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Adaptation Fund Board
Project and Programme Review Committee
Thirty-fourth Meeting
Bonn, Germany, 8-9 October 2024

PROPOSAL FOR BARBADOS

ADAPTATION FUND BOARD SECRETARIAT TECHNICAL REVIEW OF PROJECT/PROGRAMME PROPOSAL

PROJECT/PROGRAMME CATEGORY: Regular-sized Project Concept

Country/Region: Barbados
Project Title: Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions
Thematic Focal Area: Water Conservation
Implementing Entity: Caribbean Community Climate Change Centre
Executing Entities: Barbados Ministry of Agriculture and Food Security
AF Project ID:
IE Project ID: **Requested Financing from Adaptation Fund (US Dollars): 10,000,000**
Reviewer and contact person: Angelica Ospina **Co-reviewer(s):** Neranda Maurice-George
IE Contact Person:

Technical Summary	The project "Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions" aims to boost adaptive capacity of vegetable and livestock farmers to climate impacts through sustainable water management, enhanced food security, and reduction of water wastage in selected schools. This will be done through the three components below: Component 1: Strengthened ability of Barbadian farming communities to undertake concrete actions to adapt to water scarcity and drought (USD 6,350,000); Component 2: Strengthened support for Barbadian farming communities with tools and materials to mitigate climate change-driven hazards (USD 2,000,000); Component 3: Strengthened Institutional capacity for water conservation (USD 300,000). Requested financing overview: Project/Programme Execution Cost: USD 500,000 Total Project/Programme Cost: USD 9,150,000 Implementing Fee: USD 850,000

	Financing Requested: USD 10,000,000 The proposal includes a request for a project formulation grant and/or project formulation assistance grant of USD 30,000. The initial technical review raises several issues, such as the need to better define the project's main objective and scope, strengthen the cohesiveness between the proposed components, and address discrepancies in XXX as is discussed in the number of Clarification Requests (CRs) and Corrective Action Requests (CARs) raised in the review.
Date:	28 August 2024

Review Criteria	**Questions**	**Comments [date August 28, 2024]**
Country Eligibility	1. Is the country party to the Kyoto Protocol, and/or the Paris Agreement?	Yes.
	2. Is the country a developing country particularly vulnerable to the adverse effects of climate change?	Yes. The country is heavily influenced by the El Nino Southern Oscillation and is vulnerable to the adverse effects of tropical cyclones, storm surge, and floods, rising sea levels and temperature increase, which impact vulnerable communities and ecosystems.
Project Eligibility	1. Has the designated government authority for the Adaptation Fund endorsed the project/programme?	Yes. As per the Endorsement letter dated August 9, 2024.
	2. Does the length of the proposal amount to no more than Fifty pages for the project/programme concept, including its annexes?	No. **CAR1:** Please note the total pages of the proposal is 56, including annexes. Please reduce the length to no more than 50 pages.
	3. Does the project / programme support concrete adaptation actions to assist the country in addressing adaptive capacity to the adverse effects of climate change and build in climate resilience?	**Partly.** The project focuses on addressing climate-related stress on water resources in Barbados across three

		sectors: water, agriculture and education. The first component supports irrigation solutions for farmers, including a storm water pond, a climate-resilient irrigation system and training, and chemical and biological profiling of reclaimed water for irrigation. The second component is linked to food security, by supporting a tissue culture laboratory and growth room, a greenhouse nursery, and a field nursery for the multiplication of tissue culture materials. The third component supports water conservation methods implemented at education institutions and fish markets. **CR1:** While the context is explained in detail, including a number of ongoing initiatives in the water and agriculture sectors in Barbados, the specific gaps that the project is seeking to fill and its value added in terms of climate change adaptation, could be made more explicit, and introduced earlier in the proposal. How will the project avoid duplication of efforts, and build on the lessons learned by other projects (including water harvesting ponds in other farming districts)? How will climate adaptation practices be strengthened through this project, in view of those lessons and the needs of intended beneficiaries? Kindly check the flow of the climate narrative in the context/background section, and ensure that the paragraph/sub-sections are well connected amongst them, to present a more cohesive picture of where the adaptation gaps and needs are, and situate the project. Please ensure that the context/background information is more succinct and avoids repetition. This will also help to shorten the length of the proposal to 50 pages, as per the guidelines.

		CR2: Please add a specific paragraph with the overall goal of the project before the description of the project components. **CR3**: The links and synergies between the three project Components are unclear. How will the proposed activities related to water irrigation, tissue culture, and water conservation awareness at schools and markets, complement each other towards the goal of enhancing adaptative capacity/building resilience? The activities under Component 3 seem unconnected to those under Components 1 and 2, which are focused on farmers. Please clarify how will the activities proposed under Component 3 will address the climate challenges presented as part of the context. **CR4:** The intended beneficiaries of the activities could be clarified in order to strengthen the cohesiveness of the project design and its intended impact. Please clarify the geographic scope and intended beneficiaries of each Component. **CR5:** Please add a complete reference to the study undertaken to determine the feasibility of harvesting rainwater runoff from the watersheds at Spring Hall/Chance Hall to provide adequate storage in ponds for sustainable irrigation. What were the main lessons from the study and how will they be used to inform adaptation activities under Component 1? **CR6**: As part of the description of Component 1, please elaborate on Operation and Maintenance (O&M) aspects towards the sustainability of the irrigation system, and the local ownership/engagement

		of local farmers, including women farmers. Please also clarify the link with/role of existing automated weather stations/ early drought warning systems with the project activities (if applicable). **CR7:** The development of 'an atlas' identifying water sources and volumes to tap safely for irrigation is not clear. Kindly clarify what format would this atlas be in? (e.g. online?) who would be its main users? How will the data be collected and by whom, and how will it be disseminated and used? **CR8:** Please include references of the use of tissue culture towards enhanced climate change adaptation. The link between the proposed activities under Component 2, and the enhancement of farmers' adaptative capacity (in terms of access to the tools/materials, and capacity to implement them) is unclear. Please clarify how will the tissue culture laboratory, the greenhouse nursery and the field nursery activities will reach farmers, including women farmers. **CR9**: The outcomes and activities under the project's components could be further strengthened to ensure that they are tangible and measurable, and that there is a direct link to adaptation to climate impacts- more concretely, to the adaptation capacity of the intended beneficiaries. In the case of Component 1, there could be further reference to how the proposed irrigation system will be resilient to climate change shocks and stressors, and sustained over time. In Component 2, it would be useful to identify if particular types of tissue culture plants would be more effective for farmers to adapt to climate-related water stress in the context of

		Barbados. In the case of Component 3, the link between water conservation methods in schools and fish markets, and the implementation of climate change adaptation actions, needs to be strengthened. **CR10:** Kindly review the 'Project/Programme Components and Financing' table, to avoid duplication of content under Component 3, column of 'Expected Outputs'. **CR11:** Please correct the expected dates reflected in the 'Projected Calendar', as the project duration is one year (as opposed to four).
	4. Does the project / programme provide economic, social and environmental benefits, particularly to vulnerable communities, including gender considerations, while avoiding or mitigating negative impacts, in compliance with the Environmental and Social Policy and Gender Policy of the Fund?	**Unclear.** The project aims to benefit small farming populations in Spring Hall, as well as the entire farming community in Barbados. However, the proposal lacks specificity on how the proposed activities under Components 1, 2 and 3 will benefit specific farming communities and households. It is not clear if/how some of the benefits included in the proposal (e.g., income generation, employment, increase in social cohesiveness, non-communicable diseases, public procurement of locally produced food, recycling of agricultural waste) are related to the implementation of the project activities, and therefore, it's difficult to establish a direct attribution of impact. **CR12:** Please clarify the project's contribution to economic, social and environmental benefits, based specifically on the proposed activities and actions to be implemented. Please indicate if the estimated benefits can be quantified, as it would help to clarify the expected impact.

		CR13: Kindly clarify if there are any risks related to the equitable distribution of benefits from the irrigation services in the targeted area under Component 1, and from the tissue culture + crop nursery activities under Component 2. If so, how will those risks be mitigated?
	5. Is the project / programme cost effective?	**Unclear.** The section on cost effectiveness provides an overview of national data on Barbados agricultural products that can be substituted to replace agricultural imports , as well as references to the CARICOM Agri-Food system initiative, and to the Accelerated Growth Enhancement (AGE) Programme. However, the section lacks specificity on cost-effectiveness in relation to specific project activities. **CR14:** Kindly integrate more specific linkages with the project's scope and approach, as proposed under the three Components. Please ensure that cost effectiveness is demonstrated considering a sustainability point of view.
	6. Is the project / programme consistent with national or sub-national sustainable development strategies, national or sub-national development plans, poverty reduction strategies, national communications and adaptation programs of action and other relevant instruments?	**Yes.** The proposal makes reference to relevant plans and strategies linked to the sectors of implementation, as well as to key adaptation-related plans, strategies and targets. It makes reference to the alignment with the country's INDC and SDGs.
	7. Does the project / programme meet the relevant national technical standards, where applicable, in compliance with the Environmental and Social Policy of the Fund?	**Yes.** The project identifies relevant national technical standards, and states compliance in the key areas related to the project's scope...
	8. Is there duplication of project / programme with other funding sources?	**Unclear.** The proposal refers to a number of projects and government initiatives in relevant areas, evidencing that adaptation is an increasingly important and dynamic field of investment. However, there is no

		explicit reference to potential duplication with other funding sources. Among them, the 2023 Barbados Green and Resilient Recovery Development Policy Loan by the World Bank (US$100M) has a pillar on green and blue resilient development, which includes a new law on water reuse, the adoption of a climate change and agriculture policy and the establishment of an Environmental Sustainability Fund. The European Investment Bank is supporting priority water investment across Barbados, to improve water supply across the country (USD 12M), including improving efficiency, service quality and resilience to mitigate the adverse effects of climate change. **CR15:** Kindly identify other projects/funding sources that may overlap with the proposed activities, including complementarity and lessons that could be drawn to inform and strengthen the project's design.
	9. Does the project / programme have a learning and knowledge management component to capture and feedback lessons?	**Partly.** The project identifies numerous learning and knowledge management activities that could contribute to the achievement of the project's outcomes. However, these activities are not clearly categorized and mapped to the project components. Their implementation will require time and resources, and is therefore important to link them to the activities and outputs, and prioritize them as required. **CR 16:** Please ensure that the aactivities related to knowledge management and dissemination of lessons learned are well aligned to, and included explicitly as part of the activities of the relevant project Components. Prioritize as needed -considering the project objectives, implementation timeframe and budget.

		[Among the activities included in the proposal are: *practical learning and demonstration activities on best practices in water conservation and irrigation, data capture on water use by crops and production rates in the agriculture sector, database of climate resilient practices, programme for the multiplication of existing white yam and sweet potato, agriculture hub, delivery of field courses to farmers, agrometeorology support, information sharing on social and environmental resilience in agriculture through surveys, organized discussion, conferences and other media, gender-responsive engagement)].* Please include only those that contribute directly to the achievement of the project's objectives, and identify those that are already supported by other projects/funding sources, to avoid duplication and identify complementarities. Please identify how could project experiences contribute to enrich knowledge sharing across scales (global, national and local knowledge) on climate change adaptation.
	10. Has a consultative process taken place, and has it involved all key stakeholders, and vulnerable groups, including gender considerations in compliance with the Environmental and Social Policy and Gender Policy of the Fund?	**Yes,** Multi-stakeholder consultations were conducted, in addition to interviews and individual discussions with farmers and other stakeholders. **CR17**: Kindly provide further information on the consultative process, including date of consultations, and concerns raised. Please indicate if the consultative process included farmers in the targeted areas (e.g., Spring Hall). **CR18:** The project's participatory approach throughout the project's implementation could be further explained (e.g., in relation to which project activities, how will the inputs be used, etc.).

	11. Is the requested financing justified on the basis of full cost of adaptation reasoning?	**Partly.** The overall scope of the project is relevant in addressing the country's adaptation objectives to water scarcity and drought. However, the funding justification can be elaborated further, considering measurable outcomes that can be directly attributed to the project's activities. **CR19:** Kindle provide further information on the full cost of adaptation, including baselines and additionality by component.
	12. Is the project / program aligned with AF's results framework?	**Unclear**. The proposal includes a table that maps the project's objectives, indicators and outcomes, and the AF' outcomes, outputs and corresponding indicators. However, the AF information doesn't match with thae outcomes reflected in the *Adaptation Fund revised strategic results framework* adopted in 2019. **CR20:** It may be advisable to review the 2019 AF Results Framework, and refer explicitly to the outcomes related to the project, such as AF outcomes 3, 4, and 6.
	13. Has the sustainability of the project/programme outcomes been taken into account when designing the project?	**No.** The proposal does not elaborate on key aspects of sustainability as part of the project's design. Reference to the role of extension services in support to farmers needs to be further explained and linked to the project **CR21:** Please elaborate on how the adaptation benefits achieved through the project can be sustained over time, making explicit reference to the project components, for clarity. Please indicate how to enable replication and scaling up with other funds after the project's end, including arrangements through which this would be achieved (i.e., sustainability and

		maintenance of any infrastructure or installations to be developed, knowledge to be generated, management and other capacity to be improved, etc)
	14. Does the project / programme provide an overview of environmental and social impacts / risks identified, in compliance with the Environmental and Social Policy and Gender Policy of the Fund?	**Partly.** The proposal identifies a series of potential environmental and social impacts and risks, climate adaptation co-benefits, and a checklist of environmental and social AF principles (15), identifying that no further assessments are required for compliance. The concept note includes an initial gender assessment. However, it does not state the category in which the screening process has classified the project, and further consideration could be given to certain aspects. **CR22:** Please state the category in which the screening process has classified the project. **CR23**: Kindly elaborate on potential risks related to the phased development proposed for the storm water point construction. As stated in the proposal, 'The study area offers the option of carrying out a phased development that may start with the construction of the Spring Hall Pond (P1) with a watershed of 329 hectares (812 acres) and later adding other ponds later. The decision on the capacity of the ponds required can be determined after due consideration of the area of land available for farming in the environs of Spring Hall and Chance Hall.'. Please identify potential risks that could hinder the approach, in terms of the land area availability, the impact of climate stressors, or other factors that could affect the ponds development. **CR23:** Please ensure that the content is not duplicated. Several paragraphs in the environmental

		and social risk identification section are repeated in other sections of the proposal, including in the gender analysis Annex. Please check that reference to Table 12 is included in the main text, so as to improve the flow of the narrative (please check this in the overall concept note, as it may be the text with other Tables). **CR24:** The initial gender assessment includes a list of six recommendations for inclusion in the project, that emerged from the stakeholder consultations. However, these recommendations don't make reference to gender roles, gender-sensitive activities, needs, or specific available opportunities and challenges or risks for men and women. Please indicate clarify why are they included as part of the gender analysis. **CR25:** Kindly clarify if the stakeholders from different gender groups were consulted both separately and in mixed groups.
Resource Availability	1. Is the requested project / programme funding within the cap of the country?	**AF Project Review Coordination team will let the reviewer know if there is anything to be noted in the review concerning the resource availability question.**
	2. Is the Implementing Entity Management Fee at or below 8.5 per cent of the total project/programme budget before the fee?	*No.* **CR26:** The management fee ($850,000) needs to be below 8.5% of the total budget before the fee ($9,150,000). The IE and EE fees calculator available under Project Material on the AF Website can be used. https://www.adaptation-fund.org/document/ie-and-ee-fees-calculator

		CR27: The proposal it indicates a Total Project cost of $10,000.000. However, this amount does not take into account the Implementing fee ($850,000). Please revise the total project cost amount considering the fee. **CR28:** A PFG of $30,000 is being requested. The size is correct considering the size of the project (above US$5M). The PFG fee is not indicated in the concept note.
	3. Are the Project/Programme Execution Costs at or below 9.5 per cent of the total project/programme budget (including the fee)?	**Yes.**
Eligibility of IE	1. Is the project/programme submitted through an eligible Implementing Entity that has been accredited by the Board?	**Yes.** Caribbean Community Climate Change Center (CCCCC) *Accreditation Expiration Date: 07 April 2027* https://www.adaptation-fund.org/imp_entity/caribbean-community-climate-change-centre-ccccc/
Implementation Arrangements	1. Is there adequate arrangement for project / programme management, in compliance with the Gender Policy of the Fund?	n/a at concept stage
	2. Are there measures for financial and project/programme risk management?	n/a at concept stage
	3. Are there measures in place for the management of for environmental and social risks, in line with the Environmental and Social Policy and Gender Policy of the Fund?	n/a at concept stage
	4. Is a budget on the Implementing Entity Management Fee use included?	n/a at concept stage

	5. Is an explanation and a breakdown of the execution costs included?	n/a at concept stage
	6. Is a detailed budget including budget notes included?	n/a at concept stage
	7. Are arrangements for monitoring and evaluation clearly defined, including budgeted M&E plans and sex-disaggregated data, targets and indicators, in compliance with the Gender Policy of the Fund?	n/a at concept stage
	8. Does the M&E Framework include a break-down of how implementing entity IE fees will be utilized in the supervision of the M&E function?	n/a at concept stage
	9. Does the project/programme's results framework align with the AF's results framework? Does it include at least one core outcome indicator from the Fund's results framework?	n/a at concept stage
	10. Is a disbursement schedule with time-bound milestones included?	n/a at concept stage

DRAFT CONCEPT NOTE PROPOSAL FOR SINGLE COUNTRY

PART I: PROJECT/PROGRAMME INFORMATION

Title of Project/Programme:	Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions
Country:	Barbados
Thematic Focal Area:	Water Conservation
Type of Implementing Entity:	Regional Implementing Entity
Implementing Entity:	Caribbean Community Climate Change Centre
Executing Entities:	Barbados Ministry of Agriculture and Food Security
Amount of Financing Requested:	10 million (in U.S Dollars Equivalent)

Project Formulation Grant Request (available to NIEs only): Yes ☐ No ☒

Amount of Requested financing for PFG: 30 000 (in U.S Dollars Equivalent)

Letter of Endorsement (LOE) signed: Yes ☒ No ☐

NOTE: LOEs should be signed by the Designated Authority (DA). The signatory DA must be on file with the Adaptation Fund. To find the DA currently on file check this page: https://www.adaptation-fund.org/apply-funding/designated-authorities

Stage of Submission:

☐ This concept has been submitted before

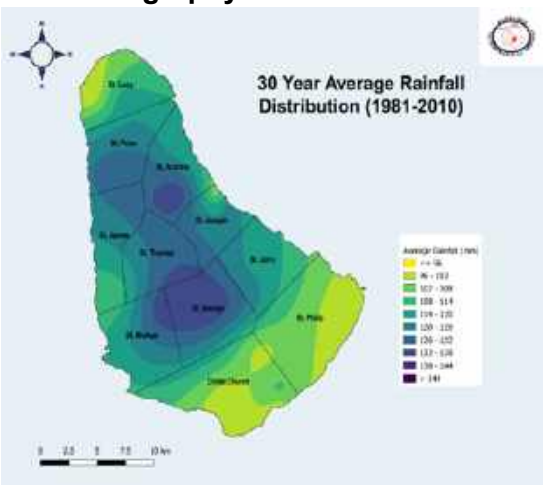
☒ This is the first submission ever of the concept proposal

In case of a resubmission, please indicate the last submission date: Click or tap to enter a date.

Please note that concept note documents should not exceed 50 pages, including annexes.

Project/Programme Background and Context:

Geography and Environment



Eighty- six percent of Barbados is capped by coral limestone, which gives the landscape a gently rolling topography, interrupted at points by deep gullies and a series of almost vertical cliffs that are coral reef formations. Barbados is characterized by a moderate tropical maritime climate with average annual temperatures of 30 – 32°C. Ambient sea surface temperatures range from 26 - 29°C and there is an almost constant amount of surface solar radiation year round. Due to some orographic effects, precipitation varies widely across Barbados. Barbados' driest areas are located along the north, south and southeastern coast in the lee of the more elevated central part of the island. The island experiences a prolonged dry season, which runs from December to May with the highest rainfall occurring in the more central parts of the island. The wet season lasts from June to November and coincides with the Atlantic hurricane season. The highest rainfall recorded during the wet season, is over the central and leeward sides of the island. Approximately 60 percent of the average annual rainfall occurs during the wet season and is associated with tropical waves. **Figure 1: Barbados Average Rainfall Distribution**

Socio-Economics

Barbados has a population of approximately 287,000[1] with a density in the region of 660 persons per km^2 making the island one of the most densely populated countries in the world. [2] According to the IMF, Barbados has a per capita gross national income of US$16,720, as of 2021. Barbados experienced several decades of solid economic growth, which led to an improvement in key social indicators, such as life expectancy, and enhanced its capabilities for handling any development challenges. However, as a small open economy, Barbados is highly vulnerable to exogenous economic shocks which are increasingly likely to compound due to climate change, leading to increasing and severe socio-economic costs in the absence of reforms and adaptation measures.

Barbados' Human Development Index (HDI value) for 2018 was 0.813, which put the country in the very high human development category and positioning it at 56 out of 189 countries and territories. Between 1990 and 2018, Barbados' life expectancy at birth increased by 4.4 years, mean years of schooling increased by 2.5 years and expected years of schooling increased by 2.3 years. The composition of poverty[3] in Barbados changed in 2016, with a significantly lower share of indigent poor (3.39 percent) compared with 2010 (6.9 percent), and an increased incidence of non-indigent poverty of 13.82 percent compared with 8.1percent in 2010. The total poverty rate (resulting from the addition of the indigent and non-indigent poverty rates) was estimated to be 17.21 percent, above the rate in 2010, which was 15 percent of Barbadian households. The Gini coefficient in 2016 was 0.32, which is below the coefficient estimated for 2010 (0.43), and suggests that inequality among households fell between 2010 and 2016. The SLC data also highlighted a disparity in poverty and vulnerability between genders, as female poverty and vulnerability rates were above that of males in all categories of households (e.g. extreme poor, non-extreme poor, and poor). [4]Barbadian women are more likely to be living in poverty even though more women than men are graduates of tertiary level education institutions. Overall poverty for females in 2016 stood at 21 percent, compared with 14 percent for males.

[5]In 2023, the Barbados economy sustained its growth trajectory, driven by the robust performance of the tourism sector. Amidst challenges such as elevated foreign interest rates, geopolitical tensions, and local climatic events affecting agricultural output and local prices, the Barbadian economy demonstrated resilience and continued its upward growth path. The economy registered an estimated growth of 4.4 percent. Despite challenges in meat and dairy production,

[1] World Population Review (Barbados 2020)
[2] CEPALSTAT Databases and Statistical Publications ECLAC.
[3] Caribbean Development Bank 2017 Economic Review of Barbados.
[4] IDB 2018 Report – Barbados Country Development Challenges
[5] Central Bank of Barbados Review of Barbados' Economic Performance January – December 2023

robust food crop production spurred overall agricultural output. By the end of 2023, food crop production increased by 20.7 percent compared to 2022. Increases in bananas, chives, thyme, plantain, and cassava drove the overall expansion. Milk, chicken, and other meat production suffered from the extreme heat during the summer months and inconsistent feed quality. The high temperatures disrupted lactation and breeding cycles, resulting in a 5 percent contraction in milk production. Chicken output fell by 0.7 percent owing to a combination of the hot weather conditions and inconsistent feed quality, while other meat production contracted by 4.3 percent. Overall, higher food crop production outweighed the decline in meat production, culminating in 1.1 percent growth in the agricultural sector. Women, who are among the most vulnerable to climate change, comprise majority of the agricultural labor force involved in land preparation, weeding, crop protection and irrigation.

Climate Change Impacts

[1]Barbados's climate is heavily influenced by the El Nino Southern Oscillation and its economy is especially vulnerable to the adverse effects of tropical cyclones, storm surge, and floods. The country's low-lying coastal areas also face severe risk of sea level rise. Observed and anticipated climate change impacts are of particular concern to Barbados given the vulnerability of its housing stock and the increased probability of hurricanes making landfall on the island. Temperatures in Barbados are projected to increase under all emissions scenarios, with median annual mean temperatures expected to rise by 1.03°C under a high emissions scenario (Shared Socioeconomic Pathway 3-7.0, SSP3-7.0) by the 2040-2050 period. Changes in rainfall are less certain, however most scenarios show an expected reduction in annual precipitation across Barbados by the 2040-2059. Under a high emissions scenario (SSP3-7.0), annual precipitation is expected to decline by approximately 9 percent by mid-century. At the sector level, climate change is likely to significantly affect: *water* scarcity due to a reduction of *water* resources through groundwater contamination from flooding, as well as soil or pollutant infiltration and saline intrusion; a situation which is especially alarming for Barbados, given its ranking among the world's most water-scarce countries; *agricultural* production through droughts, flooding, and storm damages.

Barbados is experiencing "absolute water scarcity" based on the Falkenmark[6] water stress indicator where 305-310 cubic meters of water is available per person per year. This water scarcity is being exacerbated by climate change. The projections representative for Barbados[7], using a multi-model CMIP6 ensemble with the SSP2-4.5 scenario and for the epoch 2041 – 2060, indicate that:

1. The mean annual daily maximum temperature will increase by about 1.0°C. The mean annual daily minimum temperature will increase by about 1.3°C. The daily maximum temperature increase is largest during the wet season from September to November.
2. The number of heatwaves (three consecutive days where the maximum temperature exceeds the average daily maximum temperature at the 90% threshold) has increased over the period 1991 – 2020 and may be expected to increase further with increasing temperatures.
3. Annual mean precipitation will decrease by about 9%. The decrease is particularly severe in the May - July season, effectively extending the dry season by two months.

For Barbados, the number of hot days is projected to increase substantially, in turn increasing the frequency of hot days and nights that are considered "hot", there will be more intense and shorter duration rainfall events interspersed with long periods of dry weather and increased frequency and intensity of extreme storms and sea-level rise. Higher temperatures will affect the seasonality of crops, increase evapotranspiration rates, induce heat stress on the general population, children and livestock, increase cooling costs, induce changes in plant-wildlife-insect populations and increase infectious and vector-borne diseases. Poor Barbadians become vulnerable as food price increases are often associated with drought.

More intense rainfall, severe storm conditions and hurricanes will promote flash flooding[8]; saline intrusion into ground water abstraction and irrigation wells; and salinization of agriculture lands. Barbados has experienced

[6] This method defines water scarcity in terms of the total water resources that are available to the population of a region; measuring scarcity as the amount of renewable freshwater that is available for each person each year. If the amount of renewable water in a country is below 1,700 m3 per person per year, that country is said to be experiencing water stress; below 1,000 m3 it is said to be experiencing water scarcity; and below 500 m3, absolute water scarcity (Falkenmark, M., J. Lundquist and C. Widstrand (1989), "Macro-scale Water Scarcity Requires Micro-scale Approaches: Aspects of Vulnerability in Semi-arid Development", Natural Resources Forum, Vol. 13, No. 4, pp. 258-267)

[7] Green Climate Fund FP192: The R's (Reduce, Reuse and Recycle) for Climate Resilience Wastewater Systems in Barbados (3R-CReWS) 2022

[8] https://www.facebook.com/BarbadosToday/videos/flash-flood-warning-in-effect-for-barbados/654986996748967/

high incidences of vector borne[9] and waterborne diseases that were attributed to episodic changes in temperature (+0.7°C - +4.0°C) and rainfall patterns and linked to events such as dry season droughts and wet season flash flooding. It is projected there could be an increase in water-borne diseases, due to limited water availability and wastewater sanitation. The effects of climate change are already evident in Barbados as increased flash-flooding magnitude and frequency has caused havoc in Barbados. The decreasing amount and increasingly skewed pattern of precipitation and increasing evapotranspiration due to higher temperatures will set the stage for increased drought which will further decrease underground recharge rates and increase salinization of aquifers, which provide 95% of the island's potable water supply. The overall research suggests that sustainable aquifer yields could decrease by around 50% by 2050. This is troubling for Barbados as the level of groundwater abstraction is already between 85-100% of the safe yield.

Analyses of climate change projections on temperature are aligned with the findings of Working Group I of the IPCC in their report for the Sixth Assessment Report (AR6). For precipitation and droughts there is no agreement in the CMIP6 models for the Caribbean region (although the local precipitation data for Barbados does show trends such as an increase in extremely heavy precipitation). At the onset of the 2020 wet season, Barbados had completed a 24-month period with below normal rainfall that had a severe impact on aquifer recharge and resulted in seawater intrusion into coastal aquifers and reduced yields. Hydrogeological modelling using MODFLOW 2000, indicated that by 2050 under an RCP 2.6 scenario, groundwater yields could be reduced to 26.9 million cubic meters of water per year (Mm^3/year), and 25.5 Mm^3/year under the RCP 8.5 scenario, as compared to a no climate change estimate of between 65.7 Mm3/year and 82.3 Mm^3/year, depending on which estimate is used. Studies which took a mass-balance approach to changes in groundwater storage indicated that under all climate change scenarios aquifers would be progressively depleted. The Barbados Water Authority (BWA) has estimated that their own abstraction is approximately 47 Mm3/year and that total abstraction could be as much as 62.5 Mm^3/year when other sources are included.

Water availability in Barbados is acutely affected by periods and intensities of wet and dry seasons and by extreme weather systems. A dry spell of 7-10 days has the potential to reduce crop yields, thereby impacting the livelihoods of farmers and increasing their climate vulnerability. Barbadian farmers, especially small farmers, are becoming increasingly vulnerable to drought as their livelihoods are threatened by low rainfall where crops are rainfed and by low water levels and increased production costs due to increased irrigation. [10]Livestock grazing areas reduce in nutritional value, as more low quality, drought tolerant species dominate pastures during extensive droughts, causing the vulnerability of livestock to increase. The potential for livestock diseases also increases.

Greenhouse Gas Emissions

Barbados' greenhouse gas emissions are low, contributing to less than 0.01 percent of the global total. Emissions mainly come from energy and domestic transport (73.7 percent), waste (14.9 percent), industrial processes (8.5 percent) and agriculture (3.0 percent). Land use, land use change and forestry provide a sink of greenhouse gas emissions of 51 Gg CO2e in 2010, equivalent to a reduction of 2.6 percent of total emissions for that year.[2] The main sources of greenhouse gas emissions (GHGs) in agriculture in Barbados are primarily from use of nitrogen fertilizers totaling 138 kg/ha of cropland in 2021[11]. This is in line with the world average of 135 kg/ha.

Energy is strongly tied to the provision of water in Barbados where approximately 5% of the electricity consumption in Barbados is used for providing water and wastewater services. Energy is needed to lift raw water from its source (deep ground water sources), treat and pump it to end-users. This contributes to greenhouse gas emissions as majority of the energy used to carry out these operations are from fossil fuel combustion. When taken on a per capita basis, the energy intensity water production and distribution for Barbados and other small island developing states are significantly high. Currently, Barbados relies almost entirely (96%) on fuel oil and diesel to generate electricity with the majority of it being imported at a cost of approximately 7% of the islands' GDP (United Nations Environment Programme, 2012; NREL, 2015). The use of energy-intensive water supply

[9] Barbados has the highest rate of dengue in the world (WHO)

[10] http://www.fao.org/americas/noticias/ver/en/c/419202/

[11] Barbados Agriculture and Climate Change Policy 2022

systems with these kinds of traditional energy sources places a great strain on the local carbon footprint as well as Net International Reserves, especially under current economic conditions[12].

Electricity generation accounted for 56.8% of Barbados' CO2 emissions in 2000. This contribution rose to 61.4% in 2005. The total CO2 emissions from electricity generation that year were 837,000 tonnes. As the largest source of CO2 emissions, reducing emissions from electricity generation will have a significant impact on the country's emissions profile. Based on 2005 data, reducing CO2 emissions from electricity generation by 10% can reduce the country's CO2 emissions by 6.14%. CO2 emissions tracked the electricity consumption from 2000 to 2004; both grew at around 4.5% per year.

Barbados intends to achieve an economy-wide reduction in GHG emissions of 44% compared to its business as usual (BAU) scenario by 2030. In absolute terms, this translates to a reduction of 23% compared with the baseline year, 2008. As an interim target, the intention will be to achieve an economy-wide reduction of 37% compared to its business as usual (BAU) scenario by 2025, equivalent to an absolute reduction of 21% compared to 2008. To address reduction in rainfall, increased drought conditions and increased water scarcity, Barbados has sought to use desalination technology. While desalination plants have provided additional water on the island nation, its dependence on traditional energy sources (fossil fuel combustion) results in a carbon footprint of 0.4‑6.7 kg CO2eq/m3, which is much higher than other alternatives such as increased wastewater reuse (0.1‑2.4 kg CO2eq/m3). Water wastage contributes to higher operating costs through unnecessary energy and chemical treatment usage as well as contributing to GHG emissions through the use of fossil-based energy sources.

Barbados is taking an ambitious and proactive approach towards reducing its own GHGs emissions by introducing firm adaptation and mitigation actions, which include the de-carbonization of the electricity grid and reduced emissions from other sectors. The Barbados Green Economy Scoping Nationally Appropriate Mitigation (GESNAM), form the backbone of the future Intended Nationally Determined Contribution (INDC). The Government of Barbados has started to restrict the use of potable water during drought for essential uses in an effort to reduce water wastage and this also reduces the carbon footprint and GHGs emissions from water pumping and transmission.

Water Conservation in Barbados

Climate change is impacting the ability of the Barbados Water Authority to maintain water supply across the island. Households experience water insecurity, with frequent outages in some parts of the island. One initiative funded by GCF is the installation of potable tanks to store of water, with an attached pump that kicks-in to supply the household, school, or business with water if the water mains system cannot do so. [13]A proposed water academy is to be established at the Barbados Community College (BCC) in the near future as an initiative to lead Barbados in the direction of becoming a water-smart nation. Children as young as three years old will become water monitors through the initiative which is intended to transform the attitudes of Barbadians towards water conservation. The academy, which will help the country tackle its prolonged water crisis, will also offer training and other technical assistance to professionals in the sector. Principal of the Caribbean Institute for Meteorology and Hydrology (CIMH) chairs the advisory committee to establish the academy.

Water is a vital resource and children need to understand the importance of conserving and protecting this resource. They need to learn about the water cycle, watersheds, and how water is distributed and recharged in their communities. Water education leads to overall environmental stewardship because learning about the importance of water, students can become advocates for reducing water pollution, preserving natural habitats in their communities. Children who learn about their local water sources and how water is treated and distributed can develop a deeper understanding of the value of water. They can see the finite nature of this resource and understand how changes in the water cycle affect their community and the environment. Climate change is contributing to water scarcity in

[12] FP 060: Water Sector Resilience Nexus for Sustainability in Barbados (WSRN S-Barbados)

[13] https://nationnews.com/2023/06/08/water-academy-coming-bcc/

Barbados by understanding the effects of drought on all aspects of life and the economy, they can become advocates for water conservation and find ways to use water more efficiently.

Reduce, Reuse and Recycle for Climate Resilience Wastewater Systems in Barbados (3R-CReWS)[14]
Barbados is seeking to harness reclaimed water to be utilized for aquifer recharge and agricultural irrigation through the installation of a 9km pipeline from the Bridgetown Sewage Treatment Plant to farms in nearby areas in an effort to enhance resilience to climate change by promoting water security. This is expected to reduce the extraction of groundwater leading to reduced aquifer saltwater intrusion, and increased availability of irrigation water during dry periods. Greater water availability, using reclaimed water, for irrigation purposes, should also lead to improved food security. The supply of treated reclaimed wastewater to support irrigation developments in the Codrington-Neils-Lears-Salters-Constant-Valley will provide benefits to 155 farmers (60% males and 40% males).

The use of reclaimed water from the Bridgetown Sewage Treatment Plant for irrigation purpose requires reverse osmosis membrane filtration to remove total dissolved solids to a concentration less than 450 mg/L required by the Ministry of Agriculture and Food Security for agricultural irrigation applications. Agriculture competes with other sectors for water and the Government of Barbados has increased its call for greater domestic food production through new and improved methods of farming as a response to climate change. Greater water availability, for irrigation purposes, should also lead to improved food security and health and well-being of the population.

During consultations with farmers on the 3R CREWS, there was overwhelming support for the use of treated wastewater. Farmers have been experiencing the impact of prolonged dry periods, which they say are happening more frequently and they are losing income; having access to water would be a great relief to them. The demand for reclaimed water for the agriculture sector is high and use for agriculture decreases the demand pressures on the aquifers. The 3R CREWS project directly addresses the risks of reduced water resources, which are further amplified by climate change, through wastewater recycling and reuse, associated with climate change in Barbados. The island's drinking water supply is used extensively by small farmers as their irrigation water supply and there is little reuse of wastewater for irrigation.

Barbados Climate Resilient South Coast Water Reclamation Project[15]
The Government of Barbados (GOB), through the Barbados Water Authority (BWA), has embarked on an initiative to augment existing water supplies, mitigate climate change effects, address seawater intrusion and sea level rise, diversify potable water sources, enhance water supply resiliency, and reduce the impact of treated effluent on marine life and the environment. This is to be achieved partly by upgrading the existing South Coast Wastewater Treatment Plant (SCSTP) to a Water Reclamation facility. The project objectives are to: augment existing water supplies; diversify potable water sources; enhance water supply resiliency by increasing the availability of reclaimed water treated to international discharge standards and reduce water insecurity through aquifer recharge; and reduce the impact of untreated effluent on marine life and the environment. The upgrade of the SCSTP to tertiary treatment and incorporating reverse osmosis to enable the reuse of treated reclaimed water for non-potable (non-drinking) purposes is a substantial step forward in Barbados' counteracting the impacts of climate change. The **Barbados Climate Resilient South Coast Water Reclamation Project** will play a crucial role in alleviating chronic water shortages and enhancing the efficiency of wastewater systems on the island and also supply water for irrigation to the River Plantation farming area.

Antimicrobial resistance in wastewaters in Barbados: A comparison of clinical and environmental matrices
Wastewater management strategies using reclaimed water are a critical component to help mitigate the impacts of climate change on water scarcity. Reclaimed water is wastewater that has been treated to tertiary levels so that it can be beneficially reused for non-potable sources, such as irrigation in agriculture. Wastewater discharge from human communities, healthcare institutions, water systems and animal/agricultural run-offs are potential

[14] https://www.greenclimate.fund/document/r-s-reduce-reuse-and-recycle-climate-resilience-wastewater-systems-barbados-3r-crews
[15] https://www.iadb.org/en/whats-our-impact/BA-L1063

reservoirs of antibiotic-resistant bacteria (ARB) that continuously contribute to the sewerage system[16]. The misuse of antibiotics can result in the development of resistance through mechanisms (antibiotic resistance genes (ARGs)) that can be transferred from one bacterial species to the next in various environments. These mechanisms result in antimicrobial resistance (AMR) which may pose a hazard to human, animal, and environmental health. Adequate ARGs/ARBs reduction methods should be applied to wastewater to prevent the development and dissemination of antibiotic resistance in people and animals.

Although WWTP treatment procedures have substantially improved due to technological advancements, total removal of antimicrobial compounds and other new pollutants remains unachievable at this stage, possibly resulting in the dissemination of ARGs into the environment. The tertiary treatment to be utilized in the Bridgetown and South Coast Sewage Treatment Plants aims at improving the characteristics of the secondary effluent to facilitate its reuse that reduces nitrates, phosphates, and organic matter, producing a clean and harmless wastewater effluent to be utilized for irrigation or discharged into sea[17].

Israel, Morocco, Australia, China, Mexico, and the USA reuse wastewater for irrigation. Treated wastewater in agriculture can transfer ARBs to soil at low concentrations, which can persist and proliferate in highly concentrated organic material conditions. Wastewater plays three roles in AMR development: it serves as a habitat for ARBs and ARGs, facilitates their transfer between humans and animals, and promotes AMR spread. Fundamentally, due to the increasing genetic variation bacteria can acquire ARGs leading to the development of novel resistance[18].

The reuse of reclaimed wastewater is growing in importance, especially as increasing stress is experienced concerning freshwater[19]. With the improved water quality of wastewater from WWTPs considering the negative effects of climate change, methods to reuse wastewater as a measure of climate adaptation to build climate resilience must be of utmost importance in water-scarce countries like Barbados. The benefits of wastewater reuse in agriculture are numerous, as the world is already grappling with water and food shortages[20]. However, owing to the growing threat posed by AMR, which is driven by many factors, one being the irrigation with wastewater solutions, actions must be implemented immediately to eliminate the risk.

Drinking water, sanitation and hygiene (WASH) services in Barbadian Schools

Every Barbadian child is provided with a quality education, which includes access to drinking water, sanitation and hygiene (WASH) services while at school. Barbadian children spend a significant portion of their day at school, where WASH services can impact student learning, health, and dignity, particularly for girls. The inclusion of WASH in schools in the Sustainable Development Goals (targets 4.a, 6.1, 6.2) represents increasing recognition of their importance as key components of a 'safe, non-violent, inclusive and effective learning environment' and as part of 'universal' WASH access, which emphasizes the need for WASH outside of the home. By the UN standards, the availability of water, sanitation, and hygiene (WASH) at Barbadian schools is one of the highly effective practices in increasing access and learning outcomes. Hydration is vital for children as they have a higher proportion of body water than adults and are usually a lot more active.

According to WHO/ UNICEF Joint Monitoring Programme for WASH Estimates for Schools by Country 2000-2021[21], Barbados has a school-aged population of approximately 43 000 where 31% is urban and 69% is rural.

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[16] An invisible enemy: antimicrobial resistance and its impact on the health of humans, animals and ecosystems https://blogs.iadb.org/sostenibilidad/en/an-invisible-enemy-antimicrobial-resistance-and-its-impact-on-the-health-of-humans-animals-and-ecosystems/ Antimicrobial Resistance in Water in Latin America and the Caribbean: Available Research and Gaps(Review)Moreno-Switt, A.I., Rivera, D.,Caipo, M.L.,Nowell, D.C., Adell, A.DFrontiers in Veterinary Science Volume 7, 21 August 2020, Article number 546

[17] Zagklis, D.P.; Bampos, G. Tertiary Wastewater Treatment Technologies: A Review of Technical, Economic, and Life Cycle Aspects. *Processes* **2022**, *10*, 2304. https://doi.org/10.3390/pr10112304

[18] 4. C Narciso-da-Rocha, J Rocha, I Vaz-Moreira, F Lira, J Tamames, I Henriques, *et al.* Bacterial lineages are putatively associated with the dissemination of antibiotic-resistance genes in a full-scale urban wastewater treatment plant Environ Int, 118 (2018), pp. 179-188, 10.1016/j.envint.2018.05.040

[19] CM Manaia, J Rocha, N Scaccia, R Marano, E Radu, F Biancullo, *et al.* Antibiotic resistance in wastewater treatment plants: tackling the black box Environ Int, 115 (2018), pp. 312-324, 10.1016/j.envint.2018.03.044

[20] S Sambaza, N Naicker Contribution of wastewater to antimicrobial resistance: A review article J Global Antimicrobial Resistance, 34 (2023), pp. 23 -29 https://doi.org/10.1016/j.jgar.2023.05.010.

[21] https://data.unicef.org/topic/water-and-sanitation/drinking-water/

At the primary and secondary schools, 100% of school children are provided with basic water services (approved and available), basic sanitation services (approved, useable, single-sex) and greater than 99% are provided with basic hygiene services (facility with water and soap). This is compared to the national Barbadian statistics where greater than 99% of the population have basic water services, basic sanitation services and basic hygiene services.

Barbados School Infrastructure

[22]School infrastructure for Nursery, Primary, Secondary and Special Needs reflects Barbados' chapters of national development, featuring traditional building materials such as coral stone, rubble wall or red brick structures through to more modern methods of construction using reinforced concrete blockwork. The infrastructure also illustrates a physical footprint which has been expanded to meet capacity requirements caused by the increasing school aged population. Approximately 75% of Barbadian schools were established in the 1900s. To ensure a comfortable, healthy and safe school environment, a well-designed layout, good construction practices and effective facilities management can support the health and safety of school users. Some primary climate resilience matters relate to: Energy efficiency through the incorporation of energy efficient systems, and fittings and fixtures which reduce the consumption of fossil fuels; Water conservation systems such as rainwater harvesting for secondary uses such as the watering of the agricultural projects, and the inclusion of water saving devices for taps, toilets and hoses. Transformation of public schools into green, energy-efficient, cost-effective and environmentally friendly learning environments is being planned.

An Analysis of the Water Consumption in the Barbados Ministry of Education, Technological and Vocational Training (2018 -2023)

There are 68 Barbados Government primary schools, 54 special schools, 12 nursery schools and 21 secondary schools all of which are overseen by the Barbados Ministry of Education, Technological and Vocational Training[23]. The University of the West Indies, Barbados Youth Service, Barbados Community College and the Samuel Jackman Prescod Technical Institute are the other government institutions that offer post-secondary/ tertiary education in Barbados. According to the IDB[24], the Barbadian education system caters to 45,623 students in enrolled in primary (25,039 students in both public and private schools) and secondary education (20,584 students in both public and private schools). Forty eight percent (48%) of primary school students are female and 52 % are male, whilst in secondary school 49% are female and 51% are male[25].

. **Table 1: School Data Summary**

Name of School	Student Enrolment			Water Usage m^3 (2018-2023)	[1]Number of Water Facilities
	Male	Female	Total		
All Saints Primary	188	164	352	160 221	69
Ellerton Primary	70	56	126	148 514	72
Lester Vaughn	439	453	892	184 296	232
Lodge School	510	494	1004	210 582	

1 Water toilets, trough urinals, single urinals, sinks (commercial, domestic, hand wash, laboratory), showers

The Barbados Water Authority collated data on water consumption in 58 schools and institutions and the Ministry of Education, Technological and Vocational Training during the five year period 2018 -2023. An analysis of this data showed that the Ministry of Education, Technological and Vocational Training and its associated educational institutions consumed 4 041 972 cubic meters of water from 2018 - 2023. The year 2019 recorded the highest consumption of water with 895 308 cubic meters, whilst 2022 recorded the lowest consumption of 467 383 cubic meters. In 2022, the covid pandemic was ongoing in Barbados and online schooling was undertaken nation-wide. Of the total water consumption from 2018 -2023, the Ministry of Education, Technological and Vocational Training itself[26] consumed 1 563 463 cubic meters of water or 39% of

[22] Reimagining Education in Barbados- A Bright Future for Every Child Ministry of Education and Vocational Training October 2023
[23] https://mes.gov.bb/
[24] https://socialdigital.iadb.org/en/edu/covid-19/regional-response/6132
[25] UNESCO Institute for Statistics
[26] The Ministry of Education, Technological and Vocational Training has several properties which are all metered as a single unit

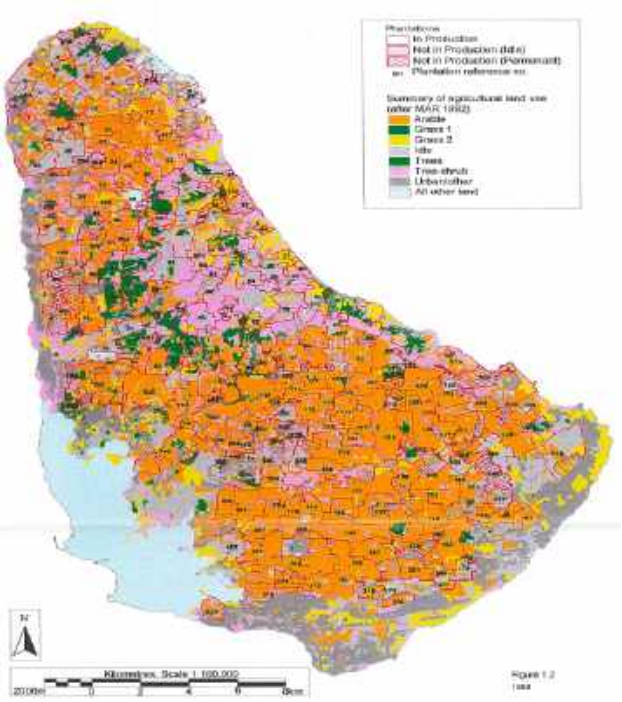
the total water (4 041 972). The water consumed per month by the Ministry of Education, Technological and Vocational Training had an average value of 16 286 cubic meters (range 19 625 - 63 755 cubic meters).

The educational institutions which consumed the largest volume of water in cubic meters over the period 2018-2023 are as follows: UWI Cave Hill (688 758), the Lodge School (210 582), Lester Vaughn Secondary School (184 296), All Saints Primary School (160 221) and Ellerton Primary School (148 514).

For comparison, data was collected on the water consumed by Barbados' thirteen fish markets (Consett Bay, Paynes Bay, Skeete's Bay, Bay Street, Six Mens, Bridgetown, Oistins, Speightstown, Bridgetown, Half Moon Fort, Weston, and Bathsheba) in Barbados under the Ministry of Maritime Affairs and the Blue Economy. Over the same five year period (2018 – 2023), these fish markets combined recorded a total cumulative water consumption of 456 156 cubic meters. The Oistins Fish Market was the largest consumer of water of all the fish markets, utilizing 107 281 cubic meters of water over 2018 -2023; the average monthly consumption was 1117 cubic meters of water (range 1 – 4533 cubic meters). This data shows that Barbados' fish markets consumed approximately 10% of the total water used by the Ministry of Education, Technological and Vocational Training and associated educational institutions over the period 2018 -2023.

.Characteristics of Agriculture in Barbados

Table 2: Summary of Farming Organizations	
Name of Farming Organization	**Number of Members**
Barbados Agriculture Society (Umbrella Body for Farmers)	500
Barbados Beef and Dairy Producers Association	25
Barbados Beekeepers Association	55
Barbados Egg and Poultry Producers Organization	125
Barbados Pig Farmers Association	100
Barbados Pig Farmers Cooperative	40
Barbados Rabbit Association	35
Barbados Sheep Farmers Inc.	50
Barbados Flower Producers Association	10
Farmers Empowerment and Enfranchisement Drive (FEED) Program BADMC River Plantation, Spring Hall	30
Fruit and Vegetable Growers Association	125
New River Life Charity (Farming for the Disabled)	30
Organic Growers and Consumers Association of Barbados	25
River Plantation Farmers	95
Spring Hall Land Lease Farmers	63
St. George Cooperative Society	25
Women in Agriculture	50
Total	1383



Barbados has a total land area of 42,994 hectares (106,240 acres). [27]There are approximately 8,199 individual agriculture small holdings utilized by small farmers of 0.2 to 10 hectares in Barbados covering 6, 074 hectares of land or 14 percent of Barbados' total land area. There are a further 9, 966 small holdings less than 0.2 hectares (4,925 acres) in size or 0.05 percent of Barbados' total land area. There are 216 agricultural plantations, each of which is more than 10 hectares in size, covering 23, 709 hectares (58, 586 acres). One hundred and seventy agriculture plantations, covering 20,515 hectares, are in agriculture and livestock production. **Figure 2: Map of Plantations and Small Holdings by Farmers in Barbados[28]**

The Ministry of Agriculture and Food Security has registered active farmers in Barbados with additional unregistered inactive farmers who have scaled back production due to praedial larceny, age (average age of a

[27] Area Development Plan Task 1: Detailed Cadastral Survey of All Registered Plantations and Small Holder Concentrations. Town and Country Development 1999.
[28] Area Development Plan Task 1: Detailed Cadastral Survey of All Registered Plantations and Small Holder Concentrations. Town and Country Development 1999. The project area is located in South West area and North of the island.

Barbadian farmer is 50 years), conversion of agricultural land to more lucrative uses, and a lack of an enabling environment by Government. These farmers produce a wide variety of food crops and/or livestock on small holdings on 0.2 – 10 hectares. There are a considerable numbers of farmers who own no land but utilize abandoned or community land for grazing animals (sheep and cows) and farming crops. Current statistics from the Ministry of Agriculture and Food Security indicate that there are 1700 female farmers and 4800 male farmers in Barbados; this includes subsistence farmers and those who farm part of the year mainly during the rainy season. Fruit crops are also produced on a small scale from trees around dwelling houses or on non-crop land[29].

[30]The poultry industry is one of the largest and most successful aspects of the Barbadian agricultural sector and a significant contributor to the economy of Barbados. Approximately 50 million kilograms of chicken is produced and consumed in Barbados per year. The poultry industry produces other value-added components such as turkey and eggs. The Barbados Egg and Poultry Producers Organization estimated that there are approximately 1,800 persons working in the industry either as small independent growers, contract growers for large producers, or as staff in the slaughtering and preparation for market. This represents approximately 30 percent of the entire agricultural labor force in Barbados employed by the industry.

Many strategies are being used by the Government of Barbados to encourage farmers to re-tool, increase efficiency, adopt good agriculture practices and enhance ecosystem services beneficial for part of the agriculture incentive program[31]. Agriculture is deeply linked with nature and famers are usually stewards and beneficiaries of ecosystem services. “Ecological infrastructure” practices such as agroforestry, conservation tillage and water conservation are necessary activities that benefit the wider Barbadian community. Without incentives, most farmers eschew the time and money required to adopt new techniques to sustain agricultural production and adopt climate smart agricultural technologies. Current efforts are ongoing to restructure the extension system at the Ministry of Agriculture and Food Security and the Barbados Agriculture Development and Marketing Cooperation to assist farmers and enhance dissemination of improved technologies. The Barbados Ministry of Agriculture and Food Security Agriculture Incentives Programme and Upfront Concessions include: rodent control, irrigation, cultivation services, farm security, new crop technology, spraying equipment and fruit tree establishment.

The Barbados Government is working to enhance water solutions for the farmers through the Farmers Empowerment and Enfranchisement Drive (FEED) programme. In 2018, the Ministry of Agriculture and Food Security embarked on the Farmers’ Empowerment and Enfranchisement Drive (FEED) programme as part of Government’s effort to save foreign exchange through a reduction in agricultural imports and to ensure national food and nutrition security. The Barbados Agricultural Development and Marketing Corporation (BADMC) is responsible for the planning, implementation and management of the FEED. The 2019 *Revised Policy Framework for* FEED, stated that at June, 2018, there were 1,634 acres of land in the BADMC land bank, 1,165 acres of which were leased to farmers. These lands are available in different parishes of Barbados namely Bath (St. John), Bawden (St. Andrew), Fairy Valley (Christ Church), Graeme Hall (Christ Church), Hope (St. Lucy), Mount Poyer (St. Lucy) and River (St. Phillip). The BADMC projected that 320 acres will be available for distribution under the FEED, 30 acres of which are at Bawdens St. Andrew in the Scotland District.

The Barbados Agriculture Development and Marketing Corporation (BADMC) will be expanding the irrigation networks in conjunction with the Barbados Water Authority to include pump houses and distribution piping at Wakefield, Spencers, Christ Church; Bath, St John and St Lucy’s Mount Poyer and Spring Hall estates. The cost of this water works will be USD 2.3 million, and the money will be provided to the BADMC who will contract the Barbados Water Authority for the benefit of those farmers. As part of Barbados’ debt for climate swap with the Inter- American Development Bank, the Green Climate Fund and the European Investment Bank, the Water Infrastructure for Food Security at River in St Philip will be one of the key climate adaptation measures[32].

[29] Area Development Plan Task 7: Evaluation of the Future of the Small Farmer in Barbados Agriculture and the Development of a System of Classification to assist Land Use Planning. Town and Country Development 1999.
[30] Barbados Egg and Poultry Producers Association – Report on the State of Poultry in Barbados 2018.
[31] Barbados Ministry of Agriculture and Food Security Agriculture Incentives Programme and Upfront Concessions.
[32] Barbados Today E Paper 19th March 2024.

Impact of Water Scarcity on Farming

Drought in Barbados is impacting the agricultural sector as there is less water penetrating the soils to the underground aquifers and in the event of flash flooding the majority of this water runs off into the sea due to Barbados' topography and soil type. Information obtained from the Caribbean Institute for Meteorology and Hydrology for 2019 indicates that Barbados' annual rainfall level in 2019 was only 60 percent of the mean average. Water prohibition was instituted by the BWA each year from 2010 -2022 with each year's prohibition for a longer period. In October – March 2010, Barbados experienced its' lowest ever rainfall since record keeping began in 1942. The rain has been falling, however not enough to adequately replenish the underground water sources following years of drought and the dry spells and this has left water demand outstripping supply for both drinking and irrigation. For agriculture, animal farmers are permitted to use hand held hoses and pressure washers (less than 3 gallons/0.003 cubic meters per minute) to wash the surroundings where animals are kept. Crop farmers however, have to find another source of water and drought will result in reduced crop production. It will be imperative to maximize the harvesting of rain water in ponds, reservoirs and other water catchments from the wet season, to make it available for use during the dry months.

Agricultural activities in Barbados are limited by the availability and price of water for irrigation. The utilization of domestic potable water for farming is prohibitively expensive for small farmers, who are then extremely reliant on rainfall to water their crops. Agricultural productivity is at risk from prolonged drought conditions, which cause increased difficulty in managing the six-week cash crops (cucumbers, melons, squash) popular with farmers. The dairy industry in Barbados has dwindled from 39 dairy farmers in 2014, to only about 16 in 2019. There has been a drop in milk production on farms because of the lack of forage. The production of goat milk on the island has been similarly affected. The interior of a chicken pen should be maintained at 25^0C or less to ensure that heat stress does not kill chicken prematurely. The majority of small chicken farmers in Barbados have pens with galvanize roofs which can reach up to 42^0C when exposed to high solar radiation leading to high temperatures inside. This causes chickens to drink more water and increases costs as chickens drink potable water. As heat waves have been experienced in Barbados over 2016 - 2020 many farmers lost a 20-30 percent of chicks devastating those solely dependent on farming for livelihood and food security.

Analysis of the Barbadian Fresh Fruit and Vegetable Sector

Barbados is a food scarce country with high levels of net food imports and minimal days of on-island supplies. The amount of agricultural land has declined and coupled with the challenges of climate changes and climate variability the sector faces an existential threat[33]. In 2018 and 2019, over 50% of Barbados' food imports were comprised of vegetables, fruits, root crops all of which can be grown locally. Barbados could achieve significant reductions in the food import bill and consequent foreign exchange savings by substituting local products. Domestically produced fruit are cheaper and climate-friendly.

Citrus Greening is one of the most serious citrus plant diseases in the world and it has killed many citrus trees in Barbados. Importing and planting new disease resistant citrus varieties[34] would create a local source of this product. Insight in trends that are observable today show an exploding demand for these fruit and what must be changed today to unlock superior value for buyers in the future. IICA noted that Barbados is in a unique position to be able to develop its honey industry based on the production of authentic natural honey and its byproducts, using hives that allow the bees to feed naturally throughout the year and offer this to product to the market as a substitute for imports.

The major tropical fruits that are imported into Barbados are: bananas, plantains, citrus (oranges, limes, lemons and grapefruit) and avocados. Many of these fruits are already being produced in Barbados on a very small scale and expansion can be accommodated with the planting, care and management of fruit trees. According to the

[33] Barbados Physical Development Plan Amended (2017) Strategic Policies: Island-wide strategic policies that have been organized into the policy areas of: Promoting Sustainable Development, Protecting Core Assets, Greening the Economy, Advancing Mobility and Accessibility and Planning for National Infrastructure.

[34] Certified citrus greening disease resistant budwood is available from California certified budwood program in Lindcove, California. Both seeds and budwood from the following two main sources: Lyn Citrus Seeds Inc, 100 eyes per cultivars. The Riverside repository (Robert R Krueger, Horticulturist & Curator, USDA-ARS National Clonal Germplasm Repository for Citrus & Dates) supplies three budsticks per cultivar free of cost and also a small quantity of seeds for rootstock.

Barbados Statistical Service, Barbados imported 2, 414 173 kg of citrus valued 5,996,326 BDS in 2018, in 2019, 2 801 517 kg valued at 6,203,581 BDS, in 2020 3,102, 820 kg valued 6.433, 776 BDS and 2,184,713 kg were imported up to September 2021 valued at 5,069, 003 BDS . The citrus comprised of oranges, grapefruit, lemons, limes, tangerines, mandarins and other citrus varieties; oranges make up 50% of the citrus imports.

Fresh Agricultural Produce Imports versus Domestic Agriculture Production

An analysis of Barbados fresh fruit and vegetable production over the period 2016 -2019 was undertaken utilizing agricultural statistics on domestic vegetable production provided by the Ministry of Agriculture and Food Security, Planning and Communications Unit. For comparative purposes and to determine the space in the market, an analysis of the fresh and chilled tropical fruit and vegetable imports was undertaken utilizing statistics provided by the Barbados Statistical Service over the period 2016 – September 2021.

In the period under review 2016 – 2021, the following seven agricultural commodities: bananas, cabbages, carrots, onions, lettuce, plantains and sweet peppers consistently had the highest imported net mass and the highest imported value. Bananas had the highest imported mass ranging from 3, 109 metric tonnes in 2016 to 1,364 metric tonnes in 2021. The most valuable crop per kilogram over the years was sweet peppers with an average cost of 4.5 BDS per kg. Onions were the second largest crop imported in terms of net mass. In 2019, 3,777 metric tonnes of avocados were imported at a value of 2.66 million BDS in that year this amount surpassed the volume of bananas and plantains combined. In 2016 -2019, sweet potatoes were the largest agriculture commodity with greater than 1000 metric tonnes being produced each year and 2000 metric tonnes in 2019. The second largest crop produced was chives with 900 metric tonnes being grown yearly. Cucumbers were the third largest crop consistently produced with up to 9550 metric tonnes being produced yearly. The ground provision, cassava had an average yearly production of 530 metric tonnes. In 2019, the largest papaya production of the four year period was recorded with 1281 metric tonnes being grown in Barbados.

Difference between Imports and Domestic Production

The 2019/2020 production of vegetables and root crops in Barbados is approximately 16,000 tonnes of vegetables and root crops annually from about 5,000 acres of such crops which are mainly rain fed with about 10 % being supplemented with irrigation. At the same time, Barbados imports about 5,000 tonnes of the same crops annually. Production of the root crops yams, eddoes, and sweet potatoes which are an integral part of the crop rotation with sugar cane are being planted less as the sugar cane industry is becoming smaller each year. From 2016 -2021, avocados, bananas, cabbages, lemons, limes and onions represent the crops that had the highest value overall and the largest difference between local and domestic production. Christophene, cauliflower, lemons and limes and avocados were five crops that there was very low or no domestic production and a large amount of importation to meet customer demand. Though lower in monetary value than the previously mentioned crops, the demand for mangoes, passion fruit and soursop increased steadily over the period 2016 -2021 with increased amounts being imported into Barbados.

Barbados could achieve significant reductions in the food import bill and consequent foreign exchange savings by substituting local products. Increasing value added agricultural activities on the island would help to reduce imports as well as support a competitive and economically viable agriculture sector where youth, women and persons who have been retrenched due to the economic austerity program BERT[35] in 2018/2019 can find entrepreneurial employment to meet their subsistence needs. Many of the vegetables imported into Barbados are also grown in Barbados but at low levels that are insufficient to satisfy local demand thereby necessitating imports. These vegetables are: cabbage, carrots, onions, pumpkins, sweet peppers and tomatoes.

Impacts of Climate Change on Food Production

A climate change scenario based on the ECHAM5 climate model[36] predicts the future temperature and rainfall changes for Barbados with an increase in unpredictability of rainfall, warmer temperatures, and an increase in the severity and frequency of extreme weather events. These changes are expected to decrease agricultural

[35] Barbados has embarked on a comprehensive Economic Recovery and Transformation (BERT) plan aimed at restoring fiscal and debt sustainability, addressing falling reserves, and increasing growth. The program seeks to protect vulnerable groups through strengthened social safety nets. One thousand public servants were retrenched in 2019 and 400 more expected to be severed in 2020 in Stage 3 of BERT.

[36] http://clearinghouse.caribbeanclimate.bz/?db_type=Climate%20Model&country=23&collection=V501&s=&sector=&topic=

productivity by 10 percent to 20 percent over the next 40 years. Many Barbadian farmers may find it particularly difficult to cope with such climate-related hazards, as they do not have the capital to invest in new adaptive practices with which to protect their homes and families. Especially sensitive to climatic changes are those households that rely almost entirely on rain-fed agriculture for their livelihoods.

Implementing and adapting to mitigate the effects caused by climate variability are urgently required. This can be achieved by adopting climate smart agriculture system which includes growing resilient varieties of crops which can withstand high temperature and precipitation, organic farming in order to promote yield of crops in extreme environments in a holistic and a sustainable way; use of organic mulch, compost manures and biopesticides will result in decreased reliance on chemical fertilizers and pesticides. This will result in reduced emission of GHG and decrease in levels of soil, water and air pollution. Also, change in crop cultivars, sowing time and cultivation techniques (such as mixed cropping systems) to provide greater durability to crops in extreme events. Healthy local foods should be affordable and easily accessible in communities across the island.

Plant Tissue Culture

Crop productivity must be resilient to climate change. Plant tissue culture techniques can be utilized to create tolerance to disease and stress, increase growth, and raise plant yields. Producing superior material for planting and creating new, elite varieties of different kinds of crops in response to changing climatic conditions are some of its advantages. The plants are free from diseases and pests and hundreds of plants can be produced in a jar, thus, it requires less space and energy. Tissues of the plants are required for the regeneration of whole plants therefore there is no loss of hundreds of mother plants and the technique poses a sustainable mass production approach. Tissue culture also reduces the overall time it takes for plants to mature. Additionally, the plants can be produced irrespective of their seasons. Tissue culture can be used enhance the quality and quantity of fruits and vegetables and their nutritional value.

The Ministry of Agriculture and Food Security Plant Tissue Culture Laboratory (PTCL) plays an integral role in plant propagation and in vitro multiplication of food crops to strengthen Barbados' food security. The MAFS was mandated to expand PTCL's portfolio to include the production of disease-free planting material for root crops, especially sweet potatoes and cassavas. The Ministry was also mandated to create a seed bank of genetic material to replace crops destroyed by a major event. The PTCL engages in the medium and long-term conservation of Barbadian heirloom plant germplasm in in vitro gene banks for future use in the event of natural disaster. There is replacement material in case of destroyed orchards and fields of vegetatively propagated species and varieties; new plantations using healthy plantlets (e.g., plantain, sweet potato, yam). The MAFS currently maintains some indigenous seeds, most notably West Indies Sea Island (WISI) cotton, "local" cucumber, pumpkin, finger squash, pigeon peas. CARDI (Barbados) maintains hot peppers, table squash and corn. Local farmers also retain seeds from papaya, rouncifers, bonaviste and pigeon peas. However, there is a need to maintain twenty (20) productive open pollinated and heirloom seeds from major crops including tomato, sweet pepper, bean, okra, lettuce, cabbage, butternut squash, and watermelon. The PTCL is already a champion for the micro propagation of root crops. With Barbados' thrust towards greater food security and reducing food imports, and mitigating adverse climate impacts, the PTCL requires an expansion of its capacity.

Despite measures taken to improve the status of the PTCL over the last four years, major infrastructural modifications are still needed in order to reach international standards. The existing laboratory is dated but functional, and to achieve the overall objectives of the Accelerated Growth Enhancement (AGE) programme, a larger facility is essential. The PTCL has a mandate to research and effect advanced propagation systems for the production of disease-free root crops towards food security and food sovereignty. These methods are taught to farmers and agriculture students from the Barbados Community College (BCC), Samuel Jackman Prescod Institute of Technology (SJPI) and University of the West Indies (UWI). In 2022, twenty coconut farmers received 100 coconut seedlings from CARDI Barbados. These seedlings were produced at the CARDI nursery under the EU/CARIFORUM financed project - Alliances for Coconut Industry Development, Expansion and Enhanced Support for the Caribbean. Farmers received a mix of dwarf and tall varieties. This initiative is expected to boost farmers production and assist in addressing the shortage of planting material on the island. Farmers were also encouraged to supply CARDI with seed nuts from these trees - a move towards the creation of a sustainable

production model for quality planting material. Information products on coconut farm management, intercropping, Red Palm Mite and Coconut Mite were also provided to farmers[37].

Project/Programme Objectives:

The stress on water resources is the largest climate change factor that will impact Barbados. With an overall reduction in rainfall, the ground water recharge and freshwater availability will be negatively impacted. This, combined with extreme events such as storms and hurricanes, is predicted to result in storm water runoff and salt water intrusion in aquifers and a loss in fresh water. The adaptation of storm water is essential for Barbados to minimize its vulnerability. The social and economic benefits of improving storm water management include contributions to groundwater augmentation and alleviation of water scarcity; assisting the agriculture sector with water which can support growing more food, reduction in the severity and frequency of flooding which can damage property, infrastructure and public health concerns of mosquito breeding in water left standing over days and spreading diseases like leptospirosis. Sustainable water management is central to building the resilience of Barbadian society and ecosystems and to reducing carbon emissions. Growing demand for water increases the need for energy-intensive water pumping, transportation, and treatment, and financing for water resource management. Sustainable, affordable and scalable water solutions include:

- Harvesting rainwater and storm water - rainwater capture is particularly useful in Barbados which experiences uneven rainfall distribution to build resilience to shocks and ensure supplies for dry periods; Techniques include surface ponds to slow run-off to reduce soil erosion and be tapped for irrigation.
- Wastewater management strategies using reclaimed water[38] are a critical component to help mitigate the impacts of climate change on water scarcity.
- Adopting climate-smart agriculture - using tissue culture to increase crop production with new drought-tolerant plant varieties; drip irrigation
- Water conservation by utilizing water saving devices in educational institutions which have consistently high daily traffic

In the agriculture sector, the project is intended to directly and indirectly reach farmers throughout Barbados (5400 active farmers, 3000 inactive farmers) over four years. The project beneficiaries incomes and livelihood security are expected to impact a farm family population of 16 200[39]. The project is well placed to impact the lives of households at risk from climate change, food insecurity and who are poorest and utilizing farming for subsistence. In addition, the entire Barbadian population is in line to benefit from the increased availability of healthy locally grown fresh fruits and vegetables that can be incorporated into their diets and provide options for the many Barbadians suffering with obesity[40].

In the education sector the project is intended to contribute to the reduction of water wastage and leakage on school compounds as well as increase the knowledge of youth about the importance of water conservation, the impacts of climate change in Barbados and the links to water scarcity and drought. The Barbadian education system caters to 45,623 students enrolled in 106 schools (nursery, primary, secondary and special). [41]Much of the school plant physical infrastructure requires upgrades to make it climate resilient and water conservation through water saving devices would contribute to this since school facilities are used intensively for the most of the year. The schools with the highest current water usage are to be targeted in this project where water audits are to be conducted to establish a baseline, identify sources of water leakage, inefficiencies in the plumbing systems, types of plumbing fixtures and fittings and provide “best-fit” water saving device options.

Through its main components and multiple outputs, the project covers several elements designed to boost adaptive capacity of vegetable and livestock farmers but also of other key actors such as extension officers

[37] https://www.facebook.com/CARDIcaribbean/posts/-barbados-20-lead-and-secondary-ring-coconut-farmers-have-received-100-coconut-s/2377571465724004/
[38] Reclaimed water is wastewater that has been treated to tertiary levels so that it can be beneficially reused for non-potable sources, such as irrigation in agriculture, landscaping, turf maintenance.
[39] Assuming a farm family comprised of three individuals
[40] NCDs are responsible for eight out of 10 deaths in Barbados, with approximately 66% of the population being either overweight or obese. A projected 39% of the population will be living with obesity, with an economic burden of 4.6% of national GDP by 2035, according to the World Obesity Atlas 2023. The current percentage of overweight or obesity in children is 31%. https://www.hsfbarbados.org/world-health-day-2023-presidents-message/
[41] Reimagining Education in Barbados- A Bright Future for Every Child Ministry of Education and Vocational Training October 2023

involved in the agriculture value chain. In building resilience in Barbados, increasing the efficiency of drinking water use in the education sector would boost water conservation efforts, island wide. Among the elements of adaptive capacity considered, particular mention should be made of those relating to human capital, the protection of the basis of agricultural production, saving financial resources related to water use and water conservation.

In order to achieve the project goal, the project has three main complementary outcomes:

Outcome 1: Reduced exposure and increased adaptive capacity of farming communities to water scarcity and drought-related risks and hazards

Outcome 2: Water conservation awareness integrated into schools, markets and education management to support climate adaptation needs

Outcome 3: Strengthened knowledge systems that build resilience to climate impacts

Component 1: Strengthened ability of Barbadian farming communities to undertake concrete actions to adapt to water scarcity and drought

The Spring Hall Land Lease (SHLLP) project originally started as a land settlement project circa 1980 on 407 acres with provision for irrigating only about 36 hectares (88 acres) of mainly crop/vegetable farming, with a dairy farm. Plot sizes average about 3 hectares and range from about half hectare to about 9 hectares, with one dairy/crop farmer allocated 27 hectares. The SHLLP has experienced water issues from inception with an inadequate irrigation water supply for the dry season and flooding during the rainy season. The BADMC implements strict water rationing/scheduling, particularly during the dry season when they experience critically low water levels in the two wells, sometimes having to cease pumping. The last significant flooding event at the SHLLP was in November 2019[42]. Both the flooding and the drought extremes lead to farmers losing crops and income. All of the farms are provided with water meters to monitor water use.

Limited irrigation can significantly impact the crop farmers' ability to effectively utilize their lands leased to them by the Barbados Agricultural Development and Management Corporation (BADMC), especially during the dryer months from January to May. Many farmers are forced to depend on "rain fed" irrigation during the higher rainfall months. Barbados can only supply a limited amount of water from the potable water distribution system for irrigation of small scale farming.

Figure 3: Potential Pond Site at Spring Hall[41]

To satisfy the irrigation demand, the BADMC initiated investigations[43] into the construction of ponds at Spring Hall/Chance Hall, St. Lucy for the storage of rainwater runoff for irrigation; excess runoff can be stored during the high rainfall months (August – November) to sustain irrigation during the five dryer months (January – May). A study was undertaken to determine the feasibility of harvesting rainwater runoff from the watersheds at Spring Hall/Chance Hall to provide adequate storage in ponds for sustainable irrigation during the months of January to May of existing and proposed farms in the environs of Spring Hall/Chance Hall.

The storm water runoff from the watersheds at Spring Hall (watershed A) and Chance Hall (watershed B), flows in separate natural watercourses formed in the landscape and converge at a point the River Bay outlet to the sea. The configuration of each watercourse offers the opportunity to locate storage ponds on the Spring Hall Watercourse (pond P1), the Chance Hall Watercourse (pond P2) or at the point (pond P3) where the two watercourses converge into a single channel that flows into River Bay. The pond sites were assessed to determine their suitability and capacity for storage of runoff.

[42] https://cccccbze-my.sharepoint.com/:v:/g/personal/cdurant_caribbeanclimate_bz/EcbdKhoG5mhMhCn0ja74i6oBTi9S896vKukdgcz6fjRKpQ?e=IhhfAf

[43] **Assessment of Rainwater Harvesting Ponds for Irrigation at Spring Hall/Chance Hall, St. Lucy** Hydrological Study of proposed Irrigation Ponds at Spring Hall/Chance Hall, St. Lucy July 29, 2022 **Prepared for:** Barbados Agricultural, Development & Marketing Corporation (BADMC) Fairy Valley, Christ Church, Barbados **Prepared by:** Stantec Consulting Caribbean Ltd, Black Rock, St. Michael, Barbados

The “Irrigation Water Requirements Model” was used to assess the land area that can be maintained with sustainable irrigation[44]. Based on investigations and the model analysis undertaken, the rainfall runoff from the Spring Hall and Chance Hall is more than adequate to fill the ponds at Spring Hall and/or Chance Hall in a single wet season and refill the ponds annually in the wet season following irrigation through the dry season. The study area offers the option of carrying out a phased development that may start with the construction of the Spring Hall Pond (P1) with a watershed of 329 hectares (812 acres) and later adding other ponds later. The decision on the capacity of the ponds required can be determined after due consideration of the area of land available for farming in the environs of Spring Hall and Chance Hall.

Outputs 1.1: Increased volumes of water retained for irrigation via a storm water pond

Activity 1.1.1: Construct storm water pond to provide irrigation water on farms

Activity 1.1.2: Install a solar powered pump system to enable distribution of water for irrigation on farms

Activity 1.1.3: Provide training for technical capacity building in hydrology and irrigation management through engagement of experts

Output 1.2: Climate-resilient irrigation system developed

Activity 1.2.1: Install an irrigation system from the storm water pond to farms in the vicinity

Activity 1.2.2: Conduct training with and provide technical support to farmers related to efficient water use

Output 1.3: Chemical and biological profiling of reclaimed water for irrigation

Activity 1.3.1: Conduct water quality testing of water from different sources (e.g. livestock farms, water treatment plants) to determine suitability for use in irrigation

Activity 1.3.2: Develop an atlas identifying water sources and volumes that can be safely tapped for irrigation

Component 2: Strengthened support for Barbadian farming communtities with tools and materials to mitigate climate change-driven hazards

Barbadian farming communities require adaptation solutions and the implementation of actions to respond to current and future climate change impacts. Adaptation actions include building storm water ponds, planting drought-resistant crops, redesigning irrigation systems and supportive government policies. Successful adaptation depends on governments and active and sustained engagement of stakeholders, including farmers, local communities, public and private sectors, civil society and an effective management of knowledge. Barbados’ adaptation actions follow a country-driven, gender-responsive, participatory and fully transparent approach, considering vulnerable groups, communities and ecosystems. It is based on and guided by the best available science and local knowledge systems, with a view to integrating adaptation into socioeconomic and environmental policies and actions.

As part of the new growth and development strategy for the agricultural sector, the Ministry of Agriculture and Food Security is seeking to reposition the HOME agricultural station as the plant germplasm repository for agricultural crops. The future operations of the HOME will be comprised of the following: Tissue Culture Facility (tissue culture laboratory, greenhouse nursery, field nursery, seed bank and the Barbados Innovation Centre for Agriculture (BICA)

The objective of the tissue culture facility is to multiply commodities of national interest to provide clean (pathogen-free) planting material for demand driven crops. These crops include: sweet potato, Sugar cane, yam, cassava, plantain, banana, papaya, major tree crops (citrus, breadfruit, avocado). To support the new thrust to increase agricultural exports, sweet potato will be major crop to be produced by the tissue culture lab. A maximum annual target of 70 million kilograms has been set to supply both export and local demand. Barbados

[44] The model incorporates the monthly assessment of the evapotranspiration rate, the net irrigation required to replace soil moisture lost through evapotranspiration, the net runoff to storage in the pond and evaporation from the pond. The model performs a monthly audit for different annual rainfall precipitation levels that informs the storage capacity of the pond required to sustain an irrigation area; it allows for the determination of the land area that can be irrigated for a selected pond volume – under various annual precipitation levels. Alternatively, the model can be used for the determination of the pond capacity required - given the runoff characteristics of the watersheds - for the specific land area selected for irrigation

current total yield of 14 000 kilograms is grown on 5,200 acres once yearly and on 1,733 acres grown three times yearly. Structuring the tissue culture supply of sweet potato for private or public agencies engaged in commercial production on a permanent, self-sufficient basis, is essential to follow a continuing program for developing and maintaining superior stocks.

Sweet Potato Tissue Culture

Sweet potato is a staple food in Barbados and is grown all year round; irrigation is a limiting factor to its production, particularly in the dry season. Most sweet potatoes are rainfed and plantations are the largest growers; under ideal rainfall conditions, farmers can have maximum of three plantings per year in the following configuration: 50% May – July (rainfed, irrigated) utilizing 7.65 – 10.30 million cuttings; 35% Sept – Dec (rainfed, irrigated) utilizing 5.36 – 7.21 million cuttings; 15% Jan – Mar (irrigated) utilizing 2.30 – 3.09 million cuttings.

Production of sweet potato plants begins with the plant breeder's tissue culture plantlets called "Generation 0". After plants are cultured, they are typically grown out in a greenhouse setting. Cuttings from these plants (now Generation 1) are then planted to produce what's known as "foundation seed." Registered Seed (sweet potato tubers) are produced directly from the foundation seed by selected growers. Certified Seed stocks are Generation 2 plants produced either from the foundation seed roots (sweet potato tubers) or directly from registered stocks. Generation 2 plants can be provided as cuttings or grown for Generation 2 certified seed, which can be purchased the following year as Certified Seed. Certified seed must be no further than two successive steps from the Foundation Seed. Growers can propagate their own cuttings using Generation 2 Certified Seed or by saving seed from their previous crops, which is often considered Generation 3 or 4.

Currently Breeder's Seed maintained at the HOME station are grown out into Foundation Seed and transferred to an open field nursery at the Central Agronomic Research Station where Certified Seed are provided as cuttings free of charge to farmers. The Ministry of Agriculture and Food Security HOME Agriculture Station recommended that a Registered Seed stock system be employed to encourage a new entrepreneurial stream of growers who would provide cuttings for purchase to farmers. It also recommended that to maintain high yields (vigor and quality in the seed stock) grower's seed stock be replenished with Generation 2 Certified Seed annually, given the level of "disease pressure".

Tissue culture for longer growing woody plants has a distinct advantage in being able to generate tree crops in a faster time than traditional propagation methods. Micro-propagation can cut 3 to 10 years off the time it takes to bulk-up new plant selections and get them to market. Therefore, generating trees from tissue culture has a greater time and opportunity cost that makes it economically viable. For short crops, the benefit is not in time but in the quality material produced. Thus, to reduce the unit cost of production and increase revenue, maximizing output through a rapid multiplication system is needed. In the small tree category, citrus trees, avocados and soursops are the highly sought after by Barbadians with avocados being the most valuable per kilogram. With a recommended spacing of 12ft, a one acre orchard would hold 300 trees. Depending on the variety, an avocado tree can yield between 230-320 kg and grafted trees start bearing after 3-4 years after planting. Rainfed avocado production depends on the amount and distribution of annual rainfall, however if drought occurs during flowering and fruit set it may also lead to smaller fruit size and quality.

Given the time and cost to generate clean vegetable planting material from tissue culture, the new innovations in generating clean planting material from sweet potato is in the rapid multiplication system. The innovation emphasis has focused on being able to:

1. Keep sweet potato plants free of pests and diseases in greenhouse nurseries as long as possible;
2. Decrease the time to produce plants in the greenhouse by using methods such as single node propagation and rooting powders;
3. Increase the production of plants in greenhouse nurseries by growing them vertically to generate more growing tips.
4. Increase the number of plants in the greenhouse or field nurseries by growing at close plant spacings;

14,000 plantlets can adequately meet Barbados' maximum sweet potato planting targets projection of demand

for other tissue culture crops, a similar capacity of around 16,000 plantlets would be adequate to service Barbados' future tissue culture needs. A tissue culture laboratory with a growth room capacity of a minimum of 30,000 plantlets is needed. Four (4) 3,000 sq. ft. greenhouse nurseries are needed for sweet potato cuttings. An additional four (4) 3,000 sq. ft. greenhouse nurseries will be needed to propagate the other row crops.

With Barbados having all year round warm climate, there is no winter season to break pest and disease cycles. Therefore, the field nursery at the HOME requires protection by full insect proof netted structures or plants should be grown in rows under row covers (knitted plastic). It will need to have a suitable crop rotation programme to reduce risk of soil pathogen and pest build-up. The HOME is seventeen (17) acres, and as such the size of the field nursery will be limited by this space. Secondary field nurseries, preferably operated by private Registered Seed growers, should be set up to ensure rapid multiplication of planting materials

Outputs

Output 2.1: Tissue culture laboratory and growth room capacity enhanced to support agriculture industry transformation

Activity 2.1.1: Supply laboratory and field instruments and upgrade laboratory facility to maximize throughput

Output 2.2: Greenhouse nursery established for the propagation of row crops

Activity 2.2.1: Construct a greenhouse nursery to support the propagation of sweet potatoes

Output 2.3: Field nursery established for rapid multiplication of planting materials

Activity 2.3.1: Construct a field nursery to support the multiplication of tissue culture materials

Component 3: Strengthened Institutional capacity for water conservation

The Barbados Water Authority (BWA) is the entity in Barbados charged with supplying the island with potable water as well as the provision of wastewater treatment and disposal services to the sewered areas of Bridgetown and the South Coast. The BWA actively promotes water conservation with tips and public information programs. [45]In 2024, it was announced that the Barbados Water Authority (BWA) will be granted about 1.5 million Barbados Dollars to provide the devices to about 1,200 vulnerable groups and "high-usage Government departments." The Barbados Green Paper 2020 on the Water Protection and Land Use Zoning Policy (Draft) proposes a new integrated approach for the protection of all of the island's water resources, including coastal waters. It also speaks to helping with installing water saving devices.

It is important to make sure that water which the BWA has supplied at a cost is not being wasted. Water leak detection in educational institutions can lead to money being saved in the long term. From an environmental and climate adaptation standpoint water conservation is essential because Barbados' freshwater supplies are under pressure as requirements for water have drastically increased. Droughts are occurring in Barbados and the rainfall needed each year to replenish the aquifers is declining. Conserving Barbados' water supply through water leak detection is a climate smart activity.

Water Leaks

One of the consequences of not addressing water leaks early is that it can be expensive if infrastructure is damaged as a limited amount of damage can grow to a great deal more if undetected. For example, a leak in the ground or breaks in water mains can cause significant damage to the foundation of a building, increase moisture within the structure and encourage the growth of mold and other infestations. The establishment and implementation of a maintenance plan can help to mitigate the possibility of this happening. One significant benefit that Barbadian communities get from water leak detection is that the maximum benefit from the water supply system is achieved. Water leak detection conserves water and contributes to a reliable water supply and ensures there is enough drinking water and water for businesses and industries.

Water Saving Devices

Water leaks can waste significant water over time and having a maintenance plan to regularly check toilets, taps,

[45] https://nationnews.com/2024/03/19/pm-pushing-water-saving-devices/#

showers, and any other plumbing fixtures and fittings so they can be repaired quickly prevents waste. Replacing traditional taps and showers with water-saving versions can significantly reduce school water usage[46]. For example, fitting push button taps and showers will shut the water flow after a certain time and utilizing low-flow shower heads. Toilets are one of the biggest uses of water in schools, so fitting water-saving devices such as water displacement devices inside cisterns and dual-flush or low-flow models save water. Urinals are an excellent water-saving alternative to toilets, but understanding the type of flushing and their timings can save even more with urinal sensors or push-button flush urinals. Rainwater harvesting systems can be an excellent way to save water for school gardens and reduce the school's carbon footprint. Educating school users/other key stakeholders to ensure proper use of these water saving devices and keeping maintenance costs to a minimum is an important project activity to be executed.

Water Education

The BWA currently has a Water Conservation Program[47], where primary schools, community groups and other organizations are taught about water conservation and educational visits to water pumping stations are hosted. Water education is crucial for mitigating climate change impacts in Barbados. It encourages environmental stewardship, appreciation of water resources, and can sensitize youth on opportunities for future careers. A collaboration with the Ministry of Education, Technical and Vocational Training in this area to support the integration into regular school criteria is envisaged.

Education supports effective and sustained water conservation practices and by ensuring that all ages are aware of the importance of water conservation and establishes conservation norms. Water education promotes understanding resource and equips students with knowledge about the water-related challenges Barbados' faces. By learning about the importance of water, youth can become advocates for reducing water pollution, protecting coast lines, and preserving swamps and ponds for aquatic life. Youth who learn about Barbados' water sources and how water is treated and distributed develop a deeper understanding of the value of water. With climate change exacerbating water scarcity in Barbados, it is necessary for students to learn about drought. By understanding these concepts, youth can become advocates for water conservation and find ways to use water more efficiently.

Output 3.1: Water conservation methods implemented at education institutions and fish markets

Activity 3.1.1: Conduct a full water audit of selected schools and fish markets to help identify every area of water consumption and where water can be saved.

Activity 3.1.2: Create and execute a tailored plan for addressing water issues at each selected school and fish market based on water audit findings

Activity 3.1.3: Procure and install/ retrofit appropriate water saving devices across plumbing fixtures at selected schools and fish markers

Activity 3.1.4: Monitor and evaluate efficiency of the water saving devices through water bill assessment and physical school and fish market visits

Activity 3.1.5: Develop guidelines for saving and conserving water across schools and fish markets in consultation with the Ministry of Education, Technological and Vocational Training, Ministry of the Environment, Blue and Green Economy and Ministry of Agriculture and Food Security

Activity 3.1.6: Execute knowledge transfer and sensitization sessions with school users/other key stakeholders on proper use of water saving devices as a collaborative effort led by the Ministry of Education, Technological and Vocational Training and the Barbados Water Authority

[46] This objective has been defined as per the MSIDC Brief and critical to the Ministry's Preventative Maintenance Plan/Maintenance Schedule

[47] https://www.youtube.com/watch?v=A2oQr5VzsZ4 BWA Water Wednesdays

Project/Programme Components and Financing:

Project/Programme Components	Expected Concrete Outputs	Expected Outcomes	Amount (US$)
1. **Strengthened ability of Barbadian farming communities to undertake concrete actions to adapt to water scarcity and drought**	**1. Increased volumes of water retained for irrigation via a storm water pond** **2. Climate-resilient irrigation system developed** **3. Chemical and biological profiling of reclaimed water for irrigation**	Reduced exposure and increased adaptive capacity of farming communities to water scarcity and drought-related risks and hazards	**6, 350,000**
2. **Strengthened support for Barbadian farming communtities with tools and materials to mitigate climate change-driven hazards**	**1. Tissue culture laboratory and growth room capacity enhanced to support agriculture industry transformation** **2. Greenhouse nursery established for the propagation of row crops** 3. **Field nursery established for rapid multiplication of planting materials**	Strengthened knowledge systems that build agricultural resilience to climate impacts	**2, 000, 000**
3. **Strengthened Institutional capacity for water conservation**	**1. Water conservation methods implemented at education institutions and fish markets** **2. Greenhouse nursery established for the propagation of row crops** 3. **Field nursery established for rapid multiplication of planting materials**	Water conservation awareness integrated into schools and market system with education management to support climate adaptation needs	**300, 000**
. Project/Programme Execution cost			**500,000**
Total Project/Programme Cost			**10, 000,000**
8. Project/Programme Cycle Management Fee charged by the Implementing Entity (if applicable)			**850,000**
Amount of Financing Requested			**10, 000,000**

Projected Calendar:

Milestones	Expected Dates
Start of Project/Programme Implementation	**January 2025**
Mid-term Review (if planned)	**July 2025**
Project/Programme Closing	**Dec 2025**
Terminal Evaluation	**January 2026**

By strengthening the adaptive capacity of farmers this will pave the way towards vegetable production resilient to climate change. It targets small farmers and will benefit 5400 farmers directly, 16 200 people indirectly. The interventions of the project will directly benefit 407 acres of land under vegetable production in Barbados. The project will work with vulnerable farmers and adopt a gender-sensitive approach in order to improve the capacity of women, who are generally among the most vulnerable. Its value-add to society is avoided greenhouse gases emissions, education through capacity building and outreach activities needed to safeguard and guarantee water security in Barbados and bolster Barbados' resilience to climate change.

The project has a multidimensional and integrated approach (technical capacity-building, introduction of climate-resilient techniques, practices and technologies, and a knowledge management system) is likely to increase the viability of the sector and facilitate wider adoption of the interventions put in place. The project proposes some climate-smart agriculture practices and techniques (drip irrigation and improved drainage, tissue culture, and integrated pest management) to reduce the negative impacts of observed and anticipated adverse climate conditions on vegetable yield leading to an increase in revenues and improvement of the financial capacity of the farmers, putting them in a better position. The Barbados Meteorological Service implemented automated weather stations island wide which enhances capacity to generate and use reliable weather information in several types of early drought warning systems relevant to the vegetable farming.

The project envisaged an integration of vegetable production activities with livestock. The project will ensure that the capacities of service providers are strengthened in order to offer the vital services to the sector to contribute to a paradigm shift in the sector. Process-based crop models are designed to predict yields from the simulation of plant functioning according to endogenous plant properties and environmental conditions. In order to foster a real paradigm shift in the sector, the knowledge management system considers the introduction of extensive tissue culture propagation in the design of future adaptation measures. This can also contribute to strengthening national technical and institutional capacities, thereby ensuring a paradigm shift. Partners from the academic community could take part in such activities with a view to increasing the number of highly qualified personnel in the field.

Vegetable yield is highly climate dependent; high temperatures combined with more frequent and longer dry spells or intense rainfall leading to proliferation of pests are likely to considerably reduce the productivity. Small-scale farmers, including females, will be particularly affected, as their capacity to respond is relatively low. Funding will facilitate the implementation of interventions aimed at removing key barriers to the establishment of a climate-resilient vegetable production system. The project has identified the multiple needs (technical, institutional, regulatory and economic) of the key stakeholders and has envisaged a wide array of interventions to address them in a sustainable way. The availability, access, and utilization of water in the agriculture and education sectors as well as reducing greenhouse gas emissions and water provision are addressed in this project. It is an important increment in the suite of actions needed to safeguard and guarantee water security in Barbados and bolster resilience to climate change.

Describe how the project/programme provides economic, social and environmental benefits, with particular reference to the most vulnerable communities, and vulnerable groups within communities, including gender considerations. Describe how the project/programme will avoid or mitigate negative impacts, in compliance with the Environmental and Social Policy and Gender Policy of the Adaptation Fund.

This project will benefit small farming populations in Spring Hall as well as the entire farming community in Barbados. Attention will be given to males, females, youth and disabled through participatory approaches to interact with these groups in order to ensure equity and transparency. Males and females working in agriculture are among the poorest members of the overall Barbados labor force. Female farmers work unpaid on family farms and engage in subsistence agriculture.

Economic Benefits

The guaranteed economic benefits include improved incomes and employment generation from water security integrated with improved capacity to participate in the domestic market supply chain. The potential will also exist for an increase in crop production since water access throughout the year will be increased and with improved productivity from heathier soils. Benefits will include savings accrued by farmers who currently supplement their water needs with potable water from the BWA water at very high cost. Open-field farmers will also improve their incomes as they would now be able to add at least two crop cycles annually with water security and better drip irrigation that wastes less water during the seasonal dry months, as well as to satisfy water supply during unexpected dry spells.

Farmers indicate that cultivation services, are not provided on a sufficiently timely basis, resulting in the inability to meet the narrow window of opportunity for planting and eventual sale of crops. The demand for tractor cultivation services will increase in the wet season and once the irrigation water is made available. By providing these services on demand farmers will be able to maximize plot usage. The more efficient provision of services such as tractor cultivation, extension, hay making and hay, detection of praedial larceny, agrometeorology, mulching and practical training thereby increasing the quantity and quality of produce under the climatic conditions. Progressively, the farming households, will be able to raise the profitability of the farm as they gradually shift from practices such as high inputs of pesticides and herbicides to organically built soils using compost, mulch and other soil building production and utilization practice.

The vegetable and food crop market structure in Barbados is relatively simple because of its limited size. The market approaches perfect competition because there are no real monopolies and there are no barriers to entry by farmer producers/sellers. The majority of farmer producers/sellers are not organized and market their produce as individuals therefore end buyers/consumers who have a wide selection of accessible options. Typically, price variation is largest in the middle person/huckster/wholesaler segment which is complicated by additional linkages in the wholesale chain and depends on their dominance and market share. In most cases the farmer producer/seller is a price taker and not able to determine price. However, farmer producers benefit significantly price wise when they eliminate the wholesaler and market directly to the end user or consumer.

Public procurement rules stipulate that bids must be evaluated based on specific criteria, including the lowest price. Traditionally, price has been used as the main criterion for selecting food suppliers, especially against the backdrop of financial constraints. However, this presents one of the most important obstacles in implementing a sustainable local food procurement system in Barbados. Large Barbadian food importers and distributors enjoy economies of scale and are able to price products lower than smaller farms. Consequently, local farmers are often unable to compete effectively within the public food procurement process where the lowest price is still the main criterion.

The FEED Policy Document indicates that the agriculture sector provides more indirect and significant economic benefits than any other sector of the economy. Consequently, the procurement of locally produced vegetables, meats and food items offers an important opportunity for the Government of Barbados to leverage its purchasing power to support the domestic agriculture sector, enhance food and nutrition security, promote health and wellness, and facilitate economic development and job creation. Though information on the total quantity of fresh food needed by public institutions e.g. Barbados Defence Force, Prison, Children Homes, Hospitals, School Meals and Juvenile Detention Centers is unavailable, 6-10 thousand meals are served daily in these institutions therefore the amount is substantial. The public procurement of local agriculture produce to provide these meals would benefit the agriculture sector greatly.

The economic benefit of water security comes from farmers not using water from the public distribution system during the seasonal dry months. With 0.75 hectares of cucumbers a farmer can utilize approximately 210 cubic meters of water per week from the public potable water system (BWA) thereby reducing that amount available for human activities. If this water is irrigation water it costs less and takes the pressure off the potable water system. The BADMC charges 0.90 USD per cubic meter of water to farmers, whilst the BWA charges a tiered

residential or commercial rate depending on the amount of water utilized up to 3.89 USD per cubic meter. There is also the greater security of domestic market for the local produce with reliable water security, and expected foreign exchange savings from the expected reduction in the importation of vegetables and root crops.

Other economic benefits in the farming system will derive from some farmers re-starting farming activities in areas which had have been left fallow due to water shortages and current BADMC lease holders have the opportunity to expand their operation for additional sources of farm income. The project activities are not expected to create any harm or interruption to other farmer income generation and employment generation activities outside of the project area. With the high levels of poverty in some households, it is expected that the project will be well received and will be of benefit to the direct beneficiary farm households, plus generating employment for marginalized households with no access to land to farm. Also, due to the current high level of fresh food imports relative to estimated annual crop production, it is not expected that significant growth in numbers of the beneficiaries in the share of the domestic fresh food supply chains will disadvantage or displace farmers outside or inside the project area.

Social Benefits

The agriculture sector plays a key role in maintaining community cohesion, social stability and lessening CARICOM food insecurity. The sector makes important contributions to Caribbean economies including: generating foreign exchange, absorbing surplus labor, providing new economic opportunities through inputs for agro processing and sustaining the livelihoods of thousands of people, particularly in rural areas[48].

An Inter-American Development Bank commissioned report[49] noted that although agriculture has not been a major contributor to GDP or to employment, the sector continues to be important for the sustainable social and economic development of Barbados. Barbados' rural population benefits from job opportunities the sector provides, and agriculture also serves as an important source of inputs for the growing agro-processing industry, and for foreign exchange earnings. A study commissioned by the IICA Delegation in Barbados on Barbadian youth in agriculture notes that youth face several challenges including access to land, capital, technical expertise and mentorship[50].

Barbados mostly imports meat, dairy, and prepared food, but it also imports fresh fruits and vegetables. Local production is insufficient to fulfil the demand for food items and the country's small size also means that there are limited land resources. Issues of water scarcity also compound this problem. Roughly ninety percent of farmers in Barbados continue to operate holdings of 0.5 hectares or less and therefore face higher costs in the absence of economies of scale. Despite the difficulties faced, the Barbadian agriculture sector provides much opportunity for youth in several key areas ranging from primary production to value-added products and support services. There are positive signs that more young people are taking advantage of these opportunities in the traditional and non-traditional areas in agriculture both in primary production and along the value chain[51].

The project will support increased income generation, employment and improved livelihood security so that households of the project beneficiary farmers will have a higher standard of living. This project aims at strengthening the adaptive capacity of the vegetable production in a context of changing climate conditions characterized by hurricanes and storms leading to floods and drought periods. In addition to these adverse climate conditions, the financial viability and overall sustainability of the livelihood of farmers is greatly threatened by a number of barriers such as: the reluctance of farmers to switch to climate-resilient vegetable varieties because they might not be accepted by housewives; adopting climate-smart agronomic practices; knowledge deficiencies relating to irrigation and drainage, land preparation, use of organic mulches/ fertilizers.

Empowerment in farming communities through capacity building for organizational, ownership and responsibility-sharing in agriculture activities and infrastructure will increase social cohesiveness. Increased disposable

[48]Beckford, C & Rhiney, K. (2019). Globalization, Agriculture and Food in the Caribbean. United Kingdom: Palgrave MacMillan

[49]Shik, O, et al. (2016). Analysis of agricultural policies in Barbados. Inter-American Development Bank

[50] Zazula, N & Mayes, J. (2019). An Analysis of the State of the Barbadian Youth Farming and the Establishment of Youth Farming Engagement Tools. Inter-American Institute for Cooperation on Agriculture

[51] An analysis of local agribusiness trends: Promoting opportunities for young Barbadian Agripreneurs (2020) prepared by Jason Francis; IICA, Barbados Environmental Conservation Trust, Future Farmers

incomes through the reduced cost of agricultural inputs and the potential for increased yields with access to water will positively impact the beneficiary's household and the community where this money is spent in commerce. Enhanced education and awareness about climate resilience and the real benefits to farmers at grassroots level will help to generate sustainable and appropriate responses that can spread country wide through farmers' word- of- mouth. Improved household food and nutrition security where farmers not only consume some of the healthy food that they grow but are able to better support their families reduce the possibility of succumbing to lifestyle diseases like diabetes and hypertension which are at epidemic proportion in Barbados[52] and negatively impact economic productivity.

[53]The relationship between non-communicable diseases and climate change stems from the macro-economic processes that contribute to anthropogenic climate change—industrialization, urbanization and globalization—that also underpin lifestyle habits that have led to the increased prevalence of NCDs. Economic development has contributed to a change in Barbadian dietary habits, including the quantity and quality of food consumed and its nutritional value. Barbadian traditional dietary staples such as yams, sweet potatoes, cassava, coucou (cornmeal) paired with fresh caught fish has been supplanted by macaroni cheese and fried chicken. Land use patterns have changed to facilitate the agricultural landscapes needed to provide food for growing populations and meat intensive diets are associated with high methane emissions. Economic development has also changed the way Barbadian travel, eschewing healthier modes of transport like walking and cycling in favor of vehicular modes of transport that contribute to carbon emissions. Recognizing these connections is important as it brings attention to the compounding effect climate change and NCDs may have on population health.

Public procurement of locally produced food also provides an excellent opportunity for Government to promote and protect health, especially in light of widespread, chronic, nutrition-related illness such as obesity, diabetes and cardiovascular disease, through the provision of fresh, local foods to public institutions such as schools, children homes, hospitals and prisons. The intensive and participatory consultative process was undertaken in project development and design to ensure transparency. Stakeholder consultations were undertaken with farming populations both inside and outside the project areas and farming commodity groups nationwide, women in agriculture and representatives NGOs for disabled and "at risk" youth. None of the project activities carry any threat of social loss or disadvantages. Further activities such as gender data collection and gender capacity building of stakeholders of the Project will increase awareness around gender issues in the sector.

Environmental Benefits

The project activities will have positive impacts on the terrestrial ecosystems from reduced pollution of the land with agricultural chemicals, increased tree cover with the planting of trees, recycling of agricultural waste into compost, fertilizer and animal feed. Increased resilience in agricultural soils for soil water retention, structure and soil fertility and reduced carbon footprints by the adoption of renewable energy in agriculture and by the anticipated reduction in the need for fresh food imports, improved land drainage and improved conservation of storm water and rainwater. The project will improve water security for farm irrigation leading to a general positive impact for the economic and social development the project areas, against a broader backdrop of declining agriculture (production, employment and farmer participation), declining agricultural losses suffered due to extreme weather events.

A. Describe or provide an analysis of the cost-effectiveness of the proposed project/programme.

[52] There's Not Really Much Consideration Given to the Effect of the Climate on NCDs"—Exploration of Knowledge and Attitudes of Health Professionals on a Climate Change-NCD Connection in Barbados Int. J. Environ. Res. Public Health 2020, 17(1),

[53] There's Not Really Much Consideration Given to the Effect of the Climate on NCDs"—Exploration of Knowledge and Attitudes of Health Professionals on a Climate Change-NCD Connection in Barbados Int. J. Environ. Res. Public Health 2020, 17(1), 198; https://doi.org/10.3390/ijerph17010198

Barbados' agriculture sector is experiencing the effects of climate change and climate variability with intense rainfall events, farmland flooding, droughts, water scarcity, reduced crop yields and harvests accompanied by uncertainties in livelihood security for farmers. Climate model data indicates that rainfall intense dry seasons will gradually increase over the next century with the average dry season rainfall decreasing to 15.5 percent of the annual rainfall, a 39.2 percent reduction over the period. The reduced rainfall over the first five months of the year will have an impact on growth rates for annual crops and reduce the available growing season for short crops. These projected changes could adversely impact livelihood security, incomes and food security in rural communities, and more so for vulnerable households highly dependent on farming activities. The cost effectiveness of the project can be best judged on the expected results over the short, medium and long term as well as on the co-benefits of the climate adaptation practices, which the project will use.

Table 3: Barbados Agricultural Products that can be substituted to replace agricultural imports 2021

AGRICULTURAL PRODUCTS		IMPORTS (KG)	LANDED VALUE (USD)
1	Broccoli	1,288,447.00	4,337,948
2	Onion	1,540,233.00	798,662
3	Carrot	554,780.00	734,062
8	Lettuce	424,146.00	684,247
4	Cabbage	477,479.00	608,615
5	Sweet Pepper	252,336.00	673,723
6	Tomato	213,733.00	249,294
7	Watermelon	223,769.00	295,683
9	Pumpkin	122,863.00	149,258
10	Cauliflower	73,446.00	133,813
11	Celery	189,957.00	209,068
12	Cantaloupe	53,761.00	87,045
13	Banana	2,053,335.00	1,006,291
14	Plantain	1,336,625.00	870,939
Meats & Milk			
15	Pork	2,071,954.00	7,636,254
16	Lamb	990,049.00	6,862,685
17	Milk	298,783.00	304,042
Fish			
18	Shrimp	121,372.00	1,023,371
19	Tilapias, Catfish	60,096.00	194,542
TOTAL		**12,347,164.00**	**26,522,676**

The expected cost effectiveness of the climate adaptation practices is fully supported by the Government of Barbados and the targeted climate change adaptations are in concert with best practice in the areas of drip irrigation, built organic soils with compost and mulch and protected agriculture systems. The project targets water use efficiency, enabled by the integration of renewable energy and other technologies for efficiency and cost effectiveness.

Taken all together the climate adaptation practices are from the most highly recommended sources of climate resilience in farming systems and are highly relevant to the adaptive capacities for building resilience in the farming system in the project area with improved livelihoods security, income generation and employment over the longer term. It is expected that with improved adaptive capacities in the farming systems, particularly in water security and built resilience in land and soil, the current production levels of average 40-50 % of expected yields in vegetables, tomatoes, fruits and sweet potato could be significantly improved due to the year-round water security and other built resilience.

Barbadian farmers are being heavily impacted by climate change and support is needed to help offset the costs associated with the negative impacts of climate change, and assist them with adopting Climate Smart Agriculture (CSA) practices in line with the National Agriculture and Climate Change Policy.

CARICOM Agri-Food System Initiative

The CARICOM Agri-Food System Initiative[54] calls for a 25% reduction in the Food Import bill of member countries by the year 2025. An analysis of Barbados' food import bill shows that Barbados has the natural resources to

[54] Vision 25% by 2025 is long term social and economic partnership between: Member States, the Regional Private Sector (CARICOM Private Sector Organization-CPSO), Regional Organizations, Producer Groups, Development Partners and Civil Society which outlines actions and critical areas of

reduce the agricultural foods on the food import bill by 25%[55]. The Ministry of Agriculture, Food and Nutritional Security (MAFS) analysis of the 2021 food import bill revealed that agricultural products account for twenty-nine percent (29%) equivalent to 101 million USD of the total Barbados food imports of 354 million USD. Based on Barbados' productive capacity, the MAFS identified nineteen (19) agricultural products that can be substituted to replace agricultural imports by 26%.

Table 4: Estimated Volume, Acreage Increases in Top 12 Crops		
Crop	**Volume Percentage Increase**	**Acreage Percentage Increase**
Broccoli	*	100%
Onion	110%	243%
Carrot	215%	241%
Lettuce	40%	23%
Cabbage	164%	120%
Sweet Pepper	55%	40%
Tomato	20%	23%
Watermelon	26%	28%
Pumpkin	31%	34%
Cauliflower	*	56%
Celery	4320%	*
Cantaloupe	15%	17%

The MAFS analyzed imports of thirty short crops[56] that are grown commercially in Barbados. The analysis revealed that twelve of these crops accounted for 92% of the imported volumes (5 397 749 KGS) and 96% of the market value (20 million USD) of those imported crops. The expected growth in volume and acreage for the twelve crops compared to 2021 production is summarized. The project will support bringing approximately 328 acres of land, ranging from three (3) acres for cantaloupe to ninety-four (94) acres for broccoli, back into productive use and by supplying additional irrigation water and technical expertise this can be achieved.

For the 2023 calendar year, these twelve short crops had the greatest capacity for substantially increasing output, generating sectoral growth and reducing the food import bill by 25% x 2025. It was also expected that sectoral growth will result in an overall expansion in gross domestic product (GDP), given the linkages between the agricultural sector and other sectors including labor, tourism and manufacturing.

Accelerated Growth Enhancement (AGE) Programme

Table 5: Market Limitations for Crops	
Short Crops	**Market Limitation**
Broccoli	Very little to non-existent supply
Onion	Seasonal supply, and limited
Carrot	Price. Limited supply
Specialty Lettuce	No Iceberg. Very little to non-existent supply of Romaine
Cabbage	Very little supply
Coloured Sweet Pepper	Very little supply
Tomato	Very little supply in wet season
Watermelon	Inconsistent supply. High spoilage and poor quality in wet season
Pumpkin	Inconsistent supply. High spoilage and poor quality in wet season
Cauliflower	Very little to non-existent supply
Celery	Very little to non-existent supply
Cantaloupe	Inconsistent supply. High spoilage and poor quality in wet season

To meet the 25% x 2025 targets, the MAFS proposed the establishment of the Accelerated Growth Enhancement (AGE) Programme under the FEED Programme, starting first with the top twelve imported short crops. MAFS identified forty skilled 'large-scale' crop farmers that have at least 5 years' experience for growing the 25% x 2025 crops; and resources (land, water, equipment) to rapidly expand their output. All the major buyers (supermarkets, shops, retailers, wholesalers) expressed a deep commitment to buying from local farmers, by reaffirming their preference for local agricultural produce. However, they highlighted the following challenges:

intervention to tackle the Region's rising food import bill, improve intra-regional trade, and create wealth and economic opportunity for every CARICOM Member State. https://caricom.org/25-by-2025-reduction-in-the-regional-food-bill/

[55] Cabinet Note 22; Ministry of Agriculture and Food Security

[56] Harvested in six months or less

Most of the 25% x 2025 crops require a high level of growing skill to achieve optimal yields. The farmers will need to have technical support provided by top international experts[57]. With support from the international consultants, the Central Agronomic Research Station (CARS) at Graeme Hall is expected to provide varietal testing support, establish research demonstration plots with mulch and precision technologies and host open days to showcase to farmers, best practices for maximizing productivity. Research plots are also to be established on various farms to advance the diffusion of these innovations. The Barbados Agriculture Development and Marketing Cooperation has five (5) Extension Officers to service twenty-eight farming districts, Land Lease districts and the FEED programme districts. This is stretching the Officers very thin and not allowing for them to adequately service the farmers. The beginner farmers of the Farmers' Empowerment and Enfranchisement Drive (FEED) need a greater level of monitoring and support to develop the skills and knowledge to be able to produce at a high level consistently. The technical support and knowledge building by the project will support the achievement of this national goal.

B. Describe how the project/programme is consistent with national or sub-national sustainable development strategies, including, where appropriate, national adaptation plan (NAP), national or sub-national development plans, poverty reduction strategies, national communications, or national adaptation programs of action, or other relevant instruments, where they exist.

According to the Barbados Agriculture and Climate Change Policy 2022, in pursuit of climate-resilient development, the Government of Barbados ensures alignment between its implementation policies concerning the Sendai Framework on Disaster Risk Reduction, the 2030 SDGs and climate action under the Paris Agreement. Barbados has operationalized the priority adaptation strategies identified in the Second National Communication. The 2022 (Draft) Physical Development Plan (PDP), the Roofs to Reefs Programme (R2RP) and the Nationally Determined Contribution Update 2021 now provide the relevant framework for Barbados to achieve its resilience goal by 2030. The Roofs to Reefs Programme (R2RP) is a holistic, integrated national initiative for the resilient development of Barbados. It provides for a response at the individual, community and country levels. It is an integrated public investment programme founded on principles of sustainable development and climate change resilience and represents the development model for Barbados for the next decade. The focus is on improving the social and environmental circumstances of Barbadians, improving living conditions and making us more resilient to the impacts of the worsening climate crisis and related natural disasters while increasing our ability to recover quickly post-disaster. Barbados' agricultural response to climate change is integrated into the R2RP as one of the key impact sectors and is also framed in the context of FAO's Climate-Smart Agriculture (CSA) approach.

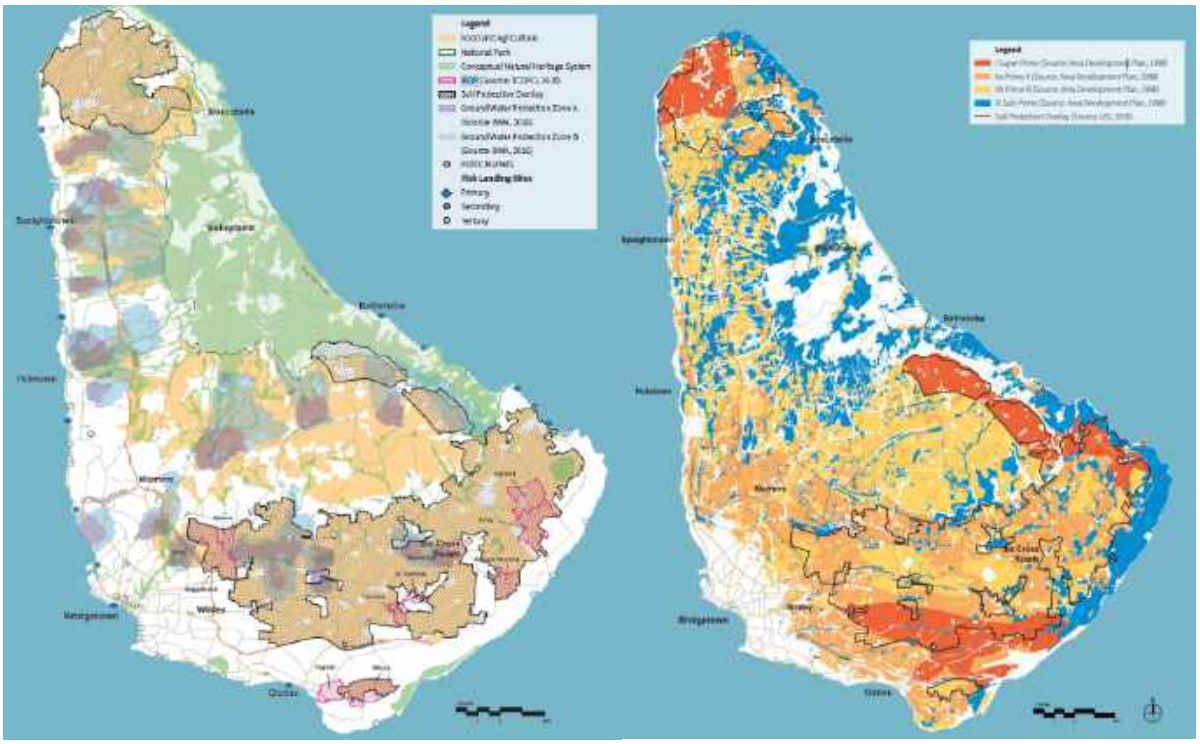
The Barbados Agriculture and Climate Change Policy (2022) includes a summary of the technical strategies aimed at crop adaptation relevant to the project as follows:

Table 6: Barbados Agriculture and Climate Change Policy (2022) Summary of Technical strategies for Crop Adaptation

Steps	Strategy
Planting Material	• Increase output of tissue culture derived planting material to generate a minimum of ⅓ disease-free plantlets for major crops
Irrigation	• Increase access to a consistent water supply through surface runoff water reservoirs and wastewater reuse pipelines; • Improve water use efficiency by promoting irrigation management to address the method and scheduling of irrigation to reduce water and nutrient losses to the environment; • Increase water harvesting and storage on farms
Pollination	• Increase beehives for pollination of flowering crops to maximize yields by ensuring 8 or more bee visits per flower; • Reduce use of insecticides toxic to bees to reduce bee mortality.
Drainage	• Use agricultural tile drainage (sub-surface drainage) to minimize, eliminate flooding,capture runoff water for irrigation;Clean and maintain suck wells
Cropping systems	• Develop economical inter-cropping models;

[57] Florida experts in Agricultural Extension & Research and Commercial Vegetable Crops Extension have been identified.

	• Increase production and planting of nationally important fruit trees in mixed cropping systems under the 1 Million Tree planting initiative to fulfil the demands of food security, provide wind breaks and sequester carbon.
Extension	• Provide digital extension including knowledge products to improve farmer-decision making; • Provide hands on training through Farmer Field Schools



According to the Barbados Physical Development Plan Amendment 2023[58], Barbados is a food scarce country with high levels of net food imports and minimal days of on island supplies. The amount of agricultural land has declined from 44% of the island in the 1980s to a total of 26.5% or just over 28,000 acres today, well below the Government's minimum agricultural land allocation requirement of 30,000 acres. This situation severely reduces the resiliency of the island when the impacts of the climate crisis and severe weather events are considered. Achieving food and nutrition security and sovereignty is recognized as one of Barbados' highest priorities. The Soil Protection Overlay of Barbados represents the best agricultural land, suitability for farming, access to irrigation water and support services necessary for the efficient production of food crops. **Figure 4: Food and Agriculture Map; Figure 5: Barbados Agricultural Land Classification**

Integrated water resources management is the process of managing human activities and natural resources on a watershed basis. This approach allows for the protection of important water resources, while at the same time addressing critical issues of current and future impacts of rapid growth and the climate crisis. Barbados is a water scarce nation, where storm water is understood as a resource. Storm water management is very important to Barbados' developed and built-up areas due to the presence of paved surfaces, buildings and site features which prevent the natural filtration of rainwater into the ground. Due to the effects of the climate crisis, it is projected that Barbados will experience increases in intense heavy rainfall events that could lead to increased incidences flash flooding. The use of properly designed storm water management practices will be very important to effectively manage the flow of water which can then be utilized for irrigation purposes.

The National Strategic Plan (NSP) of Barbados 2005-2025 sets out Government's main development agenda and is aimed at "Building a Green Economy: Strengthening the physical infrastructure and preserving the environment." Goal Four requires the protection, preservation and enhancement of physical infrastructure, environment and scarce resources and the support for the food and agricultural sector are designed to ensure a healthy, resilient and food sovereign nation. The Government will promote a viable food and agricultural sector, food security, climate change resilience, the national economy and healthy communities. It will protect the agricultural land base from alienation and fragmentation; ensure agricultural practices are sustainable and

[58] Barbados Physical Development Plan Amendment "Toward a Green, Prosperous, Healthy & Resilient Nation" October 2023

designed to protect and preserve natural resources; increase food security and sovereignty through continued emphasis on crop diversification and by striving to substitute domestic food production for imported food products; promote research into new agricultural practices and technologies that will increase diversification and improve the efficiency, profitability and sustainability of the sector.

The Government will consider environmental sustainability and climate change resiliency in the food and agricultural sector by promoting agricultural management best practices, biological pest control; farming practices that reduce the volume of agricultural waste; production of more resilient crops and varieties as a climate adaptation measure; risk mitigation measures including water storage, rainwater harvesting, improved drainage, storm water management and efficient irrigation. It will also plan for the full spectrum of food production and other agricultural crops by: undertaking an Agricultural Census; prioritizing and protecting the use of the highest classes of agricultural land for food crops; supporting livestock operations; promoting organic farming; creating strategies to address praedial larceny.

Lands within the Soil Protection Overlay represent an irreplaceable resource and will be protected over the long term for food production and other agricultural uses. The Soil Protection Overlay has been identified based on: the availability of the best agricultural land, suitability under projected climatic conditions, access to or potential for irrigation water and the provision of the support services necessary for the efficient production of food crops.

According to the Physical Development Plan Amendment 2023, the Government will consider environmental sustainability and climate crisis resiliency in the food and agricultural sector. These policies align with the Agriculture and Climate Change Policy (2022) and recognize the potential for co-existence of agricultural and renewable energy uses. The Government will promote:

a) The use of agricultural management best practices, including biological pest control, to minimize the negative impacts of agricultural activity e.g. use of pesticides and herbicides;
b) Farming practices that seek to reduce the volume of agricultural waste;
c) The production of more resilient crops and varieties as a climate adaptation measure;
d) Risk mitigation measures including water storage, rainwater harvesting, improved drainage, storm water management and efficient irrigation

The Farmers' Empowerment and Enfranchisement Drive (FEED) Programme (2018) is the Barbados Government's effort to save foreign exchange through a reduction in agricultural imports and to ensure national food and nutrition security whilst providing opportunity for youth employment. The objectives of the programme are:

- To increase the agriculture sector's contribution to Gross Domestic Product;
- To ensure long-term national food and nutrition security through improved access to safe and nutritious foods;
- To enhance the international competitiveness, growth and profitability of the agriculture sector;
- To increase net foreign exchange earnings through increased agricultural exports;
- To facilitate the sustainable development of the agricultural sector through improved access to land and inputs for agricultural production and development;
- To reduce levels of poverty and increase employment, particularly among vulnerable groups including women and the youth;
- To increase investment in the agriculture sector through the provision of infrastructure and support services.

The BADMC is currently planning, implementing and managing FEED. The programme is conducting training and apprenticeship and the first cohort of graduates (November 2019) were mentored, provided with formal instruction, including workshops and in-field training, over a six-month period. These new farmers were assigned to half-acre plots and organized into crop clusters and introduced to the rudiments of farm management and modern technologies. It is estimated that some 1,262 acres of land were made available for lease to prospective farmers under FEED. Land allocation is ongoing and up to 2 000 farmers are to be accommodated. The target groups and beneficiaries are as follows:

1. Retrenched public servants with training, experience or an interest in agriculture;
2. Agricultural cooperatives with limited or no access to land;

3. Female heads of households with an interest in agriculture;
4. Women who have basic farming skills or experience in agriculture;
5. Youth (18 to 29) with an interest in agriculture; Particular emphasis is being placed on encouraging increased youth participation in the sector with the introduction of new forms of technologies

Other policy and strategic directions consistent with the project activities include (a) the conduct of research and development, particularly in the area of drought resistant varieties (b) recommendations for capacity building for public servants to identify and assess economic impacts that may result from the projected impacts of climate change and the costs and benefits of climate adaptation measures on selected agriculture subsectors. There are some areas of the project design which cuts across different policy and strategy documents including (a) the promotion of gender equality and ensuring sustainable livelihoods by encouraging youth involvement and specific activities that support rural women (b) the urgency placed on water security from rainwater harvesting for farming systems (c) the strong focus on improved adaptive capacities for better use of the natural resources and strengthened agriculture contribution to national development. The project finds consistency with the strategy in several areas, including promotion of water use efficiency on the farm, sustainable land management, energy security to minimize environmental vulnerabilities and risks with sustainable livelihoods enhanced food security through promotion of green practices. The project will encourage limited use of agrochemicals, leading to improved soil and air quality (reduced greenhouse gas emissions), improved health of the farmers, conservation of water resources and protection of biodiversity.

The project offers environmental, social and economic co-benefits while also promoting women's empowerment. It is aligned with the following Sustainable Development Goals (SDGs): SDG 2: Zero hunger; SDG 3: Good health and well-being; SDG 5: Gender equality; SDG 8: Decent work and economic growth; and SDG 13: Climate action. Without major efforts to adapt to climate change, Barbados will not be able to achieve the Sustainable Development Goals for poverty reduction and food security. The impacts of climate change and climate variability already started to disrupt climate sensitive farming systems and livelihoods thereby threatening the country's food security where products are being imported to fill the void left by local shortages.

From an economic standpoint, the project will contribute to improving the incomes of farmers by increasing yields and creating employment opportunities associated with the provision of climate-smart agricultural services.
The project also intends to pay particular attention to the needs of women, especially during capacity-building activities and the process of applying for financial support

C. Describe how the project/programme meets relevant national technical standards, where applicable, such as standards for environmental assessment, building codes, etc., and complies with the Environmental and Social Policy of the Adaptation Fund.

The Government of Barbados is party to international agreements and commitments that speak to needs and rights relating to poverty and vulnerability, and the link to natural resources. Barbados continues to satisfy its obligations relative to sustainable development and the protection of plant genetic resources, biodiversity conservation in general, and practices that could reduce carbon footprints. Through these agreements, the Government is aware of the sensitive link between natural resources, in particular the multi-functionality of agro-ecological services, and poverty. The project will ensure due diligence to the Environmental Management Plan.

In the area of climate change adaptation, Barbados maintains several important legal frameworks[59]: Proclamation of the Planning and Development Act, and the 2021 Physical Development Plan (PDP). The GoB ensures alignment between its implementation policies concerning the Sendai Framework on Disaster Risk Reduction, the 2030 SDGs and climate action under the Paris Agreement. The 2021 Physical Development Plan and the Roofs to Reefs Programme (R2RP) now provide the relevant framework for Barbados to achieve its resilience goal by 2030.

[59] Barbados 2021 NDC Update. https://unfccc.int/sites/default/files/NDC/2022-06/2021%20Barbados%20NDC%20update%20-%2021%20July%202021.pdf

The 2021 Physical Development Plan is based on a vision of sustainable growth and development of Barbados. It addresses the critical impacts of climate change on Barbados through policies and strategies that enable the people to thrive and remain resilient under changing climate conditions. The Roof to Reefs Program (R2RP) operationalizes the PDP and provides the vehicle through which public investment will be directed. One major objective of the R2RP is "to increase freshwater storage capacity and water use efficiency and reduce emissions through the deployment of distributed renewable energy generation". Barbados has developed a number of legislative proposals to protect some of its most important sectors. Among these sectors, it is important to highlight the legislation in place to protect water resources with the "Storm-water Management Plan Update" where more efficient capture of storm-water and effluent will reduce pollution, contributing to the health of biota and protect and help preserve for future generations the coastal ecosystems, shorelines and coral reefs.

The project activities were developed within Barbados' national policy framework and seeks to build adaptive capacities for resilience in farming systems particularly with reference to drought and water scarcity. The project activities will build and improve on agro-ecosystems services for livelihood security of the target populations in their respective communities and with evidence-based co-benefits of the climate adaptation practices with improved livelihood security to other dependent populations, outside of the geographic area of the project. The Government of Barbados will ensure oversight of the respective public sector bodies in areas of relevance to the project:

1. Environmental Impact Assessment for natural resources, falls within the Town and Country Development Planning Office making the project well placed for compliance with these standards.
2. Building Codes in Barbados, are managed within the Town and Country Development Planning Office. The standards include measures to avoid the damage caused by extreme natural events, normally from hurricanes or intense rainfall.
3. The project will use solar energy instead of fossil fuel as this is best practice for building resilience through climate adaptation practices for pumping water. This is line with Barbados' stated goal of being a 100% green renewable economy by 2030[60].
4. In compliance with environmental and social policy of the AF none of the proposed activities have the likelihood of social or environmental harm. There will be environmental benefits from reduced carbon emissions thereby contributing to Barbados' Intended Nationally Determined Contribution (INDC) under the UNFCCC Barbados intends to achieve an economy-wide reduction in GHG emissions of 44% compared to its business as usual (BAU) scenario by 2030. In absolute terms, this translates to a reduction of 23% compared with the baseline year, 2008. As an interim target, the intention will be to achieve an economy-wide reduction of 37% compared to its business as usual (BAU) scenario by 2025, equivalent to an absolute reduction of 21% compared to 2008[61]
5. The increased use of mulch, compost, biopesticides, organic farming and adherence to Good Agricultural Practices will generate sustainable environmental and social benefits to vulnerable groups in the project area, through capacity building in reducing farm operating costs
6. Relative to the AF Social Policy, there are no indicators of negative spin-offs from project implementation. The project will ensure a clear implementation process that takes into account equitable and integrated social protection services. The project also aims to prevent marginalization, reduce vulnerabilities due to weak access gaps, and ensure that there are no barriers preventing equitable participation in the project by youth, women and disabled

D. Describe if there is duplication of project/programme with other funding sources, if any.

Barbados considers climate change to be a significant threat to its growth and prosperity. When vulnerability is examined as an aggregate function of demographic and socio-economic inputs, Barbados is among those Caribbean nations most vulnerable to climate change factors unique to the country that add to or further

[60] The Barbados National Energy Policy (BNEP) 2019-2030 document is designed to achieve the 100% renewable energy and carbon neutral transformational goals by 2030, becoming the first island-state in the world to do so.

[61] Barbados 2021 NDC Update. https://unfccc.int/sites/default/files/NDC/2022-06/2021%20Barbados%20NDC%20update%20-%2021%20July%202021.pdf

complicate the climate emergency. These Barbados-specific factors include, among others: water scarcity as a result of Barbados's unique hydrogeology; The climate change risk profile of Barbados is dominated by coastal and weather effects, especially sea level rise, storm surge, increased tropical storm and hurricane intensity and frequency; and other more slow-onset environmental impacts, such as flooding and drought, which is a very important and specifically Barbadian nuanced issue, as the country already suffers from water scarcity, and changes in rainfall patterns exacerbate this considerably These effects significantly impact food production through drought, changes in rainfall patterns, disease outbreaks and storm damage, as well as exacerbating existing vulnerabilities in determinants of health and water availability.

Article 8.1 of the Paris Agreement, recognizes the importance that Parties should give to averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events. Barbados is focusing its resources on mitigation, adaptation and resilience to protect its territory. Easier and greater access to finance for adaptation and resilience building is therefore critical. Finance that can be accessed quickly and easily is also necessary as, with a high debt profile, loans are not the best solution for Barbados the moment. The COVID pandemic exposed the economic vulnerability of Barbados to external shocks and adaptation to climate change and resilience building can no longer be treated separately from development nor from mitigation action. Understanding the existing financing gap for adaptation, Barbados is not currently receiving support for building climate resilience in the agriculture sector.

The Barbados Agricultural Development and Management Agency (BADMC) is a statutory corporation of government and has the mandate of the development of the Barbadian crop and livestock agricultural production and agro-processing. BADMC seeks to play a central role of supporting agriculture and agri-business. The BADMC is funded by the government through a subvention and provides agriculture services *inter alia* tractor, extension, pack house, agro-processing.

E. If applicable, describe the learning and knowledge management component to capture and disseminate lessons learned.

This project will enhance knowledge and support adaptive capacities for resilience of small farming systems, and climate change disaster risk reduction and awareness. The project activities include practical learning and demonstration activities on best practices in water conservation and irrigation, data capture on water use by crops and production rates in the agriculture sector. The collection of agricultural data[62] can be utilized to inform preparation of policy and strategic plans and programmes for improved resilience, capacity building in climate change adaptive capacities and strengthening of farming systems. Capturing of data generated in the field with the aid of researchers to support a database of climate resilient practices can be transferred to other farming sites in Barbados. A programme for the multiplication of existing white yam and sweet potato[63] varieties that are resistant to diseases to provide clean disease-free planting material for farmers, selected food and feed plants to enhance resilience in farming systems, and to minimize the predicted impact of future climate on agro-ecosystem services is to be undertaken using tissue culture.

An agriculture hub will be created for agriculture extension officers, research students, and farmers. These facilities will be powered by solar renewable energy and provide farmers with a safe space to store crop implements and materials (fertilizer, mulch, forks, hoes, nettings, agricultural chemicals, spray cans, mist blowers etc.); sanitary spaces and bathrooms women farmers and water collection from the roof and storage in a tank for non-potable purposes e.g. wetting seedlings. The Barbados Organic Growers Association has developed course modules for local organic training which can be delivered as field courses to farmers. The Barbados

[62] An Agriculture Census was last conducted in Barbados in 1989.

[63] Currently, more than 99 percent of the total production of yam and sweet potato is channeled into the fresh market, with less than 0.5percent utilized for value added product development. These root crops are eaten primarily boiled as the main starch at a meal, added to soups, used as base for other dishes or fried as chips or snack crisps. As consumers are encouraged to transition from imported grains and cereals to more traditional staples, there will be a growing demand not only for fresh but also various forms of processed traditional staples, that is, minimally processed "ready to eat" and "easy to prepare" forms to fully processed forms such as flour, cereals, snacks, pudding mixes. IICA 2015 Technical Paper.

Council for the Disabled[64] also has the capacity to lend expertise to facilitate the training of persons with disabilities in farming along with the New River Life Charity. The disaggregating of information by, sex, age and conducting gender-based analysis will facilitate capacity development and understanding of issues related to gender and agriculture.

The Barbados Meteorological Service[65] has 64 Weather Stations deployed throughout Barbados including in close proximity to Spring Hall (2 miles). The data captured can be utilized for agrometeorology support by the CIMH in collaboration with the Ministry of Agriculture and Food Security so that farmers can determine which crops to plant taking into consideration the weather conditions and forecast for both drought and extreme weather such as flooding. The focus of the agrometeorology will be on simplicity and applicability since the current CARICOF[66] drought forecasts produced by the CIMH for Barbados and the region are not widely utilized by Barbadian farmers in their crop planning since they find the information difficult to interpret. This is to empower farmers and farming communities that are threatened by drought, storms, hurricanes, flooding to respond in sufficient time and in appropriate manners in order to reduce the possibility of their farm crops, physical assets like irrigation systems, the environment and livelihoods.

A greater awareness about climate change in agriculture through information sharing on social and environmental resilience in agriculture through surveys, organized discussion, conferences and other media will enhance the development of farming systems in Barbados. A management scheme for pesticides has been to minimize environmental pollution risks as part of the "life-cycle concept" as addressed in the International Code of Conduct on the Distribution and Use of Pesticides. In June 2019, Barbados formed an empty pesticides container management stakeholder group led by the Pesticides Registrar in Barbados, based in the Ministry of Agriculture and Food Security. Women farmers of child-bearing age will be particularly facilitated. Farmer education on the correct selection and application of pesticides and benefits or organic pesticides along with how to calibrate spray cans and mist blows to ensure the proper delivery of chemicals.

Gender is an important cross-cutting theme across all project components where data collection in the form of KAP complemented by a gender assessment integration of gender responsiveness to climate change and climate variability impacts will sensitize institutions (BADMC, Ministry of Agriculture and Food Security) on the interlinkages between gender and agriculture. Gender-responsive engagement by extension and other field officers give women a voice.

The need for capacity building among farmers' communities is great because a significant number are unaware of key climate information services, tools and products that are routinely available; more exposure and training to build their capacity to integrate climate information considerations into their professional decisions is required. Many women farmers in rural areas experience greater income losses than their male counterparts from when crops are damaged in extreme weather so that they cannot vend or go to plantations to buy produce to sell, affecting their food and livelihood security. Government climate service providers are enabled to recognize the gender dimension and gender relevance of climate information services and to design and implement these in a gender-sensitive manner. This ensures that a vulnerability lens is built into the conversation and considerations for climate smart services. Additionally technical support mechanisms for aiding policy makers in understanding agriculture sector will incorporate a vulnerability lens to ensure sector resilience.

F. Describe the consultative process, including the list of stakeholders consulted, undertaken during project preparation, with particular reference to vulnerable groups, including gender

[64] The Barbados Council for the Disabled is the umbrella body for the Association for the Blind and Deaf, Challenor Creative Arts and Training Centre, Association Aid for the Physically Handicapped, The Autism Association, Myasthenia Gravis Association amongst others

[65] https://www.barbadosweather.org/

[66] The Caribbean Climate Outlook Forum (CariCOF) grouping has 31 countries and territories; 16 of which are independent countries and 15 are dependencies of France, the United Kingdom, the Netherlands, and the United States. The CIMH, as the coordinator of CariCOF and the primary climate service provider in the region, plays a central role in seasonal climate early warning and supports the NMHSs within the region with their national level climate early warning information.

considerations, in compliance with the Environmental and Social Policy and Gender Policy of the Adaptation Fund.

Multi-stakeholder consultations, in addition to interviews and individual discussions with farmers brought together farming associations and other stakeholders to gather expertise and grass-roots experiences to enhance the quality of the Adaptation Fund Proposal were an integral part of the project development process. The stakeholder consultations were designed to contribute to the development of constructive, productive relationships with the project beneficiaries. It enabled the identification of challenges which are currently having an impact on the farmers e.g. number of hours irrigation water that are scheduled in each BADMC farming district. By listening to stakeholder concerns and feedback, a valuable source of information was tapped to improve project design and outcomes, and help identify and control external risks. The adoption of ongoing consultation over the life of the project, will allow buy-in from stakeholders and to ensure the corporation is not moving away from the expectations and needs of the farmers. Through the engagement process, farmers project decisions will affect will feel they have inputted into the final outcome and that everyone's views have been taken into account. Farmers will also understand that their perspective may not be shared by their colleagues but, that there is a need for compromise. This in turn will lead to a greater chance of a successful implementation.

Table 8

Name of Farming Organization/ Group	Number of Members
Barbados Beef and Dairy Producers Association	25
Barbados Beekeepers Association	55
Barbados Egg and Poultry Producers Organization	125
Barbados Pig Farmers Association	100
Barbados Rabbit Association	35
Barbados Sheep Farmers Inc.	50
Farmers Empowerment and Enfranchisement Drive (FEED) Program BADMC River Plantation, Spring Hall	30
Fruit and Vegetable Growers Association	125
New River Life Charity (Farming for the Disabled)	30
Organic Growers and Consumers Association of Barbados	25
River Plantation Farmers	95
Spring Hall Land Lease Farmers	63
Women in Agriculture	50
Total	**808**

The project utilized an extensive stakeholder consultative process and all project components were endorsed by farmers. The Ministry of Agriculture and Food Security has 5000 registered active farmers in Barbados; there are also 3000 registered inactive farmers. Eight hundred and eight (808) farmers or 16 percent of the total Barbados farming population was consulted on the project either directly or through their farming commodity group. This was a good representation of Barbadian farmers since all of the commodity groups participated. All of the farmers and agricultural organizations endorsed the project goals and objectives and the individual components, which were designed targeting water catchment and irrigation infrastructure, farmer capacity building in climate smart agriculture, extension services and utilization of agriculture technology. This will be extended further into project implementation with a participatory approach for inclusiveness to ensure that all beneficiaries are treated fairly. All of the farming direct stakeholders consulted, utilize between 1-30 acres with the average farm being two and one half acres.

All farmer stakeholders stated that in light of the widely publicized drought predictions for Barbados[67] by both the Barbados Meteorological Service and CIMH, they were keen to learn how to farm productively in this era of climate change. Spring Hall Farmers sought the establishment of Demonstration Plots for drought tolerant new varieties. All Commodity Groups indicated that sharing of the field courses on social media as well as investigations into utilizing reverse osmosis for purifying rainwater collected from roofs to be utilized for livestock/poultry would be welcomed.

The Barbados Beekeepers Association suggested pollination services for cucurbits can be supported with high nectar trees[68] e.g. guava, mango, coconut being planting to help in feeding the bees. Bees play a crucial role in

[67] https://www.barbadosweather.org/PDF_Uploads/Barbados%206%20Months%20Drought%20Outlook.pdf

[68] Nectar is produced on all aerial parts of plants, and it attracts bees and is the basis for honey production. Pollen is protein for bees and plants can exhibit low to high availability. As long as honey bees are able to consume sufficient quantities of pollen, they will be able to obtain the nutrients they require.

pollination to increase food production. Barbados imports about half a million USD of honey every year. It costs about 600 USD establish a hive and the revenue per hive is estimated at 1800 USD per year on a 41 kilogram annual honey harvest[69].

SHLLP has a Farming Association for its members and convenes meetings to discuss farming issues. During field visits, discussions were held with farmers on their needs. In a special meeting convened, nineteen farmers utilizing one hundred and thirty nine and one half acres (139.5) of the Spring Hall Land Lease Program attended. The main crops grown by these farmers are: cucumbers, melons, sweet peppers, cabbages, peppers, okras, potatoes and yams. All of the farmers attending meetings and discussions agreed that the provision of additional irrigation water in a new would be beneficial and support their farming activities. Farmers welcomed the opportunity to participate in a Farmer Field School which will both teach, train and demonstrate how to grow new drought tolerant varieties; new cassava, yam and sweet potatoes; efficient use of bio-pesticides, environmentally friendly pest management, proper disposal of pesticide containers and collection points; new irrigation methods and materials; fertilizer combinations for increasing crop yields as well as how to interpret climate and weather data.

Ten women farmers from the Women in Agriculture Association, who utilize eleven acres of land both BADMC leased and farmer –owned in the Pine Basin, St. John, Bawden, St. Lucy, around their dwelling homes for crop, fruit and livestock farming were interviewed. These women farmers are also engaged in agro-processing activities making salad dressings, sauces and condiments sourcing their ingredients such as thyme, basil and peppers from their counterparts. The women were very excited to hear about the project and agreed that the water issues first had to be addressed and they endorsed the idea of a field school in the areas of crops, livestock and forages. The women expressed high hopes for the field school to build their knowledge and skill level. Courses on record keeping, growing fodder, comparative chemical analysis of animal feed content, rat bait testing to determine efficacy of components as well as crop testing were requested. Women farmers reported severe losses due to crop theft leading to them having to take measures such as sleeping in their fields in shifts accompanied by male colleagues, when crops were close to their harvest time.

All of the women present lamented that they faced many problems farming simply because of their gender. Firstly bullying in the marketplace, where the male-dominated field of purchasers and wholesales of agriculture products disparaged them and offered lower prices for equivalent goods sold by their male counterparts. Secondly, not being able to access funds or receive loans from institutions (banks, credit unions, other lenders) because their physically appearance does not match the pre-conceived notion of a farmer thereby leading to discrimination by lenders. They also reported being abused verbally by male farmers and knew personally of corruption in the agriculture marketplace and requested that government address this matter urgently. The women farmers and vendors who explained that they both farmed and sold their produce without going through a middle man. All of the women said that they grew produce next to their homes and sometimes they would visit plantations to harvest sweet potatoes, yams, cassava and peas to sell in the market. They were not really certain that the project would be able to assist them since they have family duties in addition to farming and may not have the time to attend training; however if land was available for lease they would be interested to increase the scale of their operations.

G. Provide justification for funding requested, focusing on the full cost of adaptation reasoning.

The guaranteed economic benefits include improved incomes and employment generation from water security integrated with improved capacity to participate in the domestic market supply chain as crop production is more reliable. The potential will also exist for an increase in crop production since water access throughout the year will be increased and with improved productivity from heathier soils. Benefits will include savings accrued by farmers who currently supplement their water needs with potable water from the BWA water at very high cost. Open-field farmers will also improve their incomes as they would now be able to add at least two crop cycles

[69] Liquid Gold – The Business of Honey in Barbados. 2019. Living Barbados

annually with water security and better drip irrigation that wastes less water during the seasonal dry months, as well as to satisfy water supply during unexpected dry spells.

The 2019/2020 production of vegetables and root crops in Barbados was approximately 16,000 tonnes of vegetables and root crops annually from about 5,000 acres rain fed land and 10 percent being supplemented with irrigation. At the same time, Barbados imported about 5,000 tonnes of the same crops. Production of the root crops: yams, eddoes, and sweet potatoes which are an integral part of the crop rotation with sugar cane are being planted less by plantations as the sugar cane industry is becoming smaller each year. These crops are mostly planted by small farmers to supply the local demand for these.

The vegetable and food crop market structure in Barbados is relatively simple because of its limited size. The market approaches perfect competition because there are no real monopolies and there are no barriers to entry by farmers. The majority of farmers are not organized and market their produce as individuals therefore buyers/consumers have a wide selection of accessible options. Typically, price variation is largest in the middle person/huckster/wholesaler segment which is complicated by additional linkages in the wholesale chain and depends on their dominance and market share. In most cases the farmer is a price taker and not able to determine price. However, farmers benefit significantly price wise when they eliminate the wholesaler and market directly to the end user or consumer.

Diversified production value chains in crops will also add to the economic benefits of the project. Progressively, farming households, will be able to raise the profitability of the farm as they gradually shift from practices such as high inputs of pesticides and herbicides to organically built soils using compost, mulch and other climate smart practices. Other economic benefits in the farming system will derive from some farmers re-starting farming activities in areas which had have been left fallow due to water shortages and expanding their operations.

H. Describe how the sustainability of the project/programme outcomes has been taken into account when designing the project/programme.

The threat to vulnerable Barbadian populations who engage in farming as their main and supplemental income is of major concern since displacement can lead to socio-economic problems. While the poor in general will be impacted, these sensitive farming households have weak coping strategies and a preoccupation with their daily needs. In an effort to maintain positive engagement with agriculture these households will require extension support services from the Government and the representative bodies to help build resilience to climate change. The farming population in Barbados is diverse with registered and unregistered farmers who make individual decisions about which crops to plant; this has sometimes led to gluts of particular crops that drives down the price of the commodity.

Project interventions that build adaptive capacities are intended to reduce the potential for adverse impacts on farming activities. Decreased rainfall and increased frequency of droughts and the associated ecosystem services will lead to reduced income and livelihood insecurity. The project will implement a set of concrete adaptation activities for building climate resilience in the agriculture sector for sustainable livelihoods, provide increased income generation and food security with special considerations for vulnerable groups like women and youth. The built resilience in the farming systems with climate change and climate resilience support environmental conditions to improve competitiveness of small farming systems in the Barbadian domestic market.

I. Provide an overview of the environmental and social impacts and risks identified as being relevant to the project/programme.

Social Impacts

The project will support increased income generation, employment and improved livelihood security so that households of the project beneficiary farmers will have a higher standard of living. There are currently 3000 skilled male agriculture workers in Barbados and 500 skilled female agriculture workers[70]. Empowerment in farming communities through capacity building for organizational, ownership and responsibility-sharing in agriculture activities and infrastructure will increase social cohesiveness. Increased disposable incomes through the reduced cost of agricultural inputs and the potential for increased yields with access to water will positively impact the beneficiary's household and the community where this money is spent. Enhanced education and awareness about climate resilience and the real benefits to farmers at grassroots level will help to generate sustainable and appropriate responses that can spread country wide through farmers' word- of- mouth. Improved household food and nutrition security where farmers not only consume the healthy food that they grow but are able to better support their families reduce the possibility of succumbing to lifestyle diseases like diabetes[71] and hypertension[72] which are at epidemic proportion in Barbados.

Table 9		
Barbados Statistical Service, Continuous Household Labour Force Survey, January to March 2024		
Sex	**Occupation**	
		Total
Male	**Skilled Agriculture Workers**	**3700**
Female		**700**
Total		**4 400**

The Barbados Statistical Service, Population and Housing Census 2021 started from August 2021 and ended on September 2022. According to the Barbados Statistical Service, Continuous Household Labour Force Survey, January to March 2024 the overall Labour Force for the January to March period was estimated at 131.1 thousand persons, comprising of 66.6 thousand males and 64.5 thousand females. The percentage of the Barbadian population engaged in agriculture is 3.4%.

Table 10													
Barbados Statistical Service, Population and Housing Census 2021													
Sex	**Occupational Group**		**5 Year Age Groups**										
		Total	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65 and over
Male	**Skilled Agricultural and Fishery**	1558	40	118	139	125	153	151	204	192	198	152	96
Female		273	5	12	15	19	35	40	29	27	36	37	18

[73]In 2023, the Barbados economy amidst challenges such as elevated foreign interest rates, geopolitical tensions, and local climatic events affecting agricultural output and local prices, the Barbadian economy continued its upward growth path. Despite challenges in meat and dairy production, robust food crop production spurred overall agricultural output. By the end of 2023, food crop production increased by 20.7 percent compared to 2022. Increases in bananas, chives, thyme, plantain, and cassava drove the overall expansion. Milk, chicken, and other meat production suffered from the extreme heat during the summer months and inconsistent feed quality. The high temperatures disrupted lactation and breeding cycles, resulting in a 5 percent contraction in milk production. Chicken output fell by 0.7 percent owing to a combination of the hot weather conditions and inconsistent feed quality, while other meat production contracted by 4.3 percent. Overall, higher food crop production outweighed the decline in meat production, culminating in 1.1 percent growth in the agricultural sector. Women, who are among the most vulnerable to climate change, comprise majority of the agricultural labor force involved in land preparation, weeding, crop protection and irrigation.

[70]https://stats.gov.bb/subjects/social-demographic-statistics/labour-market-statistics/lfs_employment-by-occupation-and-sex-annual-2023/

[71] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10399254/

[72]https://cdn.who.int/media/docs/default-source/country-profiles/hypertension/hypertension-2023/hypertension_brb_2023.pdf?sfvrsn=55f28762_4&download=true

[73] Central Bank of Barbados Review of Barbados' Economic Performance January – December 2023

The Barbados Survey of Living Conditions 2016/17 (SLC) measured all main aspects of living conditions and reports consumption based poverty rates. The SLC data highlighted a disparity in poverty and vulnerability between genders, as female poverty and vulnerability rates were above that of males in all categories of households. [74]Barbadian women are more likely to be living in poverty even though more women than men are graduates of tertiary level education institutions.

Public procurement of locally produced food also provides an excellent opportunity for Government to promote and protect health, especially in light of widespread, chronic, nutrition-related illness such as obesity, diabetes and cardiovascular disease, through the provision of fresh, local foods to public institutions such as schools, children homes, hospitals and prisons. None of the project activities carry any threat of social loss or disadvantages. Further activities such as gender data collection and gender capacity building of stakeholders of the project will increase awareness around gender issues in the agriculture sector.

[75]The Government of Barbados has embarked on Comprehensive Education Transformation which will enhance the enabling framework for the delivery of Nursery, Primary and Secondary and Special Needs education and ultimately, support the optimization of every student's academic, social, emotional and physical capabilities. The revision of existing policies relating to traditional factors *inter alia* curriculum, pedagogy and teachers' professional development, infrastructure, legislation, and administration, as well as the establishment of new policies to better embrace economic efficiency and social security are critical objectives towards a successful outcome. At the personal level, the enhancement of the education system is seeking to transform the lives of individuals by ensuring access to a fair, inclusive, relevant and modern structure for the delivery of education. In context therefore, inputs must reflect key standards for guaranteeing accreditation of the system, upward social mobility allowing for meaningful contribution to national development, climate resilience and disaster preparedness.

Table 11: Combined average performance in the 2023 diagnostic test by sex and form level

	Form 2 (11-12 years)		Form 3 (13-14 years)		Form 4 (15-16 years)	
	Male	Female	Male	Female	Male	Female
English	42	49	47	54	40	48
Ranges	0-84	0-91	0-91	0-91	0-84	0-89
Mathematics	36	38	34	38	27	32
Ranges	0-92	0-94	0-97	0-97	0-97	0-97

During the month of May 2023, the Ministry of Education, Technological and Vocational Training (METVT), administered National Diagnostic Tests to 2nd, 3rd and 4th form students of secondary schools in the areas of literacy and numeracy to assess the level of learning deficits. Currently, what is being observed more widely is that too many students are becoming overwhelmed and disengaged from the education system, and are falling further behind. This disengagement has had an impact on performance which was again reflected in the 2023 exam results

Environmental Impacts

The project activities will have positive impacts on the terrestrial ecosystems from reduced pollution of the land with agricultural chemicals, increased tree cover with the planting of trees, recycling of agricultural waste (manure, chicken litter, and broken vegetables) into compost, fertilizer and animal feed, reuse of silt and soil. Increased resilience in agricultural soils for soil water retention, structure and soil fertility and reduced carbon footprints by the adoption of renewable energy in agriculture and by the anticipated reduction in the need for fresh food imports, improved land drainage and improved conservation of storm water. The project will improve water security for farm irrigation leading to a general positive impact for the economic and social development the project areas, against a broader backdrop of declining agriculture (production, employment and farmer participation), declining agricultural losses suffered due to extreme weather events.

The environmental benefits of buying locally grown food conserves valuable natural resources and protects biodiversity. Greenhouse gases are reduced as a result of shorter distances between the farmer and consumer,

[74] IDB 2018 Report – Barbados Country Development Challenges

[75] https://mrd.gov.bb/attachments/Design%20Competition%20brief_for%20web.pdf

mitigating climate change and promoting environmental sustainability. Locally grown food tends to require less packaging compared to produce that is imported. By minimizing packaging materials, consumers reduce their environmental footprint and contribute to waste reduction efforts.

There is national emphasis on increasing agricultural production for food and nutritional security is an important policy driver in relation to achieving land degradation neutrality[76]. Action in pursuit of this national goal can contribute both to land degradation (via deforestation of tree-covered areas for conversation to agricultural land) and to land improvement (via conversion of grasslands back to productive croplands). In Barbados, from 2000 - 2019 the tree-covered area converted to croplands (0.88 km2) slightly exceeded the grassland area converted to croplands (0.55 km2). This project seeks to ensure that agricultural practices are sustainable and ecologically sound to avoid further land degradation.

Table 12

Climate change adaptation practices	Improved adaptive capacity contribution to resilient –farming	Co-benefits of the climate change adaptation practices
Mulch and composting of chicken litter, animal manures, plant waste	Reduced vulnerabilities to soil erosion with improved soil conservation, and land management.	• Compost processed from recycled organic materials, crop residues, manures, by diverting these materials from landfill reduces methane emissions. Benefits through carbon sequestration in soil, substitution of nitrogenous and other synthetic fertilizers and the flow-on effects of improved soil health and water holding capacity following their application
Agro-forestry and tree crops for food and bees	Reduced vulnerability to crop harvest loss.	• Alley cropping (planting single rows of trees and growing crops in the alley ways in between small farmers plots), silvopasture (combining trees with livestock grazing areas) increases crop productivity, improves nutrient cycling, creates and change microclimates • New farm areas brought under production
Tissue culture produces disease-resistant, climate-resistant crop varieties	Starting with disease-free plant material reduces losses caused by pests and diseases	• Reducing the need for chemical pesticides and promotes eco-friendly farming • Contributes to food security and reducing the vulnerability of smallholder farmers to climate change.
Storm water and rainwater catchment for irrigation.	Water security on in project areas	• Conservation of saved water with reduced demand on potable water for agriculture. • Reduced salinization of water and irrigation wells no longer relied on solely to cultivate during dry periods
Integration of renewable energy into built resilient farming systems.	Increased productivity reliability and crop harvests	• Potential for foreign exchange savings from reduced fresh produce imports. • Associated reduction in carbon footprints from reduced food importation • Adoption of drought resistant varieties of vegetables ad fodder plants for food security as decreases in rainfall becomes increasingly severe. • Reduced carbon footprints from utilization of solar renewable energy for water pumping

Project Occupational Health and Safety

The Barbados Safety and Health at Work Act 2015[77], referred to hereafter as „the Act" or „the SHaW Act" contains provisions for the safety, health and welfare of people at work. The Act does not prescribe specific conditions for agricultural workers. The Occupational Health and Safety to preclude injury owing to works (e.g. falling in excavations, falling objects, accidents caused by project vehicles and equipment, etc.) or operations of equipment is to be undertaken. Health and Safety Training Talks to workers prior to construction of the storm water harvesting pond are to include: Sufficient safety signage installed in conspicuous spots, provision of information materials (leaflets, booklets, etc.) regarding safety, regular provision of safety information to workers, safety measures (e.g. watchmen or flagmen, etc.) during critical construction activities.

The work site will likely generate construction noise impacting nearby farming lands. The potential transient dust

[76] MAY 2023 Barbados Final Report Land Degradation Neutrality Target Setting Programme

[77] https://labour.gov.bb/pdf/OSH/FINAL%20Draft%20of%20Summary%20of%202005%20Act%20(Dec%202015).pdf

and noise impacts due to excavation and construction works and transient increase in traffic from large earth/material trucks leading to and from construction sites will be managed with *inter alia* spraying of water from water trucks to reduce dust, covering trucks transporting materials, defined entry and exit points for vehicles and digging during working hours only, stockpiles for the shortest possible time - oriented to maximize wind sheltering

Checklist of environmental and social principles	No further assessment required for compliance	Potential impacts and risks – further assessment and management required for compliance
Compliance with the Law	✓	
Access and Equity	✓	
Marginalized and Vulnerable Groups	✓	
Human Rights	✓	
Gender Equality and Women's Empowerment	✓	
Core Labour Rights	✓	
Indigenous Peoples	✓	
Involuntary Resettlement	✓	
Protection of Natural Habitats	✓	
Conservation of Biological Diversity	✓	
Climate Change	✓	
Pollution Prevention and Resource Efficiency	✓	
Public Health	✓	
Physical and Cultural Heritage	✓	
Lands and Soil Conservation	✓	

where possible. Segregation of work areas will preclude accidents owing to improper site use and delineated approved work areas for all activities including excavation, stockpiling, access, equipment placement during excavation, and materials storage.

1. **Compliance with the Law**:

The project is in compliance with all applicable laws namely:

a. The Barbados Town and Country Planning Act (CAP 240) 1988 is an Act to make provision for the orderly and progressive development of land in both urban and rural areas and to preserve and improve the amenities thereof. The Act states that "agriculture" includes horticulture, fruit growing, seed growing, dairy farming, the breeding and keeping of livestock, the use of land as grazing land, meadow land, market gardens and nursery grounds, and the use of land for woodlands where that use is ancillary to the farming of land for other agricultural purposes. For the purposes of the Act, the use of any land for the purposes of agriculture or forestry, including afforestation, and any building occupied together with the land so used does not constitute development. The project intends to utilize lands for agriculture purposes.

b. Barbados 2020 Green Paper Water Protection and Land Use Zoning Policy[78]

The Green Paper on the 2020 Water Protection and Land Use Zoning Policy describes the existing groundwater protection zoning policy, outlines its strengths and shortcomings and proposes a new integrated approach to protection of all the island's water resources, including coastal waters.

The 2020 Draft Water Protection And Land Use Zoning Policy aims to protect public supply wells from above-ground sources of pollution and coastal waters from land-based sources of marine pollution through an

[78] https://energy.gov.bb/our-projects/2020-water-protection-and-land-use-zoning-policy/

integrated mix of legislative, technical, economic and social interventions. The Zone A is an Exclusion Zone and the only type of agricultural activity permitted within the zone includes horticulture, fruit growing, seed growing, and the use of land for market gardens, Zone B is a Pathogen Management Zone and nursery grounds, woodland or forestry with enforceable best management practices being adopted. Zone C is a chemical management zone and Zone D is an aquifer recharge contributing area. The Zone E is a non-recharge contributing area that primarily consists of areas that do not contribute to the recharge of aquifers (i.e. Scotland District). The farming district in the parish of St. Lucy is in Zone D.

Barbados[79] has a National Water Conservation Plan which examines long-term and temporary approaches to managing water. The Emergency Drought Management Plan (EDMP) identifies parameters that would be used to monitor, forecast and predict the impact of drought, such as precipitation, groundwater measurements, salinity and weather data, and reservoir levels. The EDMP defines the conditions under which a drought-induced water supply emergency exists and specifies the response actions. The Barbados Sustainable Water Management Strategy and Action Plan provides for the comprehensive management of water resources through a series of strategies in the areas of demand management, supply management and augmentation, institutional capacity building, and legislation.

c. Barbados National Strategic Plan (2006–25)

Water resources are recognized as one of Barbados' most significant and irreplaceable core assets. Water resources are protected and conserved as a means of mitigating the effects of climate change and related risk of natural disasters. To manage the impacts of human activities on Barbados' water resources, an integrated water resources management approach is used to support adaptation to climate change; protect groundwater recharge areas from pollution through application of Groundwater Protection Zone policies; enhance water re-charge and retention through increased forest cover of appropriate species, conservation and low-impact development land use practices and retaining storm water runoff. In line with the Barbados National Strategic Plan, harnessing and retaining storm water for irrigation is proposed. The project proposed to retain storm water runoff for irrigation. The project also proposes the installation of water saving devices at schools.

d. Barbados National Energy Policy (BNEP)

The Barbados National Energy Policy (BNEP) 2019-2030 is designed to achieve the 100 percent renewable energy and carbon neutral island- state transformational goals by 2030. The BNEP spans all aspects of the energy sector, and provides a framework for moving the island from a fossil fuel based economy to one completely based on renewable energy sources. It also seeks to promote linkages with the agriculture sector to encourage the production of agro-energy crops where financially and economically viable. Sustainability in agriculture will help safeguard the sustainability of the entire energy sector in the long term. The energy sector has a significant impact on all aspects of Barbados' socio- economic life, touching all the critical sectors of production and consumption The BNEP Climate Change Sector Specific Objectives include the reduction of CO2 emissions by promoting the use of clean and renewable energy, collaboration and cooperation amongst all stakeholders to reduce CO2 emissions, working with international investors and agencies to finance climate change mitigation initiatives and establishing a baseline database for the level of greenhouse gases associated with economic and developmental activities in the various sectors. The benefits of energy integration using solar power in resilient farming systems where solar power is utilized for water pumping and irrigation will result in higher levels of productivity, efficiency and competitiveness from the built resilience in agro-ecosystem services. The project proposes the use of solar power renewable energy for pumping irrigation water from the storm water pond.

2. <u>Access and Equity</u>

The project is in compliance with this principle by having a process of allocating and distributing storm water for irrigation to farmers occupying and Spring Hall in a fair an independent manner where all farmers have access.

[79] Barbados Country Document for Disaster Risk Reduction 2014 – Department of Emergency Management http://www.unccd-prais.com/Uploads/GetReportPdf/5f04d645-897c-4557-b71c-a0fa014a4adc

No potable water is to be utilized in the project. The BADMC has existing rules and regulations showing how the process ensures fair and impartial access to benefits. The BADMC and Ministry of Agriculture and Food Security under the Constitution of Barbados ensures there is no discrimination nor favoritism in accessing project benefits. Section 23 of the Constitution of Barbados: Protection from discrimination on grounds of race, etc. No law shall make any provision that is discriminatory either of itself or in its effect; and no person shall be treated in a discriminatory manner by any person. "Discriminatory" means affording different treatment to different persons attributable wholly or mainly to their respective descriptions by race, place of origin, political opinions, color or creed, whereby persons of one such description are subjected to disabilities or restrictions to which persons of another such description are not made subject or are accorded privileges or advantages which are not afforded to persons of another such description.

3. Marginalized and Vulnerable Groups

The project is not expected to impose and disproportionate adverse impacts on marginalized or vulnerable groups. The project is being undertaken in Spring Hall utilizing land for farming and will cater to all Barbadian farmers including groups such women, disabled, youth, and gender-fluid. In the case of installation of water saving devices at schools, the Barbadian education system caters to all children.

4. Human Rights

Universal Declaration of Human Rights is an overarching principle in the implementation of the project. Barbados abides by this principle and is signatory to different human rights treaties[80] which protect citizens. The Government of Barbados has mechanisms in place to identify and punish those who may commit human rights abuses[81]. The Barbados Government Posture towards International and Nongovernmental Investigation of Alleged Abuses of Human Rights - Government Human Rights Bodies: The Ombudsman's Office hears complaints against government ministries, departments, and other authorities for alleged injuries or injustices resulting from administrative conduct. The president appoints the ombudsman on the recommendation of the prime minister and in consultation with the opposition. Parliament must approve the appointment. The ombudsman is generally considered independent and effective. The ombudsman submits annual reports to parliament that contain recommendations on changes to laws and descriptions of actions taken by the Ombudsman's Office.

5. Gender Equality and Women's Empowerment

The project is designed and implemented in such a way that both women and men 1) have equal opportunities to participate as per the Fund gender policy; 2) receive comparable social and economic benefits; and 3) do not suffer disproportionate adverse effects during the development process. Barbados has a Draft Gender Policy which has been applied to ensure that no cultural, traditional, religious, or any other grounds that might result in differential allocation of benefits between men and women.

Women-only stakeholder consultations were undertaken with women farmers and those involved in agro-processing at times and locations conducive to soliciting their opinions and data was gathered. Barbados has ratified the Convention on the Elimination of All Forms of Discrimination against Women.[82]The Barbados Government signed the CEDAW Convention in 1980. Much of the social legislative changes that have occurred regarding gender equality issues have taken place within the context of CEDAW. The Barbados Government also signed the Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women, 'Belem do Para', in June 1994. The Constitution of Barbados 1966 is the supreme law and protects the human rights of persons within the country.

6. Core Labour Rights

[80] https://tbinternet.ohchr.org/_layouts/TreatyBodyExternal/Countries.aspx?CountryCode=BRB&Lang=EN
[81] https://www.state.gov/reports/2022-country-reports-on-human-rights-practices/barbados/

[82]https://caribbean.unwomen.org/en/caribbean-gender-portal/caribbean-gbv-law-portal/gbv-country-resources/barbados

Barbados has ratified the eight ILO core conventions and has national compliance. Out of **42** Conventions ratified by Barbados, of which **31** are in force, **4** Conventions have been denounced; **5** instruments abrogated; **1** has been ratified in the past 12 months (Domestic Workers Convention to come into force in May 2025)[83].

The ambit of the Ministry of Labour is to assist the Government and its Social Partners in promoting opportunities for the provision of decent and productive work, in conditions of freedom of association, equity, security and human dignity and to provide quality social and economic benefits for Barbadians. The Ministry of Labour has established a number of technical committees to facilitate collaboration with key stakeholders in the planning and execution of its policies and programmes i.e. GIVE (Great attitude, Initiative, Values and Excellence), Anti-Discrimination in the Workplace, Child Labour, Decent Work and Social Partnership. In accordance with the Laws of Barbados, the Ministry of Labour conducts Occupational Health and Safety Inspections, receives and investigates worker complaints (Employment Rights Tribunal) and monitors the implementation of government policy. The government set occupational safety and health (OSH) standards that were current and appropriate for its industries. The Shaw Act seeks to secure the provisions of safety, health, and welfare for persons in the workplace as well as those external to the workplace who may be impacted by the activities that occur there. The act was amended in July 2022 to include additional regulations covering, noise, workstations, personal protective equipment, general duties, drinking water, sanitary conveniences, washing facilities, and fuel station medical supervision. The amendment also includes the employer in the list of persons who may be penalized for contravening the Act.

7. Indigenous Peoples

Barbados does not have any persons who are classified as Indigenous Peoples.

8. Involuntary Resettlement

No involuntary resettlement will be conducted in the project. All of the lands of Spring Hall to be utilized in the project are owned by the BADMC or its predecessor the Barbados Agriculture Development Cooperation.

9. Protection of Natural Habitats

The Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (EMSP) will provide an analysis on the nature and the extent of the impact including direct, indirect, cumulative, or secondary impacts as well as management plans.

The *Barbados Physical Development Plan 2017* (Strategic Policies) describes the 'Barbados Natural Heritage System' (NHS) as a core national asset and adopts an ecosystem approach to the protection, conservation and restoration of the components of the environment. The recognition of a national NHS encourages the protection and enhancement of the quality of the natural environment through soil and groundwater conservation, protection of land and marine biodiversity, and the prevention of air, land and water pollution. Adopting a 'ridge-to-reef' approach and tackling natural ecosystem protection at the scale of watersheds and karst[84] units, this framework links the highest points of the ridge down through gullies and aquifers into the coastal zones including the ocean and reefs.

The habitat where the storm water harvesting pond is proposed to be located is in a farming district on marginal lands. In the farming districts, cultivation of vegetable crops occurs year round on the lands with the best top soil and the marginal lands are rocky with plant scrub. The Barbados Ministry of Agriculture has previously installed two storm water harvesting ponds in the River Plantation and Belle farming districts[85] which are of the same type proposed for the Spring Hall farming district. The storm water harvesting pond will be lined with impermeable waterproof geotextile fabric because Barbados is comprised of limestone which water easily penetrates. In this way the water will be effectively retained for irrigation purposes. The water to be harvested in the storm water pond, is storm water which otherwise would flood farmers' fields and then run off through the gully into the sea. The water courses in the farming district, do not contain water year round, they are dry water courses and

[83] https://normlex.ilo.org/dyn/normlex/en/f?p=1000:11200:0::NO:11200:P11200_COUNTRY_ID:103218#:~:text=Out%20of%2042%20Conventions%20ratified,in%20the%20past%2012%20months.

[84] Landscape underlain by limestone which has been eroded by dissolution, producing ridges, towers, fissures, sinkholes and other characteristic landforms

[85] Storm water Pond River Farming District.jpg

conduct water to the sea during the rainy season[86]. The water in these water courses do not usually contribute to aquifer replenishment, the water flows to the sea.

Retention of storm water can lead to the creation of stagnant ponds should thick groundcovers/herbaceous plant material be introduced. Features to facilitate attenuation of flows, filtration of silt and debris, and improve infiltration times, whilst reducing the potential for future boggy areas generated by the deposit and accumulation of dead plant material will be utilized. These features will also allow for improved maintenance through removal of accumulated silt.

There are no known communities of farmers that would be affected if the storm water is harvested.

10. Conservation of Biological Diversity

No invasive species will be introduced into Spring Hall project area; only new varieties of vegetable, fruits and animals/ poultry may be utilized in agricultural production.

There are strategies used by the Government of Barbados to encourage farmers to re-tool, increase efficiency, adopt good agriculture practices and enhance ecosystem services beneficial for part of the agriculture incentive program[87]. Agriculture is deeply linked with nature and famers are usually stewards and beneficiaries of ecosystem services. “Ecological infrastructure” practices such as agroforestry, conservation tillage and water conservation are necessary activities that benefit the wider Barbadian community. Barbados is a densely populated country which has practiced intensive agriculture including sugar cane growing since slavery. Barbados has approximately 650 species[88] of flowering plants found in the wild, 48 of which are native trees adapted to local climate and soil conditions.[89] *Bursera simaruba* (Birchgum), *Tabebuia* sp. (White wood), *Cupania Americana* (Candle wood) and *Leucaena leucocephala* (Wild Tamarind), *Swietenia mahogoni* (Mahogany) and *Ficus* are the major tree species found in Barbados. The Spring Hall Farming district and its environs is home to common Barbadian flora and fauna. The commonest flora include: Bearded Fig Tree (*Ficus citrifolia*), Fustic (*Macalura tinctoria*), Coralita (*Antigonon leptopus*), Beef wood (*Pisonia fragrans*), Hoop wiss (*Trichostigma octandrum*) and Dogwood (*Capparis flexuosa*). Fauna include: Barbados anole (*Anolis extremus*), Dove (*Zenaida aurita*), Hummingbirds (*Eulampis holosericeus*), Yellow Breast (*Coereba flaveola*), Sparrows (*Loxigilla barbadensis*) and Black birds (*Quiscalus lugubris*).

11. Climate Change

The existing agricultural practices at Spring Hall generate GHGs through biological and physical processes involved in livestock and crop production. Mixed agriculture produces all three of the main GHGs, carbon dioxide, methane (CH_4) and nitrous oxide (N_2O), through various processes. Livestock produces CH_4 through enteric fermentation and N_2O from manure, while the former cannot be significantly reduced through better practices, N_2O production can be significantly reduced through improved manure handling practices. Plants on their own remove and emit carbon and can generally be considered neutral, however the use of mineral fertilizers are generally inefficient and the use of nitrogen fertilizers will contribute to increased N_2O emissions. Changes in the crop biomass when harvesting or changing land use can also significantly increase carbon emissions, while practices that increase the soil organic matter will sequester and reduce carbon emissions. Apart from the natural processes, agricultural machinery for tillage, transport, harvesting and irrigation will contribute to the GHG emissions and therefore efficient practices and the use of renewable fuels can reduce the impact.

The project intends to utilize Spring Hall for diverse animal and vegetable farming in a “change of use” from traditional sugar cane farming. The overall estimated emission change after implementation of the project is a net gain of 7.23E-02 Gg CO_2eq yr-1, an increase of 0.13 percent over the current emissions. While the larger acreage cultivated with vegetable crops increased the GHG emissions, the sequestration of GHG by the orchard, forage bank and trees to provide pollen and nectar to bees to be planted in the project area combined with a

[86] Spring Hall Land Lease Flood Nov 2019 Open with Windows Media Player 1.avi
[87] Barbados Ministry of Agriculture and Food Security Agriculture Incentives Programme and Upfront Concessions
[88] Wild Plants of Barbados. S. Carrington. Macmillan Caribbean 2007
[89] FAO Global Forest Reserves Barbados Country Report 2015

reduction of GHGs by replacing grid electricity by solar generated power, led to an overall mitigation of the increases.

12. Pollution Prevention and Resource Efficiency

Pesticides are widely used in agricultural production to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality. Occupational exposure to pesticides often occurs in the case of agricultural workers in open fields and greenhouses. A management scheme for pesticides at Spring Hall is being utilized to minimize environmental pollution risks as part of the "life-cycle concept" as addressed in the International Code of Conduct on the Distribution and Use of Pesticides. In June 2019, Barbados formed an empty pesticides container management stakeholder group led by the Pesticides Registrar in Barbados, based in the Ministry of Agriculture and Food Security. Farmers were trained in the correct procedure for pesticide container disposal management and women farmers of child-bearing age was particularly facilitated. Pesticide container disposal units[90] have been deployed island wide by the Pesticide Registrar[91]. Farmer education on the correct selection and application of pesticides and benefits or organic pesticides along with how to calibrate spray cans and mist blows to ensure the proper delivery of chemicals was undertaken. Farmers were empowered with knowledge to understand and monitor their health status to moderate their pesticide and practices use to protect themselves and safeguard their health and that of their families.

13. Public Health

The Climate Change and Health Unit of the Environmental Health Department, Ministry of Health and Wellness conducted a Health Impact Assessment of the project and determined it will not cause potentially significant negative impacts on public health. The irrigation of food crops using untreated raw water requires appropriate regulatory and operational safeguards to ensure public and worker safety. The public health issues must therefore be assessed through a systematic approach which carefully evaluates the irrigation augmentation plan from the source to the end product or final user. Raw well water is routinely used to irrigate crops in Barbados as well as pond water. Baseline assessments were done on existing storm water harvesting ponds in Barbados (Lears and River Plantation) to build a public health risk profile on the environmental assets associated with the water sources proposed for the project. Broad spectrum analyses for chemicals (agro. and industrial) and microorganisms (waterborne pathogens) were conducted so that the chemical and biological quality of the water were understood. From a preliminary perspective, no deleterious public health issues were identified based on the information provided on the project[92].

The World health Organization Determinants of Health in Agricultural production utilized were:

- Land use, soil quality, choice of crop, use of agricultural labor and occupational health.
- Livestock – vector borne diseases, animal feed, waste
- Sustainable farming - chemical and energy use, biodiversity, organic production
- Fertilizers – nitrate levels in food, pollution of waterways, re-use of agricultural waste.
- Water – irrigation use, water quality; Pesticide usage and veterinary drugs

The known "water-borne, water based, water-related, and vector-borne diseases" in Barbados are those carried by mosquitoes (dengue, chikungunya, Zika) and leptospirosis. Mosquitos only breed in shallow standing water (less than 3ft deep), however due to the depth of the water in the storm water harvesting pond (10 -12 feet) mosquito breeding is unlikely. Leptospira is transmitted through contaminated water or animal urine that enters humans through open wounds. This disease becomes more prevalent in Barbados during the rainy season in persons who work outdoors; this is not linked to storm water harvesting[93].

[90] Pesticide Container Disposal Barbados.jpg
[91] https://www.facebook.com/gisbarbados/videos/disposal-of-pesticide-containers/164720515569669/
[92] Public Health Considerations – Irrigation Augmentation River Plantation and Spring Hall, Ministry of Health and Wellness
[93] The seroprevalence of leptospirosis in at-risk occupational groups in Barbados Dr. Marquita Gittens-St.Hilaire, Lecturer in Microbiology, Faculty of Medical Sciences, The University of the West Indies, Queen Elizabeth Hospital Martindales Rd, 2013

The Barbados Water Authority (BWA) is the entity in Barbados charged with supplying the island with potable water as well as the provision of wastewater treatment and disposal services to the sewered areas of Bridgetown and the South Coast. The Barbados Water Authority conducts water testing at all its supply wells and springs to ensure safe water[94].

The role of the Water Quality Section of the Barbados Environmental Protection Department (EPD) is to protect the water resources of Barbados. This is achieved through the evaluation of land-based activities and their associated risks and the recommendation appropriate control measures. The Water Quality Section has four main monitoring programmes:

- The Ground Water Monitoring Programme ensures that drinking water is of good quality for public consumption. The EPD, along with the Barbados Water Authority, collects samples from twenty-one (21) drinking water wells, eleven (11) agricultural wells, and seven (7) public springs.
- The Widescreen Ground Water Monitoring Programme is intensive in that it assesses parameters not normally analyzed within the regular groundwater monitoring programme. It involves the biannual collection of water samples from potable wells. Some of the approximately one hundred and twenty (120) parameters analyzed under this programme include persistent organic pollutants and heavy metals.
- The Nearshore Recreational Water Monitoring Programme involves the collection of samples from eighteen (18) west and south coast bathing beaches. The results of the sample analysis give an indication of the impact of land-based activities on the nearshore environment and thereby determines if the beach is safe for recreational activities.
- The Wastewater Monitoring Programme involves the monitoring of discharges from wastewater treatment plants across the island to determine compliance with the Marine Pollution Control Act CAP. 392A and conditions of approval.

The water in the proposed storm water harvesting pond is intended to be utilized for agricultural irrigation and therefore falls under the Ground Water Monitoring Program which tests agricultural well water.

14. Physical and Cultural Heritage

According to Barbados Physical Development Plan (2017), Cultural Heritage Conservation Areas represent a contemporary approach to achieving heritage conservation goals while integrating heritage as part of the life of the community. They consist of the buildings, landscapes, cultural spaces, archaeological resources, important views, and other contributing features that define the unique character of the community. The project areas do not have a unique cultural and physical heritage which is distinct from that of the island of Barbados. The project is not expected to impact these areas.

15. Lands and Soil Conservation

In Saint Lucy, there is the Spring Hall Land Lease (SHLLP). This project originally started as a land settlement project circa 1980 on the Project's 407 acres with provision for irrigating only about 36 hectares (88 acres) of mainly crop/vegetable farming, with a dairy. Plot sizes average about 3 hectares and range from about half hectare to about 9 hectares, with one dairy/crop farmer allocated 27 hectares. The SHLLP has experiences water issues from inception with an inadequate irrigation water supply for the dry season and flooding during the rainy season. The Project commenced using potable water from the BWA public supply mains. This eventually proved too expensive and forced a switch to the Friendship ground water well, then as irrigated area steadily increased the well located at Mount Poyer was added in 1991.

The Barbados Physical Development Plan, Integrated Rural Development Programme (IRDP) identifies lands within the Soil Protection Overlay represent an irreplaceable resource and will be protected over the long term for food production and other agricultural uses. The Soil Protection Overlay was identified based on the following criteria: the availability of the best agricultural land, suitability under projected climatic conditions, access to or

[94] https://m.facebook.com/bwa.bb/posts/2702025883420985/

potential for irrigation water and the provision of the support services necessary for the efficient production of food crops. The lands at Spring Hall are located the North and South East areas of the island within the soil protected areas (**Figure 4: Food and Agriculture Map).**

All of the land in the Spring Hall Farming district has been used for different types of farming since 1966, the year of Barbados' Independence. The marginalized land is land in the farming district that is uneven, rocky, has a shallow depth of soil, close to the edge of a gully or sloping. The lands that farmers are currently successfully farming will not be utilized for the location of the pond. According to the *Assessment of Rainwater Harvesting Ponds for Irrigation at Spring Hall/Chance Hall, St. Lucy Hydrological Study of proposed Irrigation Ponds at Spring Hall/Chance Hall, St. Lucy July 29, 2022 Prepared for: Barbados Agricultural, Development & Marketing Corporation (BADMC) Fairy Valley, Christ Church, Barbados Prepared by: Stantec Consulting Caribbean Ltd, Black Rock, St. Michael, Barbados*, the proposed location of the storm water harvesting pond is flat and rocky and is not currently used for farming. Environmentally, storm water collection is pivotal in reducing the demand on the Barbados Water Authority potable systems by farmers. By capturing rainwater, the load on municipal water supplies is reduced, especially since water scarcity is a growing concern in Barbados. This practice ensures a supplementary water source during drought and contributes to maintaining the ecological balance. Storm water harvesting aligns with the principles of sustainable development by promoting the efficient use of water resources and decreasing the environmental footprint of human activities. This best practice encourages a more responsible and mindful approach to water usage, fostering a culture of conservation and awareness. By integrating rainwater harvesting into agriculture, the Spring Hall farming community can become more resilient to increased precipitation variability and flooding.

In Barbados, cultivation is an important part of land management and supports the irrigation of crops[95]. The minimum depth that is the ideal in terms of achieving the best seed bed, aeration and water holding capacity at minimum cost is between 400 mm and 500 mm is the best cultivation depth at "least cost" in the heavy clays. The type of cultivation relates to how the soil is cultivated whether it is disc harrowed or ploughed and the type of tynes used in ploughing. For long term crops, such as bananas, plantains and forage, sub-soil tynes fitted with sweeps that lift and aerate the soil are likely to achieve the best results but must be effectively undertaken to ensure that the plough depth is a minimum of 400 mm. Disc harrows can only reach a depth of 50mm to 60mm less than the radius of the discs. Furthermore, the discing operation must be disciplined and consistent with the tractor pulling in straight lines in one direction before crossing in the other direction. At the same time the angle of the discs must be properly set to get maximum penetration. Barbadian experience has taught that discing should take place in three directions for maximum aeration and tilth improvement. Appropriate cultivation practices are to be utilized in Spring Hall.

[95] Dr. Colin Hudson Research 7th Annual Barbados Association of Sugar Technologists 1989

PART III: IMPLEMENTATION ARRANGEMENTS

A. Demonstrate how the project/programme aligns with the Results Framework of the Adaptation Fund

Project Objective(s)[1]	Project Objective Indicator(s)	Fund Outcome	Fund Outcome Indicator	Grant Amoun (USD)
1. Strengthened ability of Barbadian farming communities to undertake concrete actions to adapt to climate change-driven hazards	Number of risk-exposed farming communities protected through improved water management planning i to support optimal vegetable production	Strengthened capacity to reduce risks associated with water scarcity	No. of farmers with reduced risk to extreme drought and flood events	**6, 350,000**
2. Strengthened support for Barbadian farming communtities with tools and materials to mitigate climate change-driven hazards	Improved tissue culture facilities and capacities to produce tissue culture plants	Quality and quantity of tissue culture plants increased	Percentage of targeted farmer population utilizing tissue culture plants increased	**2, 000, 000**
3. Strengthened Institutional capacity for water conservation	Volumes of potable water saved via introduction of water saving devices	Efficiency of water use improved	Water conservation best-practices adopted	**300, 000**
Project Outcome(s)	**Project Outcome Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Am (USD)**
1. Reduced exposure and increased adaptive capacity of farming communities to water scarcity and drought-related risks and hazards	Number of farms covered by improved access to water	Targeted farming areas covered by sustainable water management systems	Percentage of farms utilizing sustainable water management techniques for improved agriculture productivity	
2. Strengthened knowledge systems that build resilience to climate impacts	Types of tissue culture (agro-ecological) services to support agricultural production and adaptive capacities	Targeted distribution and uptake of tissue culture plants by the agriculture sector	Number and types of tissue culture plants utilized by farmers	
3. Water conservation awareness integrated into schools and market system with education management to support climate adaptation needs	Number of schools and marekts implementing improved water conservation planning	Targeted schools and markets participating in water awareness and climate adaptation activities	No. and type of water adaptation actions introduced	

Outcome 1: Reduced exposure and increased adaptive capacity of farming communities to water scarcity and drought-related risks and hazards

Outcome 2: Water conservation awareness integrated into schools and market system with education management to support climate adaptation needs

Outcome 3: Strengthened knowledge systems that build agricultural resilience to climate impacts

[1] The AF utilized OECD/DAC terminology for its results framework. Project proponents may use different terminology but the overall principle should still apply

PART IV: ENDORSEMENT BY GOVERNMENT AND CERTIFICATION BY THE IMPLEMENTING ENTITY

Record of endorsement on behalf of the government[2] *Provide the name and position of the government official and indicate date of endorsement. If this is a regional project/programme, list the endorsing officials all the participating countries. The endorsement letter(s) should be attached as an annex to the project/programme proposal. Please attach the endorsement letter(s) with this template; add as many participating governments if a regional project/programme:*

(Yolande J. Howard, Permanent Secretary, Ministry of Environment and National Beautification, Green and Blue Economy)	Date*: (09, 08, 2024)*

MINISTRY OF ENVIRONMENT
AND NATIONAL BEAUTIFICATION,
GREEN AND BLUE ECONOMY

PUBLIC SECTOR REFORM
Making Barbados Work Better

REF. NO: UNEP 13/1/1 Vol. II ***DATE:*** August 9, 2024

The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Endorsement for the "Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions" project

In my capacity as Designated Authority for the Adaptation Fund in Barbados, I confirm that the above-mentioned national project proposal is in accordance with the Government's national priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in the Barbados.

Accordingly, I am pleased to endorse the above project proposal with support from the Adaptation Fund. If approved, the project will be implemented by the Caribbean Community Climate Change Centre, and executed by the Ministry of Agriculture, Food and Nutritional Security.

Yours sincerely,

Yolande J. Howard (Mrs.)
Permanent Secretary
Adaptation Fund Designated Authority

YJH/rg

9TH & 10TH FLRS., WARRENS TOWERS II
WARRENS, ST MICHAEL BB 12001, BARBADOS
TEL NO.: (246) 535-4350 FAX NO.: (246) 535-4377

B. Implementing Entity certification

Provide the name and signature of the Implementing Entity Coordinator and the date of signature. Provide also the project/programme contact person's name, telephone number and email address

I certify that this proposal has been prepared in accordance with guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans(Barbados Agriculture and Climate Change Policy and Barbados' Nationally Determined Contributions to the UNFCCC) and subject to the approval by the Adaptation Fund Board, commit to implementing the project in compliance with the Environmental and Social Policy and the Gender Policy of the Adaptation Fund and on the understanding that the Implementing Entity will be fully (legally and financially) responsible for the implementation of this project/programme.

Name & Signature Colin Young, Ph.D. Executive Director  Implementing Entity Coordinator	
Date: *(Month, Day, Year)* August 8, 2024	Tel. and email: +5018221094 cyoung@caribbeanclimate.bz
Project Contact Person: Dr. Claire Durant	
Tel. And Email: +1 (246) 254-8259 / cdurant@caribbeanclimate.bz	

Annex 1

Preliminary Gender Analysis - Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions

Context

Barbados has a population of approximately 287,000[96] with a density in the region of 660 persons per km^2 making the island one of the most densely populated countries in the world. [97] According to the IMF, Barbados has a per capita gross national income of US$16,720, as of 2021. Barbados is highly vulnerable to exogenous economic shocks which are increasingly likely to compound due to climate change, leading to increasing and severe socio-economic costs in the absence of reforms and adaptation measures.

The Barbados Survey of Living Conditions 2016/17 (SLC) measured all main aspects of living conditions and reports consumption-based poverty rates. The SLC data highlighted a disparity in poverty and vulnerability between genders, as female poverty and vulnerability rates were above that of males in all categories of households. [98]Barbadian women are more likely to be living in poverty even though more women than men are graduates of tertiary level education institutions.[99]

The Barbados Government signed the CEDAW Convention in 1980. Many of the social legislative changes that have occurred regarding gender equality issues have taken place within the context of CEDAW. The Barbados Government also signed the Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women, 'Belem do Para', in June 1994. The Constitution of Barbados 1966 is the supreme law. The obligation mandated by the Constitution to protect the human rights of persons within the country extends to a positive obligation on the State to protect women and girls from domestic violence and sexual violence. Although the GOB has a revised Draft National Gender Equality Policy, it is yet to be approved by the Cabinet of Ministers and tabled in parliament for discussion and endorsement[100]. The 2012 National Climate Change policy lists 6 national plans and strategies for which climate change adaptation would be incorporated. While the Climate Change Policy makes mention of gender issues, there was limited presentation of strategies for mainstreaming gender in relevant sectoral climate change interventions. The Policy however states that vulnerable groups, including women and young men, should be targeted and participate in action to address environmental threats.[101]

Socioeconomics

According to the Barbados Statistical Service, Continuous Household Labour Force Survey, January to March 2024 the overall Labour Force for the January to March period was estimated at 131.1 thousand persons, comprising 66.6 thousand males and 64.5 thousand females. The percentage of the Barbadian population engaged in agriculture is approximately 3.4%.

Table 1: Barbados Statistical Service, Population and Housing Census 2021												
Sex	**Occupational Group**		**5 Year Age Groups**									
		Total	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65 and over

[96] World Population Review (Barbados 2020)

[97] CEPALSTAT Databases and Statistical Publications ECLAC.

[98] IDB 2018 Report – Barbados Country Development Challenges

[99] https://caribbean.unwomen.org/en/caribbean-gender-portal/caribbean-gbv-law-portal/gbv-country-resources/barbados

[100] CCCCC, Gender Analysis and Gender Action Plan- The 3R's for Climate Resilience Wastewater Systems in Barbados (3R Crew Barbados) Preparation Project-2022

[101] *ibid*

Male	**Skilled**	1558	40	118	139	125	153	151	204	192	198	152	96
Female	**Agricultural and Fishery**	273	5	12	15	19	35	40	29	27	36	37	18

Table 2: Barbados Statistical Service, Continuous Household Labour Force Survey, January to March 2024		
Sex	**Occupation**	
		Total
Male	**Skilled Agriculture Workers**	3700
Female		700
Total		4 400

[102]In 2023, the Barbados economy amidst challenges such as elevated foreign interest rates, geopolitical tensions, and local climatic events affecting agricultural output and local prices, the Barbadian economy continued its upward growth path. Despite challenges in meat and dairy production, robust food crop production spurred overall agricultural output. By the end of 2023, food crop production increased by 20.7 percent compared to 2022. Increases in bananas, chives, thyme, plantain, and cassava drove the overall expansion. Milk, chicken, and other meat production suffered from the extreme heat during the summer months and inconsistent feed quality. The high temperatures disrupted lactation and breeding cycles, resulting in a 5 percent contraction in milk production. Chicken output fell by 0.7 percent owing to a combination of the hot weather conditions and inconsistent feed quality, while other meat production contracted by 4.3 percent. Overall, higher food crop production outweighed the decline in meat production, culminating in 1.1 percent growth in the agricultural sector. Women, who are among the most vulnerable to climate change, comprise most of the agricultural labor force involved in land preparation, weeding, crop protection and irrigation. Current statistics from the Ministry of Agriculture and Food Security indicate that there are 1700 female farmers and 4800 male farmers in Barbados; this includes subsistence farmers and those who farm part of the year mainly during the rainy season.

Unpaid Work

A case study undertaken by Bobb in 2019 describes the challenges faced by persons of different genders when it comes to their access to clean water. Based on its findings, the study concludes that access to water is critical to one's quality of life and affects men and women differently[103]. In summary, this case study indicates that a woman spends at least thirty-two hours a week doing paid work, and twice that time doing unpaid domestic work at home including, cooking, washing, gardening, caring for her children and the animals and fetching and storing water for domestic use. Men, on the other hand, spend approximately forty hours a week doing paid work but very little time doing unpaid domestic chores. Although this case study does not necessarily represent the situation throughout all of Barbados it highlights that this is a trend in the country. The 2016 Country Gender Assessment similarly identified that studies in Barbados have shown that women, in part because many are single parents, participate in income-generating activities in both the formal and informal economies as well as carrying out most unpaid care activities[104].

Climate Change

The Country's first Biennial Update Report (BUR) to the UNFCCC identified that three quarters of all vulnerable families are female-headed households which suggests disproportionate impacts of climate change on these families[105.] The report further highlights that in addition to social assistance, the Government of Barbados, places strong emphasis on facilitating and supporting women

[102] Central Bank of Barbados Review of Barbados' Economic Performance January – December 2023

[103] CCCCC, Gender Analysis and Gender Action Plan- The 3R's for Climate Resilience Wastewater Systems in Barbados (3R Crew Barbados) Preparation Project-2022

[104] Rawwinda Baksh and Associates, Country Gender Assessment Barbados, 2016

[105] Government Of Barbados, Barbados 2021 Update of The First Nationally Determined Contribution, 2022

entrepreneurship and business development. In countries such as Barbados, women and men in rural areas are vulnerable when they are highly dependent on local natural resources for their livelihood[106.] Survey inputs that informed the gender assessment for the 3 R's for Climate Resilience Wastewater Systems in Barbados Project (3RCrews) identified that both men and women were concerned with impacts relating water scarcity linked to climate change. The assessment found that 85% of women and 58% of men were very concerned about water scarcity[107]. This is reflective of the statistical data showing that in general, women engage in more water related tasks within the household, such as cooking, cleaning, and washing, and therefore tend to report greater amounts of water usage[108]. With the high number of female-led households, and given that women, children and elders are primary users of water, a concerted effort to address these concerns from a gendered and rights-based approach is paramount[109].

Agriculture

Agriculture is more than a job for many women in the Caribbean. Women engage in subsistence agriculture to support their families, while men are more likely to engage in cash crop production[110]. "The CGA puts forward that "although much of subsistence agriculture is not captured in employment or GDP statistics and is carried out by the so called 'economically inactive' population, it is nevertheless a critical contributor to the livelihoods of poorer people and is also important for food security". Many of the small subsistence plots and smallest farms in Barbados are female owned. Larger farms tend to be owned by males. Close to 80% of all farms in Barbados are owned by men (79.7%)"[111].

The Association of Women's Farmers was consulted in the development of this project. They identified that women face many problems farming simply because of their gender. Firstly, bullying in the marketplace, where the male-dominated field of purchasers and wholesales of agriculture products disparage them and offer lower prices for equivalent goods sold by their male counterparts. The Association also identified that access to funds or to receive loans from institutions (banks, credit unions, other lenders) is challenging because their physical appearance does not match the pre-conceived notion of a farmer thereby leading to discrimination by lenders.

Education

There are 68 Barbados Government primary schools, 54 special schools, 12 nursery schools and 21 secondary schools all of which are overseen by the Barbados Ministry of Education, Technological and Vocational Training[112]. According to the IDB[113], the Barbadian education

[106] CCCCC, Gender Analysis and Gender Action Plan- The 3R's for Climate Resilience Wastewater Systems in Barbados (3R Crew Barbados) Preparation Project-2022

[107] *ibid*

[108] *ibid*

[109] *ibid*

[110] *Ibid*

[111] Rawwida Baksh and Associates, Country Gender Assessment Barbados, 2016 as cited in CCCCC, Gender Analysis and Gender Action Plan- The 3R's for Climate Resilience Wastewater Systems in Barbados (3R Crew Barbados) Preparation Project-2022

[112] https://mes.gov.bb/

[113] https://socialdigital.iadb.org/en/edu/covid-19/regional-response/6132

system caters to 45,623 students enrolled in primary (25,039 students in both public and private schools) and secondary education (20,584 students in both public and private schools). Forty eight percent (48%) of primary school students are female and 52 % are male, whilst in secondary school 49% are female and 51% are male[114]. According to WHO/ UNICEF Joint Monitoring Programme for WASH Estimates for Schools by Country 2000- 2021[115], at the primary and secondary schools, 100% of school children are provided with basic water services (approved and available), basic sanitation services (approved, useable, single-sex) and greater than 99% are provided with basic hygiene services (facility with water and soap). This is compared to the national Barbadian statistics where greater than 99% of the population have basic water services, basic sanitation services and basic hygiene services.

[116]The Government of Barbados has embarked on a Comprehensive Education Transformation which will enhance the enabling framework for the delivery of Nursery, Primary and Secondary and Special Needs education and ultimately, support the optimization of every student's academic, social, emotional and physical capabilities. The revision of existing policies relating to traditional factors including inter alia curriculum, pedagogy and teachers' professional development, infrastructure, legislation, and administration, as well as the establishment of new policies to better embrace economic efficiency and social security are critical objectives towards a successful outcome. At the personal level, the enhancement of the education system is seeking to transform the lives of individuals by ensuring access to a fair, inclusive, relevant and modern structure for the delivery of education. In context therefore, inputs must reflect key standards for guaranteeing accreditation of the system, upward social mobility allowing for meaningful contribution to national development, climate resilience and disaster preparedness.

Table 3: Combined average performance in the 2023 diagnostic test by sex and form level

	Form 2 (11-12 years)		Form 3 (13-14)		Form 4(15-16 years)	
	Male	Female	Male	Female	Male	Female
English	42	49	47	54	40	48
Ranges	0-84	0-91	0-91	0-91	0-84	0-89
Mathematics	36	38	34	38	27	32
Ranges	0-92	0-94	0-97	0-97	0-97	0-97

During the month of May 2023, the Ministry of Education, Technological and Vocational Training (METVT), administered National Diagnostic Tests to 2nd, 3rd and 4th form students of secondary schools in the areas of literacy and numeracy to assess the level of learning deficits. Currently, what is being observed more widely is that too many students are becoming overwhelmed and disengaged from the education system and are falling further behind. This disengagement has had an impact on performance which was again reflected in the 2023 exam results.

Initial Stakeholder Consultations

In addition to state and non-state representatives, farming groups and organisations were among some of the stakeholders consulted during project design discussions. Where applicable to the scope of this project, these recommendations have been integrated. Table 4 highlights a list of

[114] UNESCO Institute for Statistics

[115] https://data.unicef.org/topic/water-and-sanitation/drinking-water/

[116] https://mrd.gov.bb/attachments/Design%20Competition%20brief_for%20web.pdf

stakeholders consulted in the development of this project. Key gender inputs were derived from some of these consultations.

Table 4: Stakeholders Consulted by Farming Organization/Group and Gender			
Name of Farming Organization/ Group	**Number of Members**	**Members Participating in Stakeholder Meetings**	
		Male	Female
Barbados Beef and Dairy Producers Association	25	5	0
Barbados Beekeepers Association	55	2	0
Barbados Egg and Poultry Producers Organization	125	12	3
Barbados Pig Farmers Association	100	21	4
Barbados Rabbit Association	35	1	0
Barbados Sheep Farmers Inc.	50	4	1
Farmers Empowerment and Enfranchisement Drive (FEED) Program BADMC River Plantation, Spring Hall	30	25	3
Fruit and Vegetable Growers Association	125	1	0
New River Life Charity (Farming for the Disabled)	30	1	1
Organic Growers and Consumers Association of Barbados	25	9	0
River Plantation Farmers	95	45	4
Spring Hall Land Lease Farmers	63	37	6
Women in Agriculture	50	0	28
Total	**808**	**163**	**50**

In general, there were identified areas of benefit for these groups, including in capacity development. All farmer stakeholders stated that considering the widely publicized 2020 drought predictions for Barbados by both the Barbados Meteorological Service and CIMH, they were keen to learn how to farm productively in this era of climate change[117].

The major additional recommendations from farmers for inclusion in the project were as follows:

1. River Plantation Farmers – Repealing and replacing the 1713 Act that governs the use of the Three Houses Stream water.
2. Spring Hall Farmers – Establishment of Demonstration Plots for drought tolerant new varieties should be done at Spring Hall in addition to that planned for River Plantation.
3. Barbados Egg and Poultry Producers Organization - Reduction of Heat Stress in Small Farmer Broiler Chicken Pens by piloting a project to plant of windbreak trees to reduce the heat inside the chicken pens coupled with the one-off painting of the grey colored galvanized roofs white can significantly impact the coolness of the temperature inside the pens by 20^0C increase the survival rate of chickens.
4. Barbados Egg and Poultry Producers Organization, Fruit and Vegetable Growers Association, Barbados Beef and Dairy Association, Barbados Agriculture Society – Control of Animal Pests (Mongooses, Monkeys, Cats).
5. Barbados Beekeepers Association – Support for Beehives pollination services for cucurbits specific trees should be incorporated into the tree planting to help in feeding the bees.

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6. All Commodity Groups - Sharing of the field courses from the Farmer Field Schools on social media as well as investigations into utilizing reverse osmosis for purifying rainwater collected from roofs to be utilized for livestock/poultry.

Gender Equality Considerations for Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions

The project has accounted for the views of varying groups of farmers in the design process. It is important to recognize where women and men are located along the value chain of these agricultural processes. In Support to improved climate resilient agricultural practices, crops grown by respective groups will need to be considered to ensure equitable focus and benefit of the project's resources. A more comprehensive gender assessment will be required to adequately address this area in the detailed results framework of the project.

The use of the farmer field school approach is welcomed by varying groups of farmers, including the Association of Women's Farmers. As activities are further fleshed out, details to ensure equitable access to capacity development sessions such as most appropriate training times, care support for accessing training, location and methodology of training will require further elaboration to ensure equitable participation. Stakeholder consultations with female farmers from the Cheapside Market and Barbados Association of Retailer, Vendors and Entrepreneurs Market (BARVEN) revealed that all the women said that they grew produce next to their homes and sometimes they would visit plantations to harvest sweet potatoes, yams, cassava and peas to sell in the market. They were not certain that the project would be able to assist them since they have family duties in addition to farming and may not have the time to attend training; however, if land was available for lease they would be interested to increase the scale of their operations. This will have to be further explored in the gender assessment and action plan to identify solutions to this barrier relating to improving capacities.

Awareness campaigns specifically in schools should be informed by unique approaches to learning of persons with disabilities, boys, male youth, girls and female youth. Multimodal communication and learning approaches should be explored. The project will seek to align awareness raising with the Ministry of Education's Comprehensive Education Transformation approach.

The Project will need to incorporate capacity development in the areas of gender and social inclusion specifically as it relates to distribution of benefits to farmers. The Ministry of Agriculture's Project Implementation Unit can benefit from support to the project team that increases awareness on diversity and social inclusion and specific needs of female farmers, who generally report perception of marginalization.