, differing feeding depths and dissimilar pest profiles. The soil was measurably improved in some cases due to the fertility increases, lowered pest loads and improved friability. Tables 2-A and 2-B highlight typical rotations encountered on St. Vincent and Dominica, respectively. However, there was significant evidence in some countries that the rotations were based on economic factors and not crop husbandry. Same-family rotations involved high value crops that had similar pest/disease and nutrient profiles, and the expected agronomic and soil improvement gains were not necessarily obtained.

Appropriate tillage varied from minimum, to dust mulches, and to sub-soiling. Tillage variations were often incorporated with other operations like deep planting, fallow and manual land clearing. Documented examples from Antigua and Barbuda indicated that two farms in the South West district (volcanic sandy loam soils) used minimum tillage as effected through ploughing every three years. In Barbados it was noted that most of the “organic” farmers routinely minimize tillage/compaction by using small hand-push tillers. Direct planting as a means of limiting soil disturbance and reduced tillage was in evidence in St. Kitts/Nevis, St. Lucia, Grenada and St. Vincent and the Grenadines. The method was confined to appropriate crops such as cucurbits, papaya, roots and tubers, plantain, and banana.

Table 2-A. Recorded Crop Rotations on selected farms in St Vincent

<i>Crops / Sequence in St. Vincent</i>
Melons → Peanuts → Ochroes
Carrots → String Beans → Cabbage
Tomatoes → Sweet Potatoes → Yams
Cucumbers → Tomatoes → Lettuce
Cucumbers → Carrots → Eddoes → Cabbage
Sweet Potatoes → Yams → Eddoes
Sweet Potatoes → Tomatoes → Yams
Yams & Eddoes → Tomatoes → Ginger
Tomatoes & Cabbage → Eddoes → Yams → Tannias
Sweet Potatoes → Yams → Eddoes

Table 2-B. Recorded Crop Rotations on selected farms in Dominica

<i>Crops / Sequence in Dominica</i>
Carrots → String Beans → Cabbage
Dasheen → Ginger → Yam
Bananas → Tannia → Bananas
Ginger → Passion Fruit → Pineapple

Vermiculture, although a technology popularized by Cuban volunteers in the Region, was not a practice recorded outside of Antigua and Barbuda where an enterprising farmer had developed a product range including worm compost. The Antiguan Farmer had done trials with local species but found them inefficient. He imported the California red worm in 1992 and always raised them in bins. They have not been able to move beyond his compost bins. This recorded method of rearing is significant in light of the designation of the red worm as an invasive species. The Field Assessors noted that while the deliberate introduction or reintroduction of soil fauna/flora was not a recognizable feature, many producers avoided inorganic chemicals that were believed to reduce soil biodiversity.

Water Management

Water management is at the heart of island-based agricultural adaptation with respect to Climate Change. If mitigation is about greenhouse gases, adaptation is about water. Common water management practices include rainwater harvesting (e.g. the use of water directed from guttering on farm buildings with subsequent storage), water reuse, and conservation.

Rainwater harvesting varied across the countries. In Barbados, within development project areas, well-water was supplied thereby reducing the urgency of water catchment at the farm level. In St. Kitts, ponds and wells were the major water source in the St. Peters project and Mansion. In Antigua and Barbuda, ponds and dams were the direct concerns of many producers. In St. Lucia watercourse protection had been given greater prominence post Hurricane Tomas, whilst water-

harvesting initiatives were on stream in Region 3. On-farm ponds were replenished directly from rainfall or indirectly through springs/artesian sources.

Table 3. Sustainable practices involving water management across seven countries

2. WATER MANAGEMENT (Water quantity, quality)	Perceived Frequency ³
2.1 On site water course protection (maintaining banks etc)	0
2.2 Deliberate Riverine stabilization (maintaining flow direction)	0
2.3 Harvesting	1
2.4 Collection from guttering	1
2.5 Direct Collection from rainfall	1
2.6 Adequate Drainage (to limit waterlogging/flooding)	1
2.7 Irrigation method (efficient use of water)	3
2.8 Mulch (protecting soil moisture)	2
2.9 Green cover	1
2.12 Dispensing to animals (efficient presentation, proper storage)	2
2.14 Reuse	0
2.15 Reduction (low flow taps)	0
2.17 Bio-cleansing (use of organisms to remove contaminants)	0
2.18 Water treatment/settling	0

The mode via which the available water got into irrigation systems varied between and within islands. The breakdown in St. Lucia was as follows: about 80% of the farms in Regions 7 and 8 were Rainfed; in most regions 10% of the holdings sourced gravity flow water from a stream/river; 15% used drip; and 80% of protected agriculture structures used overhead systems. The European Union - Government of St. Lucia irrigation project in the community of Delcer provided water for Region 6, and also to the environs during dry periods.

The irrigation method provided an opportunity to conserve water, with most producers in Barbados using drip systems. The rare occasion when sprinkler systems were deemed to be sustainable was highlighted by the account of an Antiguan farmer who swore that the system improved pest and disease management, particular for the control of the diamondback moth on cabbage. The sprinklers were used in the evening, when the adult moths were most active, and the water apparently disrupted them from settling on the crop. The plausibility of that system would be dependent on the augmenting of the irrigation water with a pesticide and the creation of a more humid microclimate against diseases like powdery mildew. Sprinklers can be sustainably used in pasture management, particularly if solar powered pumps are used.

A striking feature in most countries was the general absence of farm buildings except in the case of poultry and pig enterprises. Most cropping activities were a distance away from the producer's residence. Collection of rainwater in containers directly or from guttering, for farm use was not a major activity. Interestingly, in Dominica rainwater was considered an important resource and was harvested from rooftops of farmhouses using traditional bamboos and the storage drums protected with a fabric covering. The water was used for domestic and agricultural purposes. Dispensing of

³ Legend: Same as for Table 1.

water to animals and the use of water for cleaning was considered acceptable in terms of efficiency. Many producers reused water from pen-cleaning for crop “fertigation”.

Mulch as a means of conserving water was widespread and included the use of plastic. In Barbados mulching was used to varying degrees. A few growers covered nearly the entire cropping area while others just used strips. Inorganic, mainly fabric or plastic mulches, were common; however, some “organic” growers were using organic mulches such as coconut fibre and green waste from the solid waste plant in Barbados.

Apart from the conservation of water, there were a number of practices that improved the quality of the water that was either utilized in situ or allowed to run-off. In all the countries there was acknowledgement of the links between land-based operations and fish culture. Pollutants generated on land eventually reach the sea and can cause irreparable damage.

Cropping Patterns

Combined soil and water management involved the use of green covers and judicious cropping patterns (Table 4). Generally crops were selected based on an understanding of the soil type and nutrient status. Trees were used as borders between plots and as windbreaks. Fruit trees were intercropped with short-term crops such as pumpkin and squash. In Antigua and Barbuda, carrots and beets are grown in sandy loam soils best suited to the physical requirements of the crop.

Table 4. Sustainable practices involving cropping patterns across seven countries

3. CROPPING PATTERN	Perceived Frequency ⁴
3.1 Crop appropriate for area/slope	2
3.2 Proper plant growth habit	2
3.3 Crop rotation	3

In Grenada, large plants (fruit trees) were used in steeper areas, and a good mix of annuals and perennials (different families and root depths, etc) were planted to obtain good coverage. In all of the countries there were examples of appropriate crop selection. In Dominica, within and outside of the Carib Territory, the planting of specific crops was carried out taking into account their ability to reduce erosion, maintain soil nutrient balance and keep the soil intact.

Biodiversity

Very few of the farmers, interviewed on the basis of the sustainable practices on their farm, had monocultures. In most farms bees, butterflies and wasps were observed. The borders around and beyond the farms had endemic mixes of plants and weeds. The biodiversity displayed on, and proximal to, farms was indicative of a strategy through which a wide mix of products is used to hold customers and as a means of financial security. Some of the diversity was deliberately organized to explore synergies. A pineapple farm boasted no less than 20 different fruits trees and a range of crops, including sorrel, cucurbits and beans. That farm also had bee hives/ pollinators, which were sometimes rented to other farmers.

⁴ Legend: Same as for Table 1.

One farm with banana as the main crop had it intercropped with cassava; additionally, there were rows of corn and sweet potato, interspersed with pineapple and yams. Many farmers used biological insecticides, and a few used limited organophosphate pesticides only at planting time. Most farmers depended on a mix of cultural practices to control pests, including crop rotation and intercropping (Table 5). In Dominica, many of the farmers used biological control methods based on plant extracts grown on the farm. Testimony to the low use of inorganic pesticides was the observed abundance of beneficial insects and pollinators. In Dominica as well was the one documented case of small-scale sericulture. None of the documented instances of land clearing by producers included mangroves. Mangrove trees are specially adapted to being submerged in saltwater and thus provide detritus needed to fuel the important food chain of the mangrove ecosystem. Producers and fisher-folk operating in its environs understood the coastal stabilizing role played by mangrove.

Table 5. Sustainable practices involving biodiversity across seven countries

4. BIODIVERSITY	Perceived Frequency ⁵
4.1 Land clearing method (retaining flora and fauna)	2
4.2 Avoidance of monogenic strains/lines	0
4.3 Product mix (complex agro-ecological zone)	1
4.4 Bio/cultural pest management	1

Carbon Footprint

Energy efficiency and renewable systems were apparently not on the radar of most producers (Table 6). All farmers and fisher-folk interviewed used fossil fuels for pumps, tractors, engines, etc. One farm with an integrated aquaculture-hydroponics system used electricity to pump recycled water from the tilapia fishpond to vegetable beds and back to the fishpond. The owner in Antigua reported that government policy did not allow use of co-generated solar powered equipment. Upon verification, it was found that a relevant piece of legislation permitted only the Public Utilities Authority to produce power. However, Grenada reported cases of solar- and wind-powered generators being used for honey extraction, water pumping, refrigeration, lighting and produce grinding/processing.

Worldwide, the post-Kyoto response with regard to sustainability of production would be the adoption of climate-neutral technologies. Already, key exports of Fairtrade bananas require the use of environmentally-friendly techniques (e.g. use of petroleum-based agrichemicals derived from petroleum products). In Barbados, where solar water heating is commonplace, there was minimal use of alternative energy on farms. Many of the respondents noted they were weighing the cost of the investment.

⁵ Legend: Same as for Table 1.

Table 6. Sustainable practices involving carbon footprint across seven countries

5. CARBON FOOTPRINT	Perceived Frequency ⁶
5.1 Reduced Fossil fuel use	0
5.2 Reduced Electricity use	0
5.3 Renewable energy use	1
5.4 Solar	1
5.5 Wind (energy generation)	1
5.6 Waste reduction/less landfill use	0

Water Disposal

For the crop farmers, waste was not a major issue. Generally most farmers ploughed the crop residue back in (Table 7); those that had pigs used it as feed. Crop wastes (including carrot tops) were also used as mulch. Some farmers gathered the crop residues into a heap, let it dry, and then burned it to reduce pest problems (e.g. sweet potato). *These findings reinforced the observation that composting is one of the most misunderstood operations on Caribbean farms.* An appropriate composting process must be used in order to ensure that pests and pathogens that are harmful to humans and plants are destroyed. The process depends on the composting conditions (temperature, aeration, etc.) as well as on the duration of survival of pathogens and pests.

Table 7. Sustainable practices involving waste disposal across seven countries

6. WASTE DISPOSAL	Perceived Frequency ⁷
6.1 Use of crop residue/waste/entrails	3
6.2 Composting	2
6.3 Scrap metal/building material	0
6.4 Waste water	1

Instead of drying and burning to reduce contamination, the material could have been composted. On one organoponics farm, fish waste was used to fertilize on-land crops as part of the overall system of growing plants in composted organic material.

Livestock farmers generally viewed daily-generated waste as manure. Often, the manure was collected (gratis) and taken off-farm to be used by crop farmers, although increasingly farmers sold the manure if they were not growing any crops themselves. Several farmers recognized the threat to their operations posed by waste originating from inputs such as plastic containers and packaging. Apart from the impact of leached material on soil and water quality, they recognized the potential health risk. Inorganic waste disposal posed a bigger challenge. The absence of plastic recycling, except in Barbados, made the disposal of containers an issue. Other than for Grenada, there were no documented cases of the current reuse of spent oils/fuel.

⁶ Legend: Same as for Table 1.

⁷ Legend: Same as for Table 1.

Financial Sustainability

The greatest threat to the sustainability of production in all the islands was in the sphere of finance. Legislative and incentive mixed signals, fewer stratified markets to reward for environmentally sound production, and weak financing arrangements all conspire to reduce producer efficacy.

Most farmers were trained in Good Agricultural Practices (GAP), if not GAP-certified. GAP training increased the likelihood that sustainable practices would be part of the farmer's routine.

The inter-island differences in the quality or strength of marketing arrangements were noticeable (Table 8). On all islands, farmers reported having verbal contracts with hotels, restaurants, supermarkets and hucksters. Cooperative membership in some cases was linked directly to market access, with particular reference to supplying the hospitality industry. Common to the countries was the fact that often there was no formal contract arrangement.

Table 8. Sustainable practices involving marketing arrangements across seven countries

7. MARKETING ARRANGEMENTS	Perceived Frequency⁸
7.1 Contract sales	0
7.2 Listed consumers	2
7.3 Cooperatives	1
7.4 Value chain involvement	1
7.5 GAP certification	0
7.6 Standards-driven production (Fairtrade, etc)	1

A few interviewees were members of farmers' groups, but these were found to be ineffective in arranging markets, with the exception of Windward Islands Farmers' Association (WINFA) and Caribbean Farmers Network (CaFAN). WINFA banana farmers had access to the Fairtrade market. Apart from the impact on financial sustainability that Fairtrade brings, there is the emphasis on ethical, environment-friendly production. Fairtrade has a direct impact on environmental sustainability and socio-economic soundness. The social premium earned by Fairtrade farmers redounds to the benefit of entire communities.

Very few farmers supplied government institutions with vegetables on a continuous basis. A few interviewees were retailers as well as producers and had stalls at public markets. Farmers reported dissatisfaction with the inordinate delays in payment by corporate buyers and retail chains. Their financial sustainability rested with the cash turnover from farm-gate sales to hucksters. A few instances of entrepreneurial creativity included one farmer who sold his vegetables to persons in his community, even dropping off vegetables to members that were confined to their homes.

⁸ Legend: Same as for Table 1.

Tenure

Security of tenure was one of the key determinants of sustainability (Table 9). Willingness to guard the natural resources in the agricultural arena was directly proportional to the vested interest in the farm or holding. Farmers without secure title found it difficult to make long-term choices; there was always the temptation to take the short-term. Long-term leases, freehold, and well-monitored rental agreements formed the basis of sustainable agribusiness models.

Table 9. Sustainable practices involving tenure across seven countries

8. LAND TENURE	Perceived Frequency⁹
8.1 Freehold	2
8.2 Leasehold	2
8.3 Rental	1
8.4 None	1

A significant number of farmers rented lands from the government, whilst there were those with freehold interest and others in various stages of regularization. Because of the nature of this study focusing on producers who utilized sustainable practices, high levels of freehold and secure tenure were encountered. The general farming populations had less secure tenure. If St. Lucia was taken as an example, there was a trend towards increase in family-owned lands and more private rental/lease agreements. The lack of clear title had implications for access to/availability of financial resources (e.g. bank loans) to capitalize operations.

Socioeconomic Sustainability

The interviewed farmers were all recognizable members of the various communities and involved in farmers' groups, village councils, sporting groups, etc. One farmer in Antigua and Barbuda reported that the farmers with contiguous plots helped each other at planting and harvesting. Other less structured community-based groups did not have this level of cooperation. Fewer than 2% of direct interviewees stated that a number of persons in their respective communities assisted with short-term labour when extra hands were needed. Although the majority of producers were well entrenched in their communities, the major market for their produce is located outside of their local communities.

Table 10. Sustainable practices involving social impact across seven countries

9. SOCIAL IMPACT	Perceived Frequency¹⁰
9.1 Integration into neighbourhood	2
9.2 Community involvement	2

⁹ Legend: Same as for Table 1.

¹⁰ Legend: Same as for Table 1.

The overall sustainability of activities in agriculture was confined by State-wide support through legislation, incentives and disincentives. The possible amalgam of policies can be exemplified with reference to St. Kitts and Nevis. Support services to the farming community come primarily from the Department of Agriculture and allied Institutions such as CARDI, IICA, and Taiwanese Agricultural Technical mission of the ROC. The more recent policies to be amended in support of Sustainable Agriculture include the Land Development Act of 1991 (provides a contract of tenancy under the Agricultural Small Holdings Act Chap. 87 of the Laws of St. Christopher and Nevis), the National Conservation and Environment Protection (Amendment) Act, 1996, and the National Conservation and Environmental Conservation Act (1987).

The group interview phase of project implementation unearthed no instances of overt social incompatibility with the exception of the growing of illegal crops, notably *Cannabis* spp. The sustainability of production whether land-based, aquatic or marine, does not appear to be threatened by adverse community reaction. The integration of fishing activities and shared beachfront access with the Tourism industry points to a lessened degree of inter-sectoral conflict.

DISCUSSION

The Study, carried out under the SCPI umbrella and in keeping with FAO's 'Save and Grow' approach¹¹, aimed to facilitate and promote the use of some of the tried-and-tested methods. To overcome the challenges inherent in feeding a growing world population there is no option but to intensify crop production. Given the constraints farmers face, in order to grow, agriculture must learn to save. This level of crop production intensification must be built on farming systems that offer a range of productivity, socio-economic and environmental benefits to producers and to society at large. Agriculture must, literally, return to its roots by rediscovering the importance of healthy soil, drawing on natural sources of plant nutrition, and using mineral fertilizer wisely. A genetically diverse portfolio of improved crop varieties that are resilient to climate change and smarter precision technologies for irrigation would also be needed. It was recognized that to encourage smallholders to adopt SCPI, fundamental changes would be needed in agricultural development policies and institutions.

The work of Climate Scientists in the Caribbean has reemphasized the importance of rainfall and water resources to regional agriculture. Island agriculture is totally rainfall driven; whether from recharged underground sources, surface-flows or direct precipitation. The expected variability in terms of rainfall quantity and intensity will increase the vulnerability of these small states and further threaten the viability of their agriculture. Sustainability models, incorporating water management as well as related soil management issues, will be the *sine qua non* of agriculture development strategies.

Globally, agriculture directly accounts for about 14 percent of greenhouse gas emissions (methane from animal digestion and nitrous oxide from agricultural soils, etc.), and indirectly for another 17 percent due to the fact that agriculture is a major driver of deforestation and land-use change. The sector holds a large mitigation potential, mainly through reduced deforestation, soil management and increased productivity.

¹¹ <http://www.fao.org/ag/save-and-grow/>

The Baseline study was in sync with the five pillars of sustainability, viz Increased productivity, Reduced risk, Conservation of resources, Viability, and Social acceptability. The utility of this snapshot of current sustainable practices was in its capacity to point to areas for intervention or strengthening of existing efforts. As a baseline, it provided information on what practices were used in which islands with an overview approximation of the frequency of occurrence from on-island assessors.

The Conclusions and Recommendations are provided in Table 11.

It is noteworthy that the current sustainable practices are still part of an *ad hoc* approach. The study considered close to two thousand holdings/operations by GPS survey, geography, agricultural district, and importance of the major crop/product, yet there were no examples of operations utilizing a full set of sustainable practices across environmental, financial and socio-economic spheres. *One of the most important uses of this study could be the reintroduction of Good Agricultural Practices with a focus on Climate-smart agriculture that could, in one fell swoop, ensure the viability of the sector in a comprehensive way.*

Table 11. Conclusions and Recommendations

Conclusions	Recommendations	Remarks
<p>The reported practices can be the first step in the transition to developing a National Adaptation Programme of Action (NAPA) or Nationally Appropriate Mitigation Actions (NAMA).</p>	<p>Use the current tried-and-tested sustainable practices as the foundation for comprehensive, climate-smart agricultural strategies as part of NAPA</p>	<p>The Ministries of Agriculture in the targeted countries have not comprehensively addressed adaptation or mitigation issues with regard to Climate Change</p>
<p><u>Land:</u> With regard to the environmental dimension of sustainability across all the Islands -land clearing is approached with knowledge of the consequences of soil loss and the need for soil protection. The requisite soil cover, avoidance of steep exposed slopes, minimum tillage and direct planting of appropriate crops are well-understood</p>	<ul style="list-style-type: none"> - Site preparation should be conducted with minimum soil disturbance/loss - Cut vegetation should be windrowed and/or composted - Properly constructed terraces on slopes of <15% - Direct planting of fruit trees on sloping land - Contour drainage - maintain appropriate green cover during fallow 	<p>Flexibility by the State, with regard to the interpretation of land zoning regulations, has exacerbated inappropriate slope management.</p>

Conclusions	Recommendations	Remarks
<p><u>Soil quality:</u> Improvement of soil quality appears to be lagging behind, although green manures are used and nutrients recycled. Composting remains a largely misunderstood concept and some of the acclaimed crop rotations are based solely on financial considerations, and not agronomic reality.</p>	<ul style="list-style-type: none"> - Use of green manures - Crop rotations that involve less closely related plants that proportionately utilize different nutrients and have different pest complexes e.g. Cucumber-tomato-lettuce - Appropriate/Minimum tillage - Effective composting 	<p>Soil/growth media improvement is a linchpin of sustainable agriculture and will be key to water and nutrient availability.</p>
<p><u>Water use:</u> Water harvesting / conservation are limited to using low flow irrigation techniques. Several instances of the use of potable water directly from State mains were recorded. If water availability is going to be a limiting factor in the near future, then those practices will be difficult to sustain. When State-managed water sources were used (as in ponds, dams and other catchments), on-farm conservation was often lacking. There was evidence of head-end leaks in drip irrigation systems that negated the conservation gains of using a low flow technique. Absence of a reliable method of determining plant water needs can result in over-watering when using drip systems. Poor choice of emitter, mismatched pumps, long lateral lines and lack of compensation for uneven terrain suggest the need for remedial interventions in a number of cases.</p>	<ul style="list-style-type: none"> - On-farm storage of rainwater - Effective use of low flow emitters, drip irrigation - Use of green/artificial mulch - Practical soil moisture tests (e.g. “feel tests” with an auger) - Fixed receptacles for animal watering - Low flow taps for washing equipment/produce/machinery - Adequate drainage to avoid water-logging - Solar-powered sprinkler systems for pastures or soiling grasses. 	<p>The consensus of the University of the West Indies’ Climate Studies Group, as at the end of 2011, is that rainfall will be a significant variable as the climate changes, thereby impacting water availability.</p>

Conclusions	Recommendations	Remarks
<p><u>Water reuse / recycling:</u> Four islands listed water reuse/recycling of water especially in livestock rearing operations, yet there was room for improvement. Poultry and pig operations were often better organized than ruminant rearing. Sustainability concerns should be assessed prior to farm building construction to facilitate aspects such as directed runoff and storage from guttering.</p>	<ul style="list-style-type: none"> - Farm buildings constructed to direct and store water from guttering. - Reuse of water in livestock operations (e.g. use of grey water for pasture irrigation) 	<p>The increase in protected agriculture structures (such as row covers, shade-houses and enclosed greenhouses) provides new opportunities for recycling water use even in non-hydroponic systems</p>
<p><u>Environmental sustainability:</u> Only Grenada had a comprehensive planned approach to a green economy that included legislation and stated commitment to reduce carbon footprint. Dominica had some farm-based alternative energy systems. Waste reduction and the consequent relief on landfills was not a feature identified during the study</p>	<ul style="list-style-type: none"> - Ministries of Agriculture promote and incentivize climate-smart agriculture via sustainable practices as mentioned herein - Refocus on Good Agricultural Practices (GAP) as a mechanism for livelihood protection and nutrition security as opposed to an imposition for international trade 	<p>As part of nationwide environmental sustainability initiatives, the role of agriculture as a significant steward of the natural environment should be prominently projected</p>
<p><u>Financial sustainability:</u> Examples of environmentally-sound, sustainable practices were seen, but financial sustainability aspects were less evident. The apparent exclusion of producers from a number of value-chains is cause for concern. With the exception of producers belonging to a handful of farmers' organizations and the</p>	<ul style="list-style-type: none"> - Continued promotion of the Value Chain approach with a concentration on looped value chains to include by-product and end-product utilization - Proper Record Keeping as part of a regimen of business monitoring - Maintain a customer database 	<p>A major feature of financial sustainability is proper accounting for the resources utilized. Proper agricultural records incorporate more than just financial information; all major decisions can be traced through accurate and timely entries. Decision-making is thus better informed,</p>

Conclusions	Recommendations	Remarks
<p>cooperatives, the others depended on very loose verbal agreements at best. Formal, structured arrangements for the marketing of non-traditional vegetables and fruits still pose a problem. Bananas in the Windward Islands and onion in Barbados are two of the more developed value chains. The incorporation of VINCYKLUS, the agri-business cluster in St Vincent and the Grenadines is a potential source of improvement.</p>	<p>- Keep the community informed about production and sustainability issues</p>	<p>including decisions on contractual arrangements.</p>