ADAPTATION FUND

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: Implementing Entity	Regional Implementing EntityRegional
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: 149 250 (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

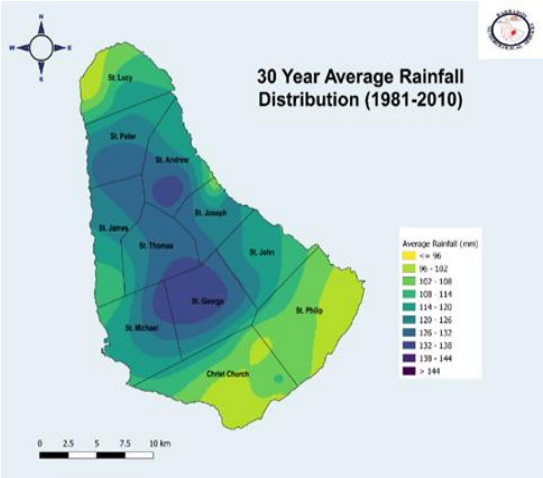
☐ This is the first submission ever of the concept proposal

In case of a resubmission, please indicate the last submission date: 8/12/20248/12/2024

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**

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. 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[1]. 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[2]. 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. Barbados is experiencing "absolute water scarcity" based on the Falkenmark[3] water stress indicator and 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; agricultural production through droughts, flooding, and storm damages[4]. It is projected there could be an increase in water-borne diseases, due to limited water availability and wastewater sanitation.

Aquifers provide 95% of the island's potable water supply and 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. 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.

[1] http://clearinghouse.caribbeanclimate.bz/?db_type=Climate%20Model&country=23&collection=V501&s=&sector=&topic=
[2] Barbados has the highest rate of dengue in the world (WHO)
[3] 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)
[4] Green Climate Fund FP192: The R's (Reduce, Reuse and Recycle) for Climate Resilience Wastewater Systems in Barbados (3R-CReWS) 2022

Barbadian farmers, especially small farmers, are becoming increasingly vulnerable to drought as their livelihoods are threatened by low rainfall where crops are rain-fed and by low water levels and increased production costs due to irrigation costs. [5]Livestock grazing areas reduce in nutritional value, as more low quality, drought tolerant species dominate pastures during droughts, causing the vulnerability of livestock to increase and 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[6]. 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 aquifers, 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 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[7].

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. 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.

Socio-Economics

Barbados has a population of approximately 287,000[8] 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. [9] 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

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

[6] Barbados Agriculture and Climate Change Policy 2022

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

[8] World Population Review (Barbados 2020)

[9] CEPALSTAT Databases and Statistical Publications ECLAC.

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[10] 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). [11]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.

[12]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, 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 o 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.

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. 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. According to UNEP, Barbados is ranked 15th in the world's most water scarce countries and sustainable water practices are needed. Water prohibition was instituted by the Barbados Water Authority each year from 2010 - 2020 and in 2023, with each year's prohibition for a longer period. During water prohibition[14] it is illegal to utilize potable water for: swimming pools, domestic baths, washing cars etc. and there are penalty fines and prison for breach.[15] Close to 80% of Barbados fresh water is derived from low lying coastal aquifers consisting of a thin lens of freshwater floating on top salt water. 98% of groundwater resources have been developed and with droughts Barbados has started to experience water supply issues in the higher elevations of the island and rise in salinity levels in coastal aquifers[16]**.** Climate change requires new and dynamic thinking[17] therefore introducing water conservation methods, contributes to climate change adaptation actions.

Water Conservation Projects being implemented to increase Barbados' Water Resilience

[10] Caribbean Development Bank 2017 Economic Review of Barbados.
[11] IDB 2018 Report – Barbados Country Development Challenges
[12] Central Bank of Barbados Review of Barbados' Economic Performance January – December 2023
[13] https://nationnews.com/2023/06/08/water-academy-coming-bcc/
[14] https://barbadoswaterauthority.com/guidelines-to-prohibition-notice/
[15] https://storymaps.arcgis.com/stories/e210f248af1847e5aacfbbca9073266
[16] March 2023, UN Conference on the Comprehensive Review of Implementation of International Decade for Action Water for Sustainable Development 2018-2028. Deputy Prime Minister of Barbados, Santia Bradshaw https://sdgs.un.org/sites/default/files/2023-03/Barbados%20%28E%29.pdf
[17] https://barbadoswaterauthority.com/wp-content/uploads/2021/09/TechMemo-Christ_Church_GW_Model.pdf

Barbados is seeking to harness reclaimed water to be utilized for aquifer recharge and agricultural irrigation through the installation of a 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[18]. This is expected to reduce 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 and benefits to 155 farmers (60% males and 40% males).[19] The existing South Coast Wastewater Treatment Plant (SCSTP) is also to be upgraded to a Water Reclamation facility. The project intends to generate tertiary treated water to be utilized for irrigation purposes and build a pipeline to transport that water to the River Plantation farming area in the south of Barbados and alleviate chronic water shortages for farmers[20]. The current proposed project is for the Spring Hall farming area in the north of Barbados to alleviate water shortages there and support year-round vegetable production[21].

Antimicrobial resistance in wastewaters in Barbados

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 reservoirs of antibiotic-resistant bacteria (ARB) that continuously contribute to the sewerage system[22]. 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.

The tertiary treatment to be utilized in the Bridgetown and South Coast Sewage Treatment Plant 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[23]. Treated wastewater in agriculture can transfer ARBs to soil at low concentrations, which can persist and proliferate in highly concentrated organic material conditions[24].[25] 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[26], actions must be implemented 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. By the UN standards, the availability of WASH at Barbadian schools is one of the highly effective practices in increasing access and learning outcomes. According to WHO/ UNICEF Joint Monitoring Programme for WASH Estimates for

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[18] Reduce, Reuse and Recycle for Climate Resilience Wastewater Systems in Barbados (3R-CReWS)[18]

[19] Barbados Climate Resilient South Coast Water Reclamation Project[19]

[20] https://www.iadb.org/en/news/barbados-launched-worlds-first-debt-climate-resilience-operation

[21] Barbados Today E Paper 19th March 2024.

[22] 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

[23] 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

[24] 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

[25] 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

[26] 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.

Schools by Country 2000- 2021[27], Barbados has a school-aged population of approximately 43 000 where 31% is urban and 69% is rural. 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

[28]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. Approximately 75% of Barbadian schools were established in the 1900s. 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. Upgrades to school plants are expected to be conducted when government is able to access funding.

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[29]. 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[30], 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[31].

. **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[32] consumed 1 563 463 cubic meters of water or 39% of 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).

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

[28] Reimagining Education in Barbados- A Bright Future for Every Child Ministry of Education and Vocational Training October 2023

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

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

[31] UNESCO Institute for Statistics

[32] The Ministry of Education, Technological and Vocational Training has several properties which are all metered as a single unit

.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). [33]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[34].

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. Registered active farmers in Barbados with additional unregistered inactive farmers produce a wide variety of food crops and/or livestock on small holdings. 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. Fruit crops are also produced on a small scale from trees around dwelling houses or on non-crop land[35].

[36]The poultry industry is one of the largest and most successful aspects of the Barbadian agricultural sector and a significant contributor to the economy. Approximately 50 million kilograms of chicken is produced and consumed in Barbados per year. 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.

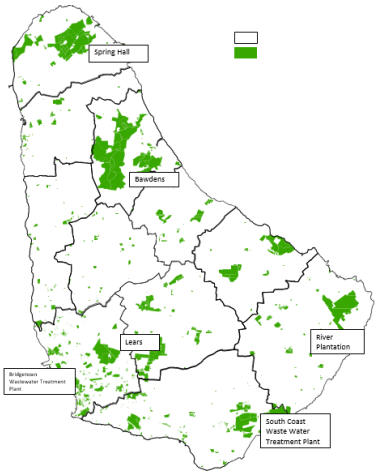
Many strategies are being used by the Government of Barbados to encourage farmers to re-tool, increase efficiency, adopt good agriculture practices and enhance ecosystem services beneficial for part of the agriculture incentive program[37]. Without incentives, most farmers eschew the time and money required 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 (BADMC) to assist farmers and enhance dissemination of climate smart technologies. The Barbados Government is working to enhance water solutions for the farmers through the Farmers Empowerment and Enfranchisement Drive (FEED) program and save foreign exchange through a reduction in agricultural imports and to ensure national food and nutrition security. The BADMC is seeking to expand the irrigation networks in conjunction with the Barbados Water Authority to include pump houses and distribution piping at Wakefield, Spencers, Bath, Mount Poyer and Spring Hall farming districts.

[33] Area Development Plan Task 1: Detailed Cadastral Survey of All Registered Plantations and Small Holder Concentrations. Town and Country Development 1999.
[34] 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.
[35] 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.
[36] Barbados Egg and Poultry Producers Association – Report on the State of Poultry in Barbados 2018.
[37] Barbados Ministry of Agriculture and Food Security Agriculture Incentives Programme and Upfront Concessions.

Impact of Water Scarcity on Farming



Drought in Barbados is impacting the agricultural sector where 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[38]. Crop farmers have to find another source of water and drought results in reduced crop production. Using potable water for farming is expensive therefore maximizing the harvesting of rain water in ponds to make it available for use during the dry months is vital. Rainwater and storm water harvesting is a green method of providing water for irrigation. Harvesting of rainwater is straightforward, economical, and innovative solution contributing to sustainability and resilience of water sources. Rainwater is considered a high-quality source of irrigation because it is nearly sodium-free. **Figure 2: Storm water Harvesting Pond at River Plantation, St. Phillip.**



Barbados has established three water harvesting ponds with capacities of 23 000 cubic meters each located at: at River Plantation, St Philip; Haggatts St. Andrew and Lears Plantation St. Michael. The water quality of these ponds is monitored by the Barbados Water Authority and the Barbados Environmental Protection Department to ensure that the water is fit to use to irrigate food crops. Lessons learned from these projects include: ensuring a maintenance regime for the connected irrigation and pump systems is undertaken as well as keeping the waterways that feed storm water to the pond is kept free of plant debris; collaboration and cooperation between Ministry of Agriculture and Food Security, BADMC, Environmental Protection Department and other technical agencies is crucial; and continued farmer engagement to increase their appreciation and commitment to good agricultural practices. **Figure 3: Major Farming Districts with Storm Water Harvesting Ponds.** The project is strengthening adaptation services for water by rainwater harvesting as a sustainable and cost-effective way to supplement irrigation water, water infrastructure is designed and built to withstand the impacts of climate change and to minimize water losses and provide access to farmers. Adaptation practices will be strengthened when addressing lessons learned by: engaging the BADMC who are the local technical experts who manage the existing water harvesting ponds to execute and implement a maintenance regime for Spring Hall water harvesting pond and the connected irrigation and pump systems in the same manner that is applied to existing ponds. The Spring Hall is a BADMC farming district therefore this will support the farmers' consistent access to irrigation water in keeping with the BADMC mandate. The Ministry of Agriculture and Food Security, BADMC, Environmental Protection Department and Barbados Water Authority have an established technical working group which monitors, evaluates and programs water services for farming and integrated water management; this working group will extend oversight to Spring Hall. Farmer engagement to increase their appreciation and commitment to good agricultural practices is currently undertaken by the Ministry of Agriculture and Food Security utilizing workshops and the Barbados Government Information Service[39] and this format will be put to work for this project as well through the generation and dissemination of appropriate content.

Barbados' agricultural productivity is at risk from prolonged drought conditions, which cause increased difficulty in managing the six-week cash crops e.g. cucumbers, melons and squash popular with farmers. The dairy industry in Barbados has dwindled from 39 dairy farmers in 2014, to only about 16 in 2019 and there has been a drop in milk production on farms because of the lack of forage; goat milk production has been similarly affected. 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 which causes chickens to drink more water thereby increasing costs. Heat waves in Barbados over 2016 - 2020 caused farmers 20-30 percent of chick loses devastating those solely dependent on farming for livelihood and food security.

Analysis of the Barbadian Fresh Fruit and Vegetable Sector

[38] In October – March 2010, Barbados experienced its' lowest ever rainfall since record keeping began in 1942

[39] https://gisbarbados.gov.bb/

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[40]. 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.[41]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 irrigation and establishing new orchards utilizing plant material from the proposed expanded nursery and tissue culture facility at the Ministry of Agriculture and Food Security.

Analysis of Barbados Fresh Agricultural Produce Imports versus Domestic Agriculture Production

An analysis of local 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 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, 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. Onions had the second highest imported 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. The most valuable crop imported per kilogram (2016-2019) was sweet peppers. The local production of sweet potatoes (2016 -2019) was the largest Barbadian 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. 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.

The 2019/2020 combined production of vegetables and root crops in Barbados was approximately 16,000 tonnes from about 4 500 acres of farmland which were rain fed and 500 acres supplemented with irrigation. Barbados imports 5000 tonnes of root crops e.g. yams, eddoes, and sweet potatoes. 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 have very low or no domestic production therefore importation is needed to meet customer demand. Customer demand for mangoes, passion fruit and soursop increased steadily over the period 2016 -2021 necessitating imports to supplement the sparse local supply.

Building Climate Resilience in Barbados using Plant Tissue Culture

[42] Small scale and subsistence farmers in the Caribbean, still use indigenous farming practices and climate change adaptation support for them must be built on sound, working ecosystems which provide a variety of benefits and services on which agricultural production systems and rural livelihoods depend. Sweet potato is ranked as the seventh most important food crop globally because it contributes majorly in terms of energy and nutrition[43]. [44]Sweet potato spreads and covers soil surface and reduces soil erosion by preventing direct impact of rain drops; roots penetrate up to one meter into the soil, increasing water absorption while reducing runoff.

[40] 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.

[41] Barbados Statistical Service

[42] Gweyi-Onyango, J.P., Sakha, M.A., Jefwa, J. (2021). Agricultural Interventions to Enhance Climate Change Adaptation of Underutilized Root and Tuber Crops. In: Leal Filho, W., Oguge, N., Ayal, D., Adeleke, L., da Silva, I. (eds) African Handbook of Climate Change Adaptation. Springer, Cham. https://doi.org/10.1007/978-3-030-42091-8_40-1

[43] https://barbadostoday.bb/2024/06/06/veteran-farmer-warns-disease-heat-drought-will-hurt-yam-sweet-potato-crops/

[44] Alternative method of reducing soil loss due to harvesting of sweet potato: A case study of low input agriculture in Nigeria, Soil and Tillage Research, Volume 158,2016 49-56,ISSN 0167-1987, https://doi.org/10.1016/j.still.2015.11.007; Sweet Potato: A Miracle Crop for Soil and Water Conservation Under Rainfed Maize in India's North-Western Himalaya. Modern Concep Dev Agrono. 9(1). MCDA. 000705. 2021. DOI: 10.31031/MCDA.2021.09.000705; Afzal, N.; Afionis, S.; Stringer, L.C.; Favretto, N.; Sakai, M.; Sakai, P. Benefits and Trade-Offs of Smallholder Sweet Potato Cultivation as a Pathway toward Achieving the Sustainable Development Goals. *Sustainability* **2021**, *13*, 552. https://doi.org/10.3390/su13020552

Sweet potatoes produces 7-8 tons of dry biomass per hectare, has low water requirements, performs weed control, is drought-tolerant and pest-resistant, and can grow under high CO_2 concentrations. The crop matures in a very short time on marginal lands and play an important role in the economy of poor households. Sweet potatoes can be baked, cooked, fried, roasted and processed into flour and are a good source of vitamins A, C, B6, dietary fiber, manganese, copper, potassium, and iron. [45]Conventional agricultural biotechnology method of tissue culture of adaptive varieties can positively address the potential negative effects of climate change and complement other measures to improve agricultural productivity and food security. To expedite the adaptation of agriculture to climate change crop adaptation is necessary[46] and sweet potato varieties often exhibit local adaptation, especially landraces[47]. Plant tissue culture is large-scale sweet potato plant propagation essential tool. 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 (rain fed, irrigated) utilizing 7.65 – 10.30 million sweet potato plant cuttings[48]; 35% Sept – Dec (rain fed, irrigated) utilizing 5.36 – 7.21 million cuttings; 15% Jan – Mar (irrigated) utilizing 2.30 – 3.09 million cuttings.



[49]Superior genotypes can be propagated using plant tissue culture in an efficient and cost-effective method and researchers can be assured that plants propagated and transferred to farmers are free from pathogens. This reduces the need for chemical pesticides and promotes eco-friendly farming. In vitro selection carried out under controlled environment conditions in confined spaces is highly effective and cheaper to maintain. Barbados has reliable and established tissue culture protocols for local sweet potato and yam varieties[50]. Sweet potatoes do not produce seed and plant tissue culture aids in the speedy production of high-quality, disease-free plants year round and plant tissue culture techniques support their present and future agriculture[51]. **Figure 4: Barbados Sweet Potato Varieties**

[52]In 2020, research on 15 varieties of sweet potato across five Caribbean countries, identified several drought-tolerant varieties under commercial production in Dominica ("SDPW-01" and "SRDY-DOM"), Grenada ("Cricket Gill" and "Hucky"), Jamaica ("Ganja" and "Fire on Land"), and St. Lucia ("SSLYY"). [53]These climate resilient varieties are an excellent choice for production as the region continues to experience more severe dry seasons[54]. In addition to drought, sweet potato is affected by many RNA viruses where [55]Geminiviridae and Caulimoviridae

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[45] Modern biotechnology for climate change adaption of crops April 2024 DOI: 10.13140/RG.2.2.15309.24804
International Journal for Biotechnology and Molecular Biology Research Vol. 2(13), pp. 222-231

[46] Crop adaptation to climate change: An evolutionary perspective, Molecular Plant, Volume 16, Issue 10, 2023, Pages 1518-1546, ISSN 1674-2052, https://doi.org/10.1016/j.molp.2023.07.011. (https://www.sciencedirect.com/science/article/pii/S1674205223002137)

[47] Crop adaptation to climate change: An evolutionary perspective, Molecular Plant, Volume 16, Issue 10, 2023, Pages 1518-1546, ISSN 1674-2052, https://doi.org/10.1016/j.molp.2023.07.011. (https://www.sciencedirect.com/science/article/pii/S1674205223002137)
Wijerathna-Yapa A, Hiti-Bandaralage J. Tissue Culture-A Sustainable Approach to Explore Plant Stresses. Life (Basel). 2023 Mar 14;13(3):780. doi: 10.3390/life13030780. PMID: 36983935; PMCID: PMC10057563.

[48] The sweet potato vine is cut into pieces about 1ft long (cuttings) and used as planting material for a new crop.

[49] Variability of Morphological Characters in the Sweet Potato [Ipomoea batatas (L.) Lam.] Varieties under Barbados Agro-climatic Conditions August 2012, Conference: 2012 ASHS Annual Conference

[50] https://www.cardi.org/wp-content/uploads/2011/02/Sweet-Potato-Prod-Tech-Guide.pdf

[51] Application of Plant Tissue Culture in Crop Improvement November 2024 DOI: 10.37446/volbook032024/93-114
In book: Advances in Plant Biotechnology Chapter: 5 Publisher: Cornous Publications LLP, Puducherry, India

[52] Journal of the Caribbean Agro-Economic Society Volume 12: No: 1 Dec 2020. A Sweet Potato Farmer's Guide for the Selection of Sweet Potato Cultivars in Barbados using Physical Characteristics and Total Sugars. Evangeline Ragoonath-Devonish; Nelissa Thomas; Dr. Angela Alleyne, UWI

[53] https://youtu.be/zac7QzMccPg?si=mNA9-j7AD2TrDl25

[54] Plant Tissue Culture Current Status and Opportunities in a Changing Environment Editors: Zahid Hameed Siddiqui, Khalid Rehman Hakeem, **ISBN:** 9781774917275

[55] Alleyne, A.T., Cummins, C., Rowe, K. *et al.* Sequencing and assembly of small RNAs reveal the presence of several begomoviruses, potyviruses, badnaviruses and mastreviruses in the sweet potato leaf virome in Barbados. *J Plant Pathol* **101**, 339–347 (2019). https://doi.org/10.1007/s42161-018-00214-1

accounted for more than 75% of the virus found in the sweet potato leaf in Barbados[56]; sweet potato virus infection remains the main biotic constraint on production in many countries[57]. These asymptomatic and endemic viruses can hinder the production of virus-free plants for new planting material in clean plant management systems involving plant tissue culture production. Sweet potato production in Barbados has been affected in the past by viruses[58], however the Home Agriculture Station in Barbados supplies disease-free planting material to farmers for sweet potato production. Disease management has focused on the use of clean planting material derived from tissue culture. Under the 2021 FAO Project TCP/BAR/3701, a *Manual for Production and Selection of Clean Planting Material by Sweet Potato Farmers in Barbados* was developed[59]. In 2021, the Ministry of Agriculture and Food Security and the University of the West Indies campus in Barbados, in collaboration with the Food and Agriculture Organization of the United Nations (FAO), launched a project aimed at training farmers and establishing plant nurseries for producing clean planting material through tissue culture. Ongoing farmer training, both formal and informal, includes activities such as identifying disease symptoms, managing weeds, and raising awareness about wild *Ipomoea* species that can host sweet potato viruses[60] [61].

Project/Programme Objectives:

This project seeks to support the agriculture and education sectors in becoming more climate resilient by: harvesting rain water and storm water to be utilized for irrigation; supporting farmers in adopting climate smart technologies and plant varieties through information dissemination by Agricultural Extension Officers and providing disease-free tissue culture plants in staple crops like sweet potatoes; supporting farmers in increasing locally grown fruits and vegetables for import substitution; improvement of Ministry of Agriculture and Food Security tissue culture and nursery facilities to increase plant production capacity; promoting and encouraging agricultural school yard programs and student agriculture training, elimination of water wastage in schools and farmers markets by installing water saving devices and expanding water conservation education.

The adaptive capacity of Barbados to adjust to and respond to the climate changes and impacts on the agriculture and water sector are being supported in an important way by this project. By supplying irrigation water harvested during storm events farmers are able to increase production year round and flooding of farmers' fields is reduced as the excess water is channeled to the storm water pond. The increased production of disease free tissue culture sweet potato plants and their distribution free of charge to farmers contributes to the growing of this staple crop, the production of which is hampered by virus disease spread. Tissue culture propagation of drought-tolerant sweet potato varieties contributes to increased food production under adverse conditions. Sweet potatoes are the largest Barbadian agriculture commodity and >1000 metric tonnes are grown annually with 2000 metric tonnes in 2019. According to the Barbados Water Authority, 35.5 million cubic meters of potable water are used annually by all economic sectors combined, where schools utilize 0.8 million cubic meters. The reduction of water wastage and leakage on school compounds as well as increasing the knowledge of youth about the importance of water conservation, the impacts of climate change is being sought[62].

The storm water pond under Project Component 1 is intended to provide irrigation water to Spring Hall farmers as direct beneficiaries, whilst the indirect beneficiaries are farmers' households and the population of Barbados with access to larger amounts of local vegetables and root crops at a lower price than imported ones. The pilot

[56] A.T. Alleyne, C. Cummins, K. Rowe, M. James, D.L. Gutierrez, S. Fuentes, Sequencing and assembly of small RNAs reveal the presence of several begomoviruses, potyviruses, badnaviruses and mastreviruses in the sweet potato leaf virome in Barbados, J. Plant Pathol. 101 (2019) 339–347, https://doi.org/ 10.1007/s42161-018-00214-1.
J.F. Kreuze, A. Perez, M.G. Gargurevich, W.J. Cuellar, Badnaviruses of sweet potato: symptomless coinhabitants on a global scale, Front. Plant Sci. 11 (2020) 313, https://doi.org/10.3389/fpls.2020.00313

[57] Angela T. Alleyne, Structural and functional analysis of a resistance gene and resistance gene analogs in local cultivars of Ipomoea batatas Lam. from Barbados, Physiological and Molecular Plant Pathology, Volume 120, 2022, 101855, ISSN 0885-5765, https://doi.org/10.1016/j.pmpp.2022.101855.

[58] James MS, Phillip MT, Fuentes S, Salazar LF (2003)A study on the cause of sweet potato virus disease in Barbados. Bridgetown. In: Proceedings of the Barbados National Agricultural Conference 2003: agricultural research and development: meeting the challenges of the 21st century. 10pp Karyeija RF, Kreuze JF, Gibson RW,

[59] Manual on Nursery Production and Selection of Sweet Potato Planting Material, Department of Biological and Chemical Sciences, University of the West Indies Cave Hill Campus and Ministry of Agriculture and Food Security Barbados

[60] Tennant, P.; Rampersad, S.; Alleyne, A.; Johnson, L.; Tai, D.; Amarakoon, I.; Roye, M.; Pitter, P.; Chang, P.-G.; Myers Morgan, L. Viral Threats to Fruit and Vegetable Crops in the Caribbean. *Viruses* **2024**, *16*, 603. https://doi.org/10.3390/v16040603

[61] Caribbean Development Bank 2023 Annual Report CDB funded the Regional Sweet Potato Value Chain Enhancement and Technology Transfer project, executed by the Caribbean Agriculture Research and Development Institute. The project produced a sweet potato value chain analysis, market assessment, and development of business cases and investment profiles

[62] Reimagining Education in Barbados- A Bright Future for Every Child Ministry of Education and Vocational Training October 2023

study chemical and biological profiling of irrigation water will encompass the major farming districts in Barbados including Spring Hall benefitting farmers nationally and contribute to Barbados' environmental stewardship to reduce water pollution. The enhancement of the tissue culture laboratory to ramp up the production of sweet potato and other vegetable plantlets is intended for the direct farmer beneficiaries in Spring Hall and nationally and the indirect beneficiaries are the Barbadian consumers. The greenhouse nursery and field nursery are essential supporting structures since tissue culture plants cannot be planted directly into open fields from the lab they must be acclimatized or "hardened" first. The Tissue Culture Laboratory and the Greenhouse and Field Nursery are located at the Ministry of Agriculture and Food Security compound. Agriculture extension services are required for the transfer of technical knowledge e.g. in climate smart methods to the grassroots farmers and are intended to benefit the farmers in Spring Hall and farmers in all the farming districts of Barbados. The Ministry of Agriculture and Food Security has an existing Farmer Field School and demonstration plots located on its compound and this facility will also be utilized to support the farmers at Spring Hall; Barbadian farmers are accustomed to visiting the Ministry for workshops and training.

The farm families from Spring Hall which is estimated population of 2 200[63] would be the direct beneficiaries of the rainwater harvesting pond (100 000 cubic meters) since the availability of irrigation water year-round allows crops to be successfully grown even during the dry season. In addition, with the expansion of the Ministry of Agriculture and Food Security tissue culture and nursery facilities, the entire farming Barbadian population which is approximately 6,500 farmers (26 000 individuals in farm families) would benefit from sweet-potato planting material and other crop plants. 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[64].

This project has three complementary outcomes:

Outcome 1: Increased adaptive capacity within the agriculture and education sector services

Outcome 2: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level

Outcome 3: Strengthened livelihoods for vulnerable farmers in targeted areas

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

Environmentally, storm water collection is pivotal in reducing the demand on the BWA potable systems by farmers. 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. By integrating rainwater harvesting into agriculture, the Spring Hall farming community can become more resilient to increased precipitation variability and flooding. Spring Hall has an inadequate irrigation water supply for the dry season and floods 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. According to the Spring Hall Farmers Association, flooding and drought led to individual farmers losing crops and income of up to 50 000 USD in 2019 -2023. **Figure 5: Potential Pond Site at Spring Hall[41]; 2019 Flood in farmers field[65].** Climate change is imposing additional stress on Barbados' agricultural systems and can lead to an increased reliance on antibiotics, pesticides and herbicides for the protection of crops and livestock against pests and diseases. This heightened use may contribute to the emergence of antimicrobial resistant bacteria which can disseminate through water, soil, and farm produce. The interconnection between climate change and antimicrobial resistance presents a challenge where environmental changes e.g. rising temperatures, accelerate microbial reproduction.

[63] Assuming a farm family comprised of four individuals

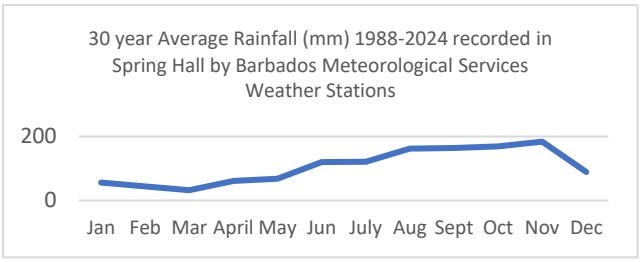
[64] NCDs are responsible for eight out of 10 deaths in Barbados, with approximately 66% of the population being either overweight or obese. A projected 39% of the population will be living with obesity, with an economic burden of 4.6% of national GDP by 2035, according to the World Obesity Atlas 2023. The current percentage of overweight or obesity in children is 31%. https://www.hsfbarbados.org/world-health-day-2023-presidents-message/

[65] https://www.facebook.com/share/r/12DScdjASMC/





The Spring Hall Land Lease (SHLLP) [66] currently has nineteen longstanding farmers utilizing one hundred and thirty nine and one half acres (139.5) of the Spring Hall Land Lease and the main crops grown are: cucumbers, melons, sweet peppers, cabbages, peppers, okras, potatoes and yams. The BADMC FEED program also has 52 farmers managing 54 parcels of land in Spring Hall and more farmers from the FEED program are being placed at Spring Hall. During drought periods, farmers receive as little as 2 hours of water being pumped to their farms from the BADMC Irrigation wells in the areas and this is insufficient for planting needs; the provision of additional irrigation water in a new catchment would be beneficial and support farming activities and reduce flooding in Spring Hall.



The BADMC initiated a study [67] into the construction of ponds for the storage of rainwater runoff for irrigation; excess runoff can be stored during the high rainfall months (Aug – Nov) to sustain irrigation during the five dryer months (Jan – May). This 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 main conclusions from the STANTEC study were that: the rainfall runoff from the Spring Hall (Watershed 'A') and Chance Hall (Watershed 'B') is more than adequate to fill the ponds at Spring Hall and Chance Hall in a single wet season and refill the ponds annually in the wet season following irrigation by farmers through the dry season. The irrigation of 101 hectares (250 acres) can be achieved by constructing a pond of approximately 389 Million Litres (100 Million Gallons) at Spring Hall (Pond P1). Carrying out a phased development with the construction of the Spring Hall Pond (P1) with a watershed of 329 hectares (812 acres) and later adding the Chance Hall Pond (P2) with a watershed of 133 hectares (325 acres) would harvest rainfall runoff which currently flows into the sea at River Bay. The storm water runoff from the watersheds flows in separate natural watercourses formed in the landscape and converge at a point the River Bay outlet to the sea and this valuable, un-utilized fresh water resource can be harnessed to support small farmers in the area. The configuration of each watercourse offers the opportunity to locate storage ponds on the Spring Hall Watercourse[68]. The pond sites were assessed to determine their suitability and capacity for storage of runoff and the Spring Hall Pond 1, was selected as its estimated cost fits within the project expected budget. An "Irrigation Water Requirements Model" was used to assess the farmland area that can be maintained with sustainable irrigation from Spring Hall Pond 1[69]. Barbados has a projected annual mean precipitation decrease by about 9% in May- July and an extended dry season by two months the availability of irrigation water will be crucial for farming. Projected increased temperatures affect the seasonality of crops and increase evapotranspiration rates. The effects of climate change are already evident in Barbados with increased rainfall during storms and flash-flooding magnitude and frequency. In terms of water consumption, irrigation is second only to domestic use and harvesting rainwater, including that from flash floods represents a sustainable source of water to boost farming productive activities.

An Energy Audit[70] of the BADMC was conducted including its twenty irrigation pumping stations nationwide. Irrigation pumps normally run on a twelve hour cycle from 6a.m. - 6p.m. The schedules also depend on the water

[66] Stakeholder Meeting Report – BADMC Spring Hall Land Lease Farmers Speightstown Barbados 20 January 2020

[67] **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

[68] The Government of Barbados owns these lands

[69] 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

[70] BADMC Energy Audit Report 2019

levels in the irrigation wells, where low water levels during drought impact the running times of up 6 hours; pumps can run for six hours every other day for different sections within an irrigation district. The average monthly consumption at the pumping stations is 72,928 kWh including at Spring Hall, St. Lucy. More water needed to irrigate crops means more electricity is used to pump the water and continued operation of the pumps and 12-4pm represent the peak demand period for electricity. This Energy Audit recommended replacement of existing irrigation pumps with solar pumps supported by battery backups.

Outputs 1.1: Water harvesting via a storm water pond in Spring Hall

Activity 1.1.1: Construct a 100 000 cubic meter storm water pond to provide irrigation water on farms

Activity 1.1.2: Install a solar-powered climate resilient pump and irrigation system from the storm water pond to 71 farms in Spring Hall

Output 1.2: Institutional strengthening of BADMC and Ministry of Agriculture and Food Security in irrigation management

Activity 1.2.1: Provision of specialized technical job training and technical courses (climate resilient agriculture) for Ministry of Agriculture and Food Security personnel

Activity 1.2.2: Provide guidance to St. Lucy school agriculture programs on efficient water management and rainwater harvesting

Output 1.3: Chemical and biological profiling of Irrigation Water Sources –Pilot Study

Activity 1.2.1: Conduct water quality testing at sources in BADMC farming districts (Spring Hall, River, Lears, Haggatts)

Activity 1.2.2: Conduct AMR surveillance in the BADMC farming districts on Livestock and Crop Farms

Activity 1.2.3: Analyse and evaluate the results of the pilot study to support improved environmental management

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

Tissue Culture

The Ministry of Agriculture and Food Security Plant Tissue Culture Laboratory (PTCL) plays an integral role in plant propagation of food crops to strengthen Barbados' food security especially disease-free planting material for root crops e.g. sweet potatoes and cassavas. The tissue culture laboratory will also contribute plant material which can be used by 6500 beneficiary farmers nationwide to increase production of vegetable crops that are imported into Barbados in large quantities. The Ministry is 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 and maintains some indigenous seeds e.g. "local" cucumber, pumpkin, finger squash, pigeon peas. A field nursery is needed to maintain twenty productive open pollinated and heirloom seeds from major crops including tomato, sweet pepper, bean, okra, lettuce, cabbage, butternut squash, and watermelon; protection by full insect proof netted structures and plants grown in rows under row covers are required. Four 3,000 sq. ft. greenhouse nurseries are needed for sweet potato cuttings. An additional four 3,000 sq. ft. greenhouse nurseries will be needed to propagate the other row crops.

Table 3: Barbados Sweet Potato Farmers

Farms	Sweet Potato Plant Spacing (centimeters)	# Sweet Potato cuttings /5 meters	Average Kg Yield/ 5 meters
Edgecumbe	38	6	14-18
Valley	15-25	10	11-26
Armag	38-43	7/8	11-18
Foursquare	46	6	9

In 2024[71], Barbadian farmers noticed a complex of viruses attacking the sweet potato crop, slashing yields and driving prices up. There is an island-wide shortage of sweet potatoes with a pound of sweet potato now costing 3.5 USD, a 2.5 USD increase. The impact of the viruses is so severe that a 10-acre field, which typically yields 50 000 pounds (22 680kg) of sweet potatoes, now produces 10 times less. Viruses have also increased production costs, forcing farmers to use more fertilizer to maintain yields. Sweet potatoes, which traditionally

[71] https://barbadostoday.bb/2024/12/24/farmers-turn-to-lab-grown-slips-as-virus-cripples-sweet-potato-production/

take 14-16 weeks to mature, now require longer periods due to viruses, and adverse weather has exacerbated the problem. Farmers can improve yields with clean planting material in sufficient volumes. The Ministry of Agriculture is assisting farmers through the tissue culture lab, to produce and distribute clean planting material, but it will take time to scale up to meet demand. Tissue culture plants are supplied to farmers free of charge. The Tissue Culture Laboratory, field and greenhouse nurseries are located at the Ministry of Agriculture and the tissue culture plants produced there are collected from there by the farmers.

The PTCL is skilled in the micro propagation of root crops and these methods are taught to Barbadian farmers nationwide and agriculture students from the Barbados Community College, Samuel Jackman Prescod Institute of Technology and University of the West Indies[72]. Barbados PTCL Tissue Culture practitioners participate in training courses, most recently in (2024) on obtaining clean, virus tested sweet potato tissue culture plants through a collaborative effort between The Ministry of Agriculture and Food Security and The Louisiana State University Agriculture Centre[73]. Trainings include: propagation of virus-tested sweet potato, virus (testing, indexing, nucleic acid extraction and analysis, eradication through meristem tip culture) and surface sterilization techniques. [74]With Barbados' thrust towards greater food security and reducing food imports, and the PTCL requires an expansion of its capacity and infrastructural modifications. The Ministry of Agriculture and Food Security HOME Agricultural Station Development and Strategy Report 2024 provided a comprehensive review and analysis of needs along with recommendations and specifications. Barbados current national yield of sweet potatoes 14 000 kilograms can be increased with tissue culture. Structuring the tissue culture supply of sweet potato for large farmers engaged in commercial production on a permanent, self-sufficient basis, is essential to follow a continuing program for developing and maintaining superior stocks. A tissue culture laboratory with a growth room capacity of a minimum of 30,000 plantlets is needed; 14,000 plantlets to meet sweet potato planting targets and capacity of 16,000 plantlets of other types for vegetables in import substitution. Once cuttings from tissue culture plants are transferred from the greenhouse to the field nursery, this is when tremendous multiplication happens. With Barbados having all year round warm climate, there is no winter season to break pest and disease cycles. Therefore, the field nursery must be protected by full insect proof netted structures or plants should be grown in rows under row covers or knitted plastic. A crop rotation program is also required to reduce risk of soil pathogen and pest buildup.

Agriculture Extension

The role of agricultural extension is fundamental in building the capacities of Barbadian farmers and helping them to maintain good agricultural practices. In Barbados 80% of the strategies employed, include face-to-face interaction, farmer field schools, demonstration plots, training through workshops and seminars and training and visits. Important in the context of climate change is knowledge, technology and innovations associated with coping and managing variability and natural hazards. Knowledge transfer is recognized as a key process in change management and technology adoption. The BADMC has five Extension Officers to service twenty-eight farming districts including the (IRDP, Land Lease and FEED)[75]. This is stretching Extension Officers thin and not allowing for them to adequately service the farmers. Novice farmers need a greater level of monitoring and support to develop their skills and knowledge. Ministry of Agriculture's Extension Services Unit, Virtual extension assistant (Launched Feb 2025)[76], aims to provide farmers with technical information and training to improve efficiency and profitability in their farming operations, focusing on sustainable and commercial agricultural practices and also as a tool for collection of national agricultural data. A structured delivery mechanism will strengthen national capacities to mitigate and adapt to agricultural related climatic hazards e.g. the Barbados Meteorological Service[77] has Weather Stations in close proximity to Spring Hall where data assists farmers in determining which crops to plant. Farmers are being heavily impacted by climate change and Extension Services assists them with adopting Climate Smart Agriculture practices in line with Barbados' National Agriculture and Climate Change Policy.

[72] https://www.facebook.com/CARDIcaribbean/posts/-barbados-20-lead-and-secondary-ring-coconut-farmers-have-received-100-coconut-s/2377571465724004/

[73] https://www.lsuagcenter.com/topics/crops/sweet_potatoes Established in 1949, the LSU AgCenter Sweet Potato Research Station in Chase, Louisiana dedicates research, innovation and service to the sweet potato industry

[74] Ministry of Agriculture and Food Security HOME Agricultural Station Development and Strategy Report 2024

[75] Agriculture Production Acceleration 2023, Ministry of Agriculture and Food Security

[76] https://www.facebook.com/gisbarbados/photos/-as-it-works-to-improve-and-enhance-engagement-with-farmers-across-the-island-th/1056816753151407/

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

Outputs

Output 2.1: PTCL Tissue culture laboratory and growth room capacity to accommodate 30 000 plantlets

Activity 2.1.1: Construct and provision a tissue culture laboratory with a growth room capacity of a minimum of 30,000 plantlets utilizing designs and specifications in the HOME Germplasm Station Development Report

Activity 2.1.2: Supply tissue culture plants to farmers and St. Lucy school agriculture programs

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

Activity 2.2.1: Construct Four (4) 3,000 sq. ft. greenhouse nurseries for sweet potato cuttings and four (4) 3,000 sq. ft. greenhouse nurseries to propagate row crops (yam, cassava, plantain, banana) utilizing designs and specifications in the HOME Germplasm Station Development Report

Output 2.3: Field nursery established for rapid multiplication of planting materials and indigenous heirloom plants

Activity 2.3.1: Construct an insect-proof[78] field nursery of 5 acres to accelerate plant multiplication in clean, controlled conditions utilizing designs and specifications in the HOME Germplasm Station Development Report

Output 2.4: Institutional strengthening of BADMC and Ministry of Agriculture and Food Security technical capacity in agricultural extension in climate smart cultivation

Activity 2.4.1: Provide specialized technical job training and courses for Ministry of Agriculture and Food Security personnel

Activity 2.4.2: Expand farmer climate smart cultivation practices in Spring Hall through extension services demonstrations and field guides

Activity 2.4.3: Support school agriculture programs in St. Lucy in adopting climate smart cultivation practices

Activity 2.4.4: Partner with the existing Ministry of Agriculture and Food Security Agriculture Extension Unit in the execution of their mandate to collect and analyse farming data and provide targeted training for farmers for the project

Component 3: Strengthened climate adaptation capacity for water conservation in agriculture and education sectors

Project Component 3 seeks to improve conservation of potable and irrigation water so that the amount of water that is extracted from Barbados' aquifers is reduced especially during drought; farmers use potable water for irrigation when rainwater or irrigation water is not available. BADMC Irrigation wells draw water from the same aquifers that potable water wells draw water from; potable water is subjected to microbiology testing and is treated with chlorine before distribution whilst irrigation water is raw un-chlorinated well water. Barbados is one of the most water scarce (< 305 m3 of renewable freshwater per capita per year) and is facing a predicted, climate change induced 15-30% reduction in rainfall[79]. In 2018, Barbados water stress level was 87.5 percent, indicating that the country is very close to withdrawing all of its renewable freshwater resources of 80 million m3/year and the country is experiencing rapid depletion of freshwater aquifers, an increase in saline intrusion, and pollution of groundwater resources and coastal seawater. Extracting water, treating it to make it potable or not efficiently utilizing it represents and unnecessary drain on this valuable resource. Efficiency gains in water conservation can be achieved through use of water saving devices in educational institutions, improvements in existing farming irrigation systems, building farmer education on aspects such as evapotranspiration rates and linkages to environmental conditions, climate smart crop selection and applying drought and climate outlooks to crop planning guided by Extension Officers (Component 2). Increasing water conservation means that Barbados' limited water resources can stretch farther - for example tissue culture sweet potato plants which have all their water demands met by irrigation and/or rainfall produce larger yields and better quality tubers, whilst if water demands are not met produce smaller tubers and poorer yields are the result. Sweet potatoes are usually irrigated using a rain gun which discharges 20-100 cubic meters of water per hour depending on water pressure-drip irrigation is not used for sweet potatoes because the method of harvesting involves digging which would damage irrigation lines.

[78] White flies transmit the sweet potato virus complex

[79] Barbados 2021 Update of the First Nationally Determined Contribution

[80]Declining water availability for irrigation is adversely affecting agriculture production, and can cause environmental degradation by groundwater over-abstraction, therefore the Ministry of Agriculture and Food Security is actively engaged in promoting high efficiency irrigation and improved water management practices. Surface drip irrigation is popularly used by Barbadian farmers because it offers efficient water delivery directly to plant roots, conserves water and nutrients and doesn't promote foliar disease. However, it has high initial costs, clogs with debris and salts, can be damaged by farm machinery and extreme weather and the sun affects the tubes, shortening their usable life. The Barbadian terrain is mostly flat and level and this is compatible with a non-pressure system and the flow rates at which irrigation water is provided. Installing a drip irrigation system can be complex for large, irregular fields and if not done properly can waste water.

The BWA [81] supplies potable water at a subsidized cost as a public good and minimizing wastage ensures there is enough potable water for all economic sectors. According to the BWA, 35.5 million cubic meters of potable water are used annually where the Ministry of Education, Technological and Vocational Training and its associated educational institutions consumed 4 041 972 cubic meters of water from 2018 - 2023. This means that approximately 3% of Barbados' potable water was consumed annually by educational institutions. BWA water meter readings from 371 registered farms showed that 2018-2024, 1 859 581 cubic meters of potable water were used with an average of 265 654 cubic meters of potable water annually. With an estimated 6500 farmers in Barbados, it can be extrapolated that over 4 000 000 cubic meters of potable water is being consumed by farming annually. Data from the BADMC Irrigation showed that from 2022-2024, 3 203 303 cubic meters of irrigation water was pumped or an annual average of 1.07 million cubic meters. . A rough estimate of water consumed by agriculture (potable and irrigation) is equivalent to 5 million cubic meter annually.

The BADMC has 9 well houses[82] at 25 farming areas across Barbados which draw water from irrigation wells for distribution. Farmers (including those at Spring Hall) do not rely solely on irrigation water supplied by BADMC, many are also connected to the BWA potable water system. When the BADMC is not able to supply sufficient water especially at drought time or their particular crop needs additional water, farmers switch to potable water for irrigation. When there is drought, BWA water pressure becomes low and there are scheduled and unscheduled water outages as residences and businesses are using the same limited water source as farmers, leading to crop irrigation reduction and sometimes inadequate irrigation. During drought, BADMC rations irrigation water to farmers by pumping water for several hours and then stopping; this is also used to ensure that the irrigation wells do not draw up salt water. In 2019, BWA wells in St Lucy (Spring Hall) were impacted by the extreme drought resulting in less available aquifer groundwater and increased salinity in wells supplying St Lucy and St Peter districts[83]. The BWA instituted nightly shutoffs and also provided a water tanker service as a temporary measure for householders; farmers had to fend for themselves as BADMC irrigation water was also reduced. Barbados' aquifers are comprised of a fresh water lens floating on salt water. Since mid-2022, the Ministry of Agriculture and Food Security offers officially registered farms a special agriculture water rate for BWA potable water used in farming at 0.90[84], BADMC Irrigation water is charged at the same rate; before 2022 farmers paid up to 3.89 USD per cubic meter of potable water depending on volume consumed. From April 1st 2025, all registered farmers can now access an agriculture water rate of 0.50 USD per cubic meter (BADMC Irrigation Water and BWA Potable Water) as agreed by the Cabinet of Barbados.

The Ministry of Agriculture and Food Security maintains an attractive marketing infrastructure in an effort to promote vending, entrepreneurship and encourage patronage, and ensures that persons engaged in marketing produce do so in proper sanitary conditions. There are eight public markets in Barbados utilized by farmers, citizens, hucksters and hawkers of vegetable and fruit produce daily: Aberdeen Jones Centre, Cheapside Public Market, Eagle Hall Public Market, Fairchild Street Public Market, Glebe Public Market, Marhill Street Market, Palmetto Mall and Market, Six Cross Roads Public Market. These are utilized by over 740 vendors of produce and other goods, farmers and hawkers daily. BWA data from the five largest public markets showed an average annual water use of 49 000 cubic meters; these markets do not currently have water saving devices or specific

[80] The World Bank, Barbados Green Recovery and Resilient DPL (P179112) Report Number: PDG 383
[81] https://nationnews.com/2024/03/19/pm-pushing-water-saving-devices/#
[82] Belle, Ruby Well, Daniel, Dixon, Shepherd, Spring Hall Land Lease, Stuart, Mount Poyer, King Road
[83] https://barbadostoday.bb/2019/10/30/bwa-well-sources-in-st-lucy-impacted-by-extreme-drought-like-conditions/amp/
[84] This was introduced in 2022, in previous years farmers paid standard rates depending on the volume of water used up to 3.89 USD per cubic meter

water saving programs. Markets require potable water for cleaning and fluming because it helps prevent the spread of foodborne illnesses and spoilage. Farmers are therefore consuming potable water for irrigating, growing and selling their crops at markets and saving water at every step of the production and marketing chain leaves more in the aquifer.

Project component 3 ties into Barbados' wider goals under the CARICOM 25 by 2030[85] agenda to reduce food imports, improve youth engagement in agriculture and build resilience. The [86]Ministry of Education, Technological and Vocational Training has been pushing for every student across Barbados to learn about agriculture and sensitize them on the importance of food security and helping them to understand and appreciate the local foods. Individual schools have activities for World Food Day with themes e.g. 'Local Foods, Endless Possibilities', activities to transform schoolyards into food hubs using low-cost wick garden beds made from recycled buckets[87], School Agriculture Entrepreneurship Programs focused on developing the entrepreneurial skills in youth already involved in agriculture[88] and school ground climate smart agriculture food production systems[89]. Youth involvement is essential for sustainability of Barbados' agricultural sector. This project is supporting students through training and initiatives that encourages innovation, agricultural careers and entrepreneurial potential of young farmers. For example, the growing of tissue culture plants which are disease free, give large yields and can produce at a faster rate, knowledge building and hands-on activities where students grow and harvest vegetables for themselves is key to attracting younger generations to agriculture. Supporting student learning leads to sustained, positive change and providing youth with experience, knowledge, and skills, which they can apply to food production. With agriculture school programs in St. Lucy benefitting from expertise and tissue culture plants, these student farmers gain access to free produce which they can take home to bolster their household food security. Component 1 water harvesting + Component 2 Tissue Culture Plants and Other Crop Plants and Agriculture Extension+ Component 3 Water Saving and Student Farming increasing their household food security = Increased Agriculture Production.

Rainwater harvesting in drums from school house roofs is the method used to supply irrigation water for school gardens. These ongoing activities demonstrate to students the link with climate smart agriculture, water conservation, water harvesting[90] all together because being climate smart is a theme, and installing water conservation devices on the school compound (taps, toilets, hoses etc.) teaches and reinforces the value of scarce water resources. Barbados' educational institutions accommodate up to one thousand students using the facility daily, and replacing traditional taps, hoses and toilets with water-saving versions can significantly reduce school water usage[91]; toilets are one of the biggest uses of water in schools. Demonstrating the proper use of water saving devices is important as it keeps maintenance costs to a minimum since schools are high traffic areas with "high wear and tear". During school vacation and holidays, the facilities are used for summer camps and community activities, also subsistence farmers living in the environs may use outdoor taps to water their livestock. The BWA has a Water Conservation Program[92], where school students are taught about water conservation and educational visits to water pumping stations are hosted and St. Lucy schools will be targeted under this project.

Output 3.1: Water conservation methods implemented

Activity 3.1.1: Conduct a water audit of highest water-use schools in St. Lucy, central agricultural market (Cheapside) and farming irrigation systems at Spring Hall farms to identify water conservation areas.

Activity 3.1.1 a: Procure and install/ retrofit appropriate water saving devices at schools, agriculture markets and farmer irrigation systems

Activity 3.1.1 b: In association with St. Lucy School science departments, use the installation of water saving devices as a teaching lesson/demonstration

[85] https://caricom.org/food-security-initiative-expanded-extended-to-2030/
[86] https://www.loopnews.com/content/education-chief-pushing-for-agriculture-in-all-schools/
[87] https://barbadostoday.bb/2025/03/27/growing-tomorrow-students-spearhead-food-security-initiative/amp/
[88] http://www.barbadosentrepreneurshipfoundation.org/agriculture-challenge/
[89] https://www.cardi.org/blog/schools-among-the-recipients-of-climate-smart-agricultural-food-production-systems-in-barbados/
[90] https://www.facebook.com/share/p/1Gu3KfpSwE/
[91] This objective has been defined as per the MSIDC Brief and critical to the Ministry's Preventative Maintenance Plan/Maintenance Schedule
[92] https://www.youtube.com/watch?v=A2oQr5VzsZ4 BWA Water Wednesdays

Activity 3.1.1 c: Create and execute plans for water-use schools in St. Lucy, central agriculture market (Cheapside) and Spring Hall farmer irrigation systems based on water audit findings

Activity 3.1.1.d: Execute knowledge transfer and sensitization sessions with students and farmers on proper use of water saving devices as a collaborative effort led by the Barbados Water Authority

Activity 3.1.1 e: Evaluate effectiveness of water saving devices via water bill assessment (Cheapside Central Market) and Spring Hall farms visits

Activity 3.1.2: Conduct extension officer outreach to farmers in Spring Hall on improving water efficiency in crops utilizing all available tools (e.g. crop evapotranspiration rates, soil moisture requirements, drought outlooks and crop planning)

Output 3.2: Building Student Agriculture Program Capacity at Educational Institutions

Activity 3.2.1: Facilitate St. Lucy school student learning tours of Ministry of Agriculture Tissue Culture Laboratory/ Nurseries

Activity 3.2.2: Assist St. Lucy school agriculture programs with best-practice for tissue culture plant cultivation

Activity3.2.3: Ministry of Agriculture and Food Security Provide technical support to St. Lucy school agriculture programs on care and management of tissue culture

Project Theory of Change



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**	Increased adaptive capacity within the agriculture sector services and infrastructure assets	**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 farmers with root crop plants** **2. Greenhouse nursery established for the propagation of row crops** 3. **Field nursery established for rapid multiplication of planting materials**	Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas	**1, 500, 000**
3. **Strengthened adaptation capacity for water conservation in the education and agriculture sector**	**1. Water conservation methods implemented** **2. Stakeholder education in water conservation enhanced** 3. **School agriculture programs supplied with and cultivating tissue culture plants**	Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	**491, 614**
. Project/Programme Execution cost			**875,576**
Total Project/Programme Cost			**9,217,190**
8. Project/Programme Cycle Management Fee charged by the Implementing Entity (if applicable)			**782,810**
Amount of Financing Requested			**10, 000,000**

Projected Calendar:

Milestones	Expected Dates
Start of Project/Programme Implementation	**Q4 2026**
Mid-term Review (if planned)	**Q4 2028**
Project/Programme Closing	**Q4 2030**
Terminal Evaluation	**Q4 2030**

PART II: PROJECT / PROGRAMME JUSTIFICATION

Strengthening the adaptive capacity of farmers will pave the way towards vegetable production resilient to climate change. The project will work with 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, capacity building, outreach activities to bolster water security and 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) 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 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. 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

encompassing partners from the academic community and increasing the number of highly qualified personnel.

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.

The proposed activities under Components 1 and 2 will benefit specific farming communities and households in the following manner: farmers will have increased access to irrigation water and be able to grow crops year round as opposed to what currently obtains where farmers cease planting during droughts or lose crops during severe hot weather because evapotranspiration is high and keeping up with water is too costly. The Ministry of Agriculture and Food Security produced a Cabinet Note (22) /MAFS Agricultural Production Acceleration 2023 where aspects of Barbados' agriculture sector were analyzed including: Agricultural Imports, Retailers and Distributors Requirements, Market Peaks and Troughs, Quality and Standards, Technical Support, FEED Program Production Support, Crop Production Increases in 12 Short Crops and Accelerated Growth Enhancement. This information was used to determine the 15% production increase estimate in a supportive environment (e.g. year-round irrigation water and planting material like disease-free tissue culture sweet potato plants which give high yields). In addition, during farmers' stakeholder meetings it was indicated that year-round irrigation water and technical support were limiting production and once these were addressed vegetable production would increase. According to the BADMC, farmers in Spring Hall currently produce 12 000 metric tonnes per annum and with increased water, farmers themselves estimated that they can increase production by 15%[93]; farmers therefore have more vegetables to sell to increase income; farmers usually employ farm workers to assist with sowing, reaping, weeding etc. and this generates employment for skilled and unskilled persons who live close by the farms; according to the Central Bank of Barbados 2024[94], with current economic development the unemployment rate has fallen and this can contribute to social cohesion; adverse weather conditions have led to vegetable shortages and price increases and for Barbadian suffering with non-communicable diseases the availability of fresh, local produce is essential to maintain a healthy diet and according to the Barbados National NCD commission, affordable local produce will help[95]; public procurement of locally produced fruit and vegetables is less costly.

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. An increase in crop production is expected since water availability year round will be increased. Benefits will include savings accrued by farmers who currently supplement their water needs with potable water from the BWA. 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 and unexpected dry spells. The demand for tractor cultivation services will increase in the wet season and once the irrigation water is made available and with the support of Extension Officers, to access these services farmers will be able to maximize plot usage. Extension services practical training increases the quantity and quality of produce under

[93] Spring Hall Farmers Meeting Report Jan 2020

[94] https://barbadostoday.bb/2024/05/11/balancing-development-social-cohesion/

[95] https://barbadostoday.bb/2024/06/14/healthy-food-must-be-affordable-too/

the changing climatic conditions leading to farming households being able to raise farm profitability.

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 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 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 potable water system during the seasonal dry months. There is also the greater security of domestic market for local produce with improved access to irrigation water, 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. 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. Also, with school students learning about agriculture, food production and water conservation they contribute to sustainability of the initiative. 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. Due to the current high level of fresh food imports relative to Barbados' estimated annual crop production, it is not expected that significant growth in the domestic fresh food supply will be a disadvantage.

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[96]. An IADB commissioned report[97] 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

[96]Beckford, C & Rhiney, K. (2019). Globalization, Agriculture and Food in the Caribbean. United Kingdom: Palgrave MacMillan
[97]Shik, O, et al. (2016). Analysis of agricultural policies in Barbados. Inter-American Development Bank

that youth face several challenges including access to land, capital, technical expertise and mentorship[98]. 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[99].

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. 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 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. Free Extension services, free irrigation services, free tissue culture plants, resources and opportunities are equally available to both genders upon request to the Ministry of Agriculture and Food Security. Recognizing and addressing unintended gender biases in services provision or access monitored through collaboration and integration with the national work of the Bureau of Gender Affairs in the [100]Ministry of People Empowerment and Elder Affairs which collects data, conducts surveys, prepares national statistics and lends technical expertise to addressing gender issues. Gendered livelihood activities will be taken account of in service provision.

The climate smart vegetable varieties are to be grown at the demonstration plots at the Farmer Field Schools located on the compound of the Ministry of Agriculture and Food Security and after farmer training the produce is to be sold to the public at minimal cost to introduce it nationally and promote acceptance. The Ministry of Agriculture currently grows different type of produce such as watermelons, cassava, tomatoes to investigate agronomic traits and which are then sold to the public at below market rates; an activity which is very popular and well received by Barbadians.

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 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[101]. [102]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. 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.

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98 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

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

100 https://www.facebook.com/people.bds/?locale=cx_PH

101 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),

102 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

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 fruit trees by farmers. 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 conservation 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 project will also contribute to water conservation nationally in educational institutions and farmers markets.

Quantification of Project Benefits

Table 4: Barbados 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, poor quality in wet season
Pumpkin	Inconsistent supply. High spoilage, poor quality in wet season
Cauliflower	Very little to non-existent supply
Celery	Very little to non-existent supply
Cantaloupe	Inconsistent supply. High spoilage, poor quality in wet season

Application of financial metrics alongside qualitative and quantitative data, surveys, and key performance indicators to determine monetary value of the project benefits. Surveys of farmers' incomes from vegetable production and employment generation (e.g. number of farm workers hired and pay), cost of irrigation using rainwater vs cost of irrigation using potable water, numbers of crop cycles annually, prices fetched for different types of seasonal vegetables, ability to secure contracts to supply vegetable produce to government institutions based on price, volume, variety and consistency (compared to imported items of the same type), consumption levels of local produce and health indicators would support economic modelling. Data on the cubic meters of potable water saved to the aquifer by farmers by substitution with harvested rainwater, assessment of the reduction in flood damage to farmers' crops, increased acreage cultivated and value of the crops sold to local consumers, import substitution, and standard of living and Gini Coefficient for farmers are all metrics to quantify the project impact. A full cost benefit analysis and economic impact is to be conducted at the funding proposal stage.

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

Establishing a rainwater/ storm water harvesting pond to provide irrigation water for farming is an environmentally responsible action which will generate economic and environmental savings for the BWA and BADMC because farmers will limit utilizing potable water for crop farming and reduce reliance on water pumped by the BADMC from its irrigation wells contributing to lower operational costs.[103]. According to the STANTEC study, the Spring Hall rainwater pond would be refilled twice yearly meaning that the nominal value of the water would be 180 000USD. Data from the BADMC irrigation department, recorded an average usage of irrigation water used at Spring Hall over 2014 -2020 at 244 553 cubic meters. This means that the harvested rainwater will almost offset the irrigation water pumped, leaving it in Barbados' aquifer to be treated and converted to potable water. The economic cost of pumping and distributing water by both the BADMC and BWA is more than the cost at which it is sold to farmers; costs are subsidized by the Government of Barbados. According to the Home Agriculture Station Tissue Culture Laboratory[104] calculation based on current practice by Barbadian farmers, the estimated sweet potato yield per acre (0.4 hectares) is 9072-13608 kg under irrigation; if potatoes are rain-fed, yields can

[103] https://agriculture.gov.bb/Resources/Forms/

[104]Report on Determination of Requirements for Sweet Potato Planting Material, 2024, Tissue Culture Laboratory, Home Agriculture Station, Ministry of Agriculture and Food Security

decrease by 3-4 fold. The estimated number of sweet potato cuttings needed for planting per acre @ 30 centimeter spacing is 8,000, whilst @ 46 centimeter spacing is 5,300; planting material is free to farmers. Each virus-free tissue culture plantlet can yield approximately 14 cuttings, therefore 30 000 plantlets can yield ideally 420 000 cuttings and used for 79 acres of sweet potatoes (716 700 – 1,075,000kg harvest); a bountiful l harvest in 2025, twice yearly would be valued at almost 2.5-3.8 Million USD.

The installation of solar renewable energy powered irrigation pumps at the pond, reduces the BADMC carbon footprint compared to the current fossil fuel powered pumps. The Energy Audit[105] of the BADMC recommended water pumps at the pumping stations will reduce their electricity expense by approximately 28%. Optimizing water resource usage by harnessing water that naturally flows into the sea at River Bay from Spring Hall water courses during intense rain events, contributes to Barbados' overall water security with the added positive environmental impact of reduced flooding. Reducing potable water wastage and leakage at educational institutions and farmers markets by installing water-saving devices and repairing leaks supports national water conservation efforts. Investments in the upgrade of the Ministry of Agriculture and Food Security tissue culture laboratory, field and greenhouse nursery are necessary allowing for the increased production of disease-free tissue culture sweet potato plants. 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.

Table 5. Barbados Agricultural Product Imports 2021	Imports (KG)	Landed Value (USD)
Broccoli	1,288,447	4,337,948
Onion	1,540,233	798,662
Carrot	554,780	734,062
Lettuce	424,146	684,247
Cabbage	477,479	608,615
Sweet Pepper	252,336	673,723
Tomato	213,733	249,294
Watermelon	223,769	295,683
Pumpkin	122,863	149,258
Cauliflower	73,446	133,813
Celery	189,957	209,068
Cantaloupe	53,761	87,045
Banana	2,053,335	1,006,291
Plantain	1,336,625	870,939
Pork	2,071,954	7,636,254
Lamb	990,049	6,862,685
Milk	298,783	304,042
Total	**12,165,696**	**25,304,763**

An analysis of Barbados' food import bill shows that Barbados has the natural resources to reduce the agricultural foods on the food import bill by 25%106. The Ministry of Agriculture and Food 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%. The MAFS analyzed imports of thirty short crops107 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 (broccoli, onion, carrot, lettuce, cabbage, sweet pepper, tomato, watermelon, pumpkin, cauliflower, celery and cantaloupe) compared to 2021 production is expected to exceed 100% in order to meet demand. 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. **Table 4: Barbados Agricultural Produce Imports 2021**

The CARICOM Agri-Food System Initiative[108] calls for a 25% reduction in the Food Import bill of member countries by the year 2030. To meet the targets, the MAFS proposed the establishment of the **Accelerated Growth Enhancement (AGE) 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 crops; and resources (land, water, equipment) to rapidly expand their output. All the major buyers (supermarkets, shops,

[105] BADMC Energy Audit Report 2019
[106] Cabinet Note 22; Ministry of Agriculture and Food Security
[107] Harvested in six months or less
[108] 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 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/

retailers, wholesalers) expressed a deep commitment to buying from local farmers, by reaffirming their preference for local agricultural produce, and Table 5 summarizes the market limitations. The farmers will need to have technical support provided by top international experts[109]. With support from the international consultants, the Central Agronomic Research Station 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. Farmers need a greater level of monitoring and support to develop the skills and knowledge to be able to produce at a high level consistently and the technical support and knowledge building by the project will support achievement of this national goal.

The cost-effectiveness of the PTCL (Component 2) and the greenhouse nursery and field nursery are high particularly because the disease-free sweet potato plants are in consistent high demand by farmers who grow this staple food for Barbadians and the rapid propagation leads to a higher yield in shorter time. Barbados produced 3.5 million kilograms of sweet potatoes in 2023 and 3.5 million kilograms in 2024. Year-round production supports farmers in maximizing the number of growing cycles. By expanding the small space now being utilized all of the LSU trained personnel apply all their technical skills acquired for various stages of production including transitioning tissue-cultured plants to field conditions. In this way, benefits accrue through sustainable practice, efficiency gains, reduced waste, and resource optimization. Though tissue culture plants (sweet potatoes and other types) are provided free to farmers as a public good, this upfront investment, can lead to significant long-term cost savings in terms of quality, low cost nutritious food being available for Barbadians and its health benefits along with import substitution and improved farmer livelihood.

The upfront costs of water conservation measures of installing water saving devices at farming irrigation systems, farmers markets and educational institutions will lead to avoided costs of responding to drought and reduce the monies spent by the BWA and BADMC in pumping and distributing potable and irrigation water and lower utility bills for the organizations. Barbados is water scarce and regularly suffers from insufficient supply leading to shutoffs in the water systems. Water shutoffs means that plant water demands cannot be met and yields are reduced and farmers markets and schools are closed leading to social impacts. Increased education on the importance of water conservation positively impacts the entire community, multiplying gains. The future value of nurturing agricultural entrepreneurship in school students who can contribute to the sector nationally in the coming years is important.

A. 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.

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

Steps	Strategy
Planting Material	•Increase output of tissue culture plants to generate disease-free plantlets for major crops
Irrigation	•Increase access water supply through surface runoff water reservoirs/ wastewater reuse •Improve water use efficiency by promoting irrigation management, 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 •Reduce use of insecticides toxic to bees to reduce bee mortality.
Drainage	•Use agricultural tile drainage to minimize, eliminate flooding, capture runoff water for irrigation; Clean and maintain suck wells
Cropping systems	•Develop economical inter-cropping models; •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 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

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

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 program 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 includes a summary of the technical strategies aimed at crop adaptation relevant to the project as follows:

According to the Barbados Physical Development Plan Amendment 2023[110], 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.

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 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;

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

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 FEED Program (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 FEED trained graduates (2019) were mentored, provided with formal instruction, including workshops and in-field training. 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 with the guidance and support of the Bureau of Gender Affairs.

B. 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.

The Planning and Development Act 2019-5 is an Act to make provision for the orderly and progressive development of land, powers to regulate land use and development and related matters including "proposed developments on the environment with the objective of ensuring sustainable development including the development of ponds". The Barbados Water Authority Act 2023 provides for the management of water and related matters. The following project outputs are in full compliance with the aforementioned acts. *Outputs 1.1: Water harvesting via a storm water pond in Spring Hall; Output 2.1: PTCL Tissue culture laboratory and growth room capacity to accommodate 30 000 plantlets; Output 2.2: Greenhouse nursery established for the propagation of sweet potatoes and row crops; Activity 3.1.1 c: Create and execute plans for water-use schools in St. Lucy, central agriculture market (Cheapside) and Spring Hall farmer irrigation systems based on water audit findings*

In the area of climate change adaptation, Barbados maintains several important legal frameworks[111]: Proclamation of the Planning and Development Act, and the 2021 Physical Development Plan (PDP) and 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.

The 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 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". The legislation protects water resources with the ‘‘Storm-water Management Plan Update" where more efficient capture of storm-water and effluent will reduce pollution, contributing to health and protect and help preserve 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

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

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; standards include measures to avoid the damage caused by 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[112].
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; 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 BAU by 2025[113]
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

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

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 and seeking easier and greater access to finance for this. 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 and education sector.

The 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 has 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 and irrigation services. This agency manages the current water harvesting ponds and their irrigation systems and Spring Hall Land farmers are provided irrigation services from wells. In 2023, the Government of Barbados committed an initial 7.5 million USD for the upgrade of the physical infrastructure of schools. Specific funding for water conservation actions is required. The Government of

[112] 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.

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

Barbados is currently seeking to implement climate-resilient school projects that focus on integrating building design and practices, to enhance resilience to climate change impacts as a part of the overall transformation of the education system. The Government has embarked on Comprehensive Education Reform where suitable concepts for modern school infrastructure for Education Transformation, Climate Resilience and Sustainable Infrastructure were identified. Factors like ventilation, passive cooling, energy efficiency (solar/wind energy), water conservation, climate resilience, and disaster preparedness were included. Moving forward with these designs is not yet underway.

D. [114]If applicable, describe the learning and knowledge management component to capture and disseminate lessons learned

The project will support increased production rates in the agriculture sector. The collection of agricultural data[115] will be utilized to inform policy and strategic plans for capacity building and strengthening of farming systems; a database of climate resilient practices hosted at the Ministry of Agriculture and Food Security Climate Change Unit as a tool for farmers[116]. The objective of the Ministry of Agriculture Extension Services Unit is to contribute to the development and productivity of the farming community; assist in the improvement of the quality of life of the farming community through agricultural education and facilitate training of farmers in various areas. The data collected by the extension officers will be funneled to the MAFS existing Extension Services Unit and BADMC for analysis and recording and research students and farmers will be encouraged to access this information to support their work. Ministry of Agriculture's Extension Services Unit, Virtual extension assistant is also as a tool for collection of national agricultural data. Organizations currently partner with the MAFS Extension Services Unit in expanding farmers training and engagement e.g. FAO, IICA, Barbados Organic Growers Association has developed accredited[117] course modules for organic training; Barbados Council for the Disabled[118] and New River Life Charity have expertise in training of persons with disabilities . 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 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. The focus of the agro meteorology by Agriculture Extension Officers will be on simplicity and applicability since the current CARICOF[119] 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 to respond in sufficient time and in appropriate manners in order to reduce the possibility of their farm crops, physical assets like irrigation systems being impacted. The Barbados Meteorological Services (BMS) issues a monthly climate outlook newsletter. The Feb 2025 Issue 161 key messages were: Near to above-average rainfall is expected until July; an Agricultural Drought Watch is now in effect for parts of Christ Church, St. Philip, St. Michael and St Lucy. An agricultural drought warning is possible for April and May. The longer-term alert level for Hydrological drought has been elevated to yellow for March and a hydrological drought watch may be in issued from April, persons should monitor the BMS seasonal outlooks for updates. The Heat season is still expected to begin around late March/ early April. BMS collects data island-wide utilizing a network of mini-automated weather stations and generates an outlook which can be applied by farmers to their crop scheduling. The deployment of more stations creates a denser network and the addition of sensors for parameters such as soil moisture and dew point add value. More widespread use if this information by agriculture stakeholders is to

[114] https://barbadostoday.bb/2024/07/23/school-designs-to-drive-education-transformation/ https://www.youtube.com/watch?v=-37hWOf3-yw

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

[116] 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.

[117] Barbados Vocational Training Board, Barbados Accreditation Council

[118] 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

[119] 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.

be encouraged to build their climate resilience

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. 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.

E. Describe the consultative process, including the list of stakeholders consulted, undertaken during project preparation, with particular reference to vulnerable groups, including gender considerations, in compliance with the Environmental and Social Policy and Gender Policy of the Adaptation Fund.

Multi-stakeholder consultations[120], 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. 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. Gender segregated meetings were held with women only and also with mixed groups (men and women). Eight hundred and eight farmers or 16 percent of the total Barbados farming population was consulted on the project either directly or through their farming commodity group. Meetings were held with the Spring Hall Farmers as a separate group. 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. 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[121] 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[122] e.g. guava, mango, coconut being planting to help in feeding the bees. 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[123].

SHLLP Farming Association, discussions were held 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,

[120] Consultancy for the preparation of full funding proposal, Building climate resilience in the agriculture sector in Barbados" Report on stakeholder consultations, 14th February 2020, Prepared by: Dr. Claire Durant

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

[122] 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.

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

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 in BADMC farming districts and in St. Lucy, around their dwelling homes for vegetable, 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) 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. 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.

Table 7

Farming Organization	**# of Members**	**[124]Consultation Date**
Barbados Beef and Dairy Producers Association	25	10/02/ 2020
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	
BADMC FEED Farmers	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	12/02/ 2020
Spring Hall Land Lease Farmers	63	20/01/2020
Women in Agriculture	50	29/01/2020
Total	**808**	
Ministry of Agriculture and Food Security		16/07/2024 06/07/2024
Home Agriculture Station and Tissue Culture Laboratory		10/04/2024, 06/05/2024 22/01/ 2025
BADMC		01/03/2020
Barbados Water Authority		26/03/2024 21/02/2024 03/05/2024
Ministry of Education, Technical and Vocational Training		4/2/2024 26/06/2024

The results of the consultations were addressed by: seeking to build a rainwater harvesting pond to increase access to irrigation water year-round; providing extension services support and training in climate smart agriculture and other methods to improve crop productivity; including the collection and analysis of meteorological data to be applied to long term planning of crops; augmenting the work and collaborating with the farmer field school and demonstration plots on the Ministry of

[124] Consultancy for the preparation of full funding proposal, Building climate resilience in the agriculture sector in Barbados" Report on stakeholder consultations, 14th February 2020, Prepared by: Dr. Claire Durant

Agriculture and Food Security compound to provide farmer training (at times to accommodate women who have family care responsibilities); collaborating with the existing Ministry of Agriculture and Food Security Extension Services Unit to collect and analyze gender segregated data on the agriculture sector. Perceived discrimination by lenders against women farmers and addressing praedial larceny is outside the scope of this project. The 2022 Protection of Agricultural Products Act has penalties for those found guilty of stealing farm produce, with fines reaching up to Barbados Dollars 100 000 or five years in prison.

F. 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 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.

This project as designed in this proposal is expected to be able to meet its stated objectives stated solely with the funding provided by the Adaptation Fund. This project does not rely on co-financing for it to be implemented or to achieve its objectives.

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.

G. 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. The Operation and Maintenance (O&M) of the current irrigation systems in the farming districts is managed by the BADMC which has a dedicated Irrigation Department. In this way, the sustainability of the irrigation system is maintained and the local ownership/engagement of farmers, including women farmers benefit; challenges with the current system are reported to the BADMC which then utilizes its experts and engineers to rectify the problem. In the development and installation of the irrigation system for the proposed pond at the Spring Hall, the BADMC has the capacity to manage and maintain the system.

The sustainability of component 2 with regard to: Output 2.1: PTCL Tissue culture laboratory and growth room capacity to accommodate 30 000 plantlets; Output 2.3: Field nursery established for rapid multiplication of planting materials and indigenous heirloom plants is to be achieved via the staff of the Ministry of Agriculture who were recently trained by the LSU and have the acquired the technical capacity to maintain the facilities; Institutional strengthening of BADMC and Ministry of Agriculture and Food Security personnel in agricultural extension in climate smart cultivation is to be achieved via the following methods: Working with agriculture stakeholders and involving them in project implementation stages along with creating a collaborative environment where they understand how to contribute to project sustainability. Allocating resources to training and building human capacity will support project management and maintenance along with linking to new programs.

The sustainability of Component 3 water saving devices is to be maintained through collaboration with the existing school and markets maintenance teams that usually keep the institutions in good order supported by the Barbados Water Authority which renders assistance nationwide in all matters related to water use and conservation. School agriculture programs currently fall under the ambit of the Ministry of Education, Technical and Vocational Training and are maintained on a regular basis by the school science department, therefore it is expected that they will continue to integrate this learning tool in student education. Project replication and scaling up is contingent upon the availability of additional resources.

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

Table 8: 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

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[125]. 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[126] and hypertension[127] which are at epidemic proportion in Barbados.

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

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

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

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%.

[128]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.

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**

[129]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.

During 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.

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

The gender gap in agriculture is manifested in women's work burden and time poverty. By viewing the project climate-smart agriculture through a 'work and time burden lens' will help in designing effective gender-responsive interventions. To minimize gender disparities a focus on equitable resource access and empowerment through education and training and in decision-making. Women are uniquely positioned to better collect gender-sensitive data due to their ability to build trust and foster comfort with women and ensures that the voices and experiences of women are properly

[128] Central Bank of Barbados Review of Barbados' Economic Performance January – December 2023
[129] https://mrd.gov.bb/attachments/Design%20Competition%20brief_for%20web.pdf

represented. The provision of meals, transportation, sanitation facilities, meeting concerns will be supported. Women have a preference for women supervisors and trainers, as this fosters a supportive environment and this will be accommodated as far as possible.

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.

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[130]. 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.

Risks

The risks associated with equitable distribution of benefits from the irrigation services in the targeted area under Component 1, and from the tissue culture and crop nursery activities under Component 2 are low because: all of the farms in Spring Hall are currently served with irrigation from the BADMC and water is pumped for the same number of hours to all the farms from the integrated system; the establishment of the storm water pond will augment the water pumped from the BADMC irrigation wells; tissue culture sweet potato plants and other crops planting material produced at the Ministry of Agriculture and Food Security Home Agriculture Station and Tissue Culture laboratory are provided free charge to all registered farms who can request their desired amount from the facility and collect and plant in their prepared fields.

Identification of potential risks that could hinder the approach, in terms of the land area availability, the impact of climate stressors/ other factors that could affect the ponds development

In the Spring Hall farming district, the lands are owned by the Government of Barbados and the land for siting the proposed rainwater harvesting pond and the surrounding lands in the watershed are also owned by the Government of Barbados. This important farming area is managed by the BADMC. Climate stressors, like extreme heat waves and droughts will not impact the development of the pond, however floods and storms may cause delays in construction. The pond is designed to retain flood water and storm water for irrigation and reduce disruptions to successful food crop planting and harvesting. A view of the Barbados Today Newspaper report linked here demonstrates the flooding that occurs in Spring Hall St. Lucy[131].

Category in which the CCCCC screening process has classified the project

The project was recommended by the CCCCC as a “Category B” with moderate risk and impacts. The CCCCC has developed the Caribbean Climate Online Risk and Adaptation Tool that aims at both screening projects for potential climate risks and managing the risks identified. This Environmental and Social Management System (ESMS) is CCCCC commitment to remain relevant and strategic in responding to the constantly shifting and increasing impacts of climate change. The CCCCC has experience and applied the knowledge to analyze scientific data sets in implementing effective solutions that mitigate, adopt, or eliminate the hazards and risk.

Project Occupational Health and Safety

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

[131] https://www.facebook.com/BarbadosToday/videos/barbados-remains-under-a-flash-flood-warning-this-video-shows-flooding-in-the-no/10158020869678191/

The Barbados Safety and Health at Work Act 2015[132], 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 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 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 – Low risk, project in compliance with all current laws, monitoring to be utilized to maintain compliance**:

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

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		**Low risk**- project in compliance with all current Barbados laws and Barbados Legal Affairs Dept. will monitor all activities to maintain continued compliance.
Access and Equity		**Low risk**, project in compliance by having a process for allocating and distributing storm water for irrigation and BADMC, Ministry of Agriculture and Food Security have regulations to maintain non-discriminatory access based on Barbados constitution.
Marginalized and Vulnerable Groups		**Low risk**, all groups have access and monitoring and evaluation to be conducted though Ministry of People's Empowerment and Elder Affairs.
Human Rights		**Low risk**, project compliance ensured through statutes in Barbados Constitution and monitoring and evaluation by Barbados' Ombudsman.
Gender Equality and Women's Empowerment		**Low Risk**, Barbados ratified Convention on the Elimination of All Forms of Discrimination against Women, signed the CEDAW, Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women; monitoring and evaluation to be undertaken throughout the project
Core Labour Rights		**Low risk**, Barbados has ratified the eight ILO core conventions and has national compliance, Ministry of Labour works with social partners promoting opportunities for the provision of decent and productive work, Barbados government set occupational safety and health standards for its industries, monitoring to be conducted to maintain compliance
Indigenous Peoples		**Low risk**- Barbados does not have any persons who are classified as Indigenous Peoples
Involuntary Resettlement		**Low risk**, all project lands are owned by the government and do not current have persons living on the lands
Protection of Natural Habitats		**Low risk**, preliminary environmental assessments indicated low risk, monitoring and evaluation will be conducted in accordance with recommendations form the full Environmental and Social Impact Assessment, Environmental and Social Management Plan
Conservation of Biological Diversity		**Low risk**, no invasive species will be introduced by the project only small scale land clearing specifically for the water harvesting pond, monitoring and evaluation will be conducted by Ministry of Environment and National Beautification
Climate Change		**Low risk,** project will support small scale artisanal agriculture and water harvesting for farming and at school facilities, monitoring and evaluation to be conducted by Ministry of Agriculture Climate Change Unit
Pollution Prevention and Resource Efficiency		**Low risk**, project to promote integrated pest management alongside the current Ministry of Agriculture management scheme for pesticides currently being utilized by farmers to minimize environmental pollution risks in the International Code of Conduct on the Distribution and Use of Pesticides; monitoring and evaluation to be conducted by the Ministry of Agriculture

Public Health		**Low risk,** 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; monitoring and evaluation to be done
Physical and Cultural Heritage		**Low Risk**, The project areas do not have a unique cultural and physical heritage which is distinct from that of the island of Barbados
Lands and Soil Conservation		**Low Risk**, project lands have been used for different types of farming since 1966, the year of Barbados' Independence. Monitoring and evaluation by the Ministry of the Environment will support continued best practice

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[133]

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 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[134] 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)

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

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

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 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 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. 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- Low risk, project in compliance by having a process for allocating and distributing storm water for irrigation and BADMC and Ministry of Agriculture and Food Security have regulations based on Barbados constitution</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. 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.

3. <u>Marginalized and Vulnerable Groups- Low risk, all groups have access and monitoring and evaluation though Ministry of People's Empowerment and Elder Affairs</u>

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. <u>Human Rights – Low risk, project compliance ensured through statutes in Barbados Constitution and monitoring and evaluation by Barbados' Ombudsman</u>

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[135] which protect citizens. The Government of Barbados has mechanisms in place to identify and punish those who may commit human rights abuses[136]. 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

[135] https://tbinternet.ohchr.org/_layouts/TreatyBodyExternal/Countries.aspx?CountryCode=BRB&Lang=EN

[136] https://www.state.gov/reports/2022-country-reports-on-human-rights-practices/barbados/

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 – Low Risk,** Barbados ratified Convention on the Elimination of All Forms of Discrimination against Women, signed the CEDAW, Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women; monitoring and evaluation to be undertaken throughout the project

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.[137]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- Low risk, Barbados has ratified the eight ILO core conventions and has national compliance, Ministry of Labour works with social partners promoting opportunities for the provision of decent and productive work, Barbados government set occupational safety and health standards for its industries, monitoring to be conducted to maintain compliance**

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)[138].

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 – Low Risk**

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

[138] 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.

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

8. **Involuntary Resettlement – Low risk, all project lands are owned by the government and do not current have persons living on the lands**

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 and do not have any persons who live on these lands. School facilities in Barbados are owned by the government and have no persons living at these facilities

9. **Protection of Natural Habitats- Low risk, preliminary environmental assessments have indicated a low risk and monitoring and evaluation will be conducted in accordance with the recommendations form the full Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (EMSP)**

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[139] 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 Ministry of Agriculture and Food Security has previously installed three storm water harvesting ponds[140] 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 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 conduct water to the sea during the rainy season[141]. 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 negatively affected if the storm water is harvested.

10. **Conservation of Biological Diversity- Low risk, no invasive species will be introduced by the project and only small scale land clearing specifically for the water harvesting pond, monitoring and evaluation will be conducted.**

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. No land clearing is expected except in the existing

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

[140] Storm water Pond River Farming District.jpg

depression for siting the water harvesting pond

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[142]. 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[143] of flowering plants found in the wild, 48 of which are native trees adapted to local climate and soil conditions.[144] *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- Low risk, project will support small scale artisanal agriculture and water harvesting for farming and at school facilities, monitoring and evaluation to be conducted by Ministry of Agriculture Climate Change Unit**

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 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 – Low risk, project to promote integrated pest management alongside the current Ministry of Agriculture management scheme for pesticides being utilized to minimize environmental pollution risks in the International Code of Conduct on the Distribution and Use of Pesticides; monitoring and evaluation to be conducted by the Ministry of Agriculture**

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

[142] Barbados Ministry of Agriculture and Food Security Agriculture Incentives Programme and Upfront Concessions
[143] Wild Plants of Barbados. S. Carrington. Macmillan Caribbean 2007
[144] FAO Global Forest Reserves Barbados Country Report 2015

Pesticides. In 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[145] have been deployed island wide by the Pesticide Registrar[146].

13. **Public Health – Low risk, 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; monitoring and evaluation to be done**

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 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[147]. 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[148]. 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[149].

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.

[145] Pesticide Container Disposal Barbados.jpg
[146] https://www.facebook.com/gisbarbados/videos/disposal-of-pesticide-containers/164720515569669/

[147] Public Health Considerations – Irrigation Augmentation River Plantation and Spring Hall, Ministry of Health and Wellness
[148] 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
[149] https://m.facebook.com/bwa.bb/posts/2702025883420985/

- 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 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 – Low Risk, The project areas do not have a unique cultural and physical heritage which is distinct from that of the island of Barbados**

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 – Low Risk, project lands have been used for different types of farming since 1966, the year of Barbados' Independence. Monitoring and evaluation by the Ministry of the Environment will support continued best practice**

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 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**.** In Barbados, cultivation is an important part of land management and supports the irrigation of crops[150]. 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.

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. 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

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

into agriculture, the Spring Hall farming community can become more resilient to increased precipitation variability and flooding.

PART III: IMPLEMENTATION ARRANGEMENTS

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

Project Objective(s)	Project Objective Indicator(s)	Fund Outcome	Fund Outcome Indicator	Grant Amount (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 to support optimal vegetable production	**Outcome 4:** Increased adaptive capacity within relevant development sector services and infrastructure assets	**4.2.** Physical infrastructure improved to withstand climate change and variability-induced stress	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	**Outcome 3:** Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	**3.1.** Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses **3.2.** Percentage of targeted population applying appropriate adaptation responses	1,500,000
3. Strengthened climate adaptation capacity for water conservation in agriculture and education sectors	Volumes of potable water saved via introduction of water saving devices; school agriculture programs cultivating tissue culture plants	**Outcome 8:** Support the development and diffusion of innovative adaptation practices, tools and technologies	8. Innovative adaptation practices are rolled out, scaled up, encouraged and/or accelerated at regional, national and/or subnational level	491, 614
Project Outcome(s)	**Project Outcome Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Amount (USD)**
1.Increased adaptive capacity within the agriculture sector services and infrastructure assets	**1**. Responsiveness of agriculture sector services to farmers evolving needs from changing and variable climate **2**. Irrigation and Water harvesting physical infrastructure improved to withstand climate change and variability-induced stress	**Output 4:** Vulnerable development sector services and infrastructure assets strengthened in response to climate change impacts, including variability	**4.1.2.** No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by sector and scale)	6,350,000
2.Strengthened livelihoods for vulnerable farmers in targeted areas	**1**. Percentage of farming households and communities having more secure access to livelihood assets **2.** Percentage of farmer population with sustained climate-resilient alternative livelihoods	**Output 3.1**: Targeted population groups participating in adaptation and risk reduction awareness activities **Output 3.2:** Strengthened capacity of national and subnational stakeholders and entities to capture and disseminate knowledge and learning	**3.2.2** No. of tools and guidelines developed (thematic, sectoral, institutional) and shared with relevant stakeholders	1,500,000
3.Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	**1.** Percentage of national stakeholders aware of predicted adverse impacts of climate change, and of appropriate responses **2**. Percentage of schools and farmers applying appropriate adaptation responses	**Output 8:** Viable innovations are rolled out, scaled up, encouraged and/or accelerated.	**8.1.** No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated	491,614

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)*

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



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

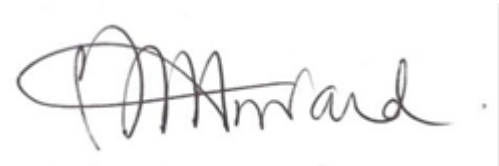
The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

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

Revised PFG Submission Form[1]

Project Formulation Grant (PFG)

Submission Date: April 20, 2025

Adaptation Fund Project ID: AF00000406
Country: Barbados
Title of Project/Programme: Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions
Type of IE (NIE/RIE/MIE):
Implementing Entity: Caribbean Community Climate Change Centre
Executing Entity: Barbados Ministry of Agriculture and Food Security

A. Project Preparation Timeframe 1 year

Start date of PFG	Nov 2025
Completion date of PFG	Oct 2026

B. Proposed Project Preparation Activities ($)

List of Proposed Project Preparation Activities	Output of the PFG Activities	US$ Amount	Budget note[2] Consultancy services for Activity
1. Review of the ***Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions Concept Note*** and supporting documents	Inception Report including results of pre-evaluation assessment, methodology, Work Plan, and Final Deliverables	5 400	International consultant on project development and project cycle management and climate adaptation 5400 USD (600 USD per day @9 days)
2. Prepare a project management plan in compliance with the AF Gender Policy	Project management plan	9 000	International consultant on project development and project cycle management and climate adaptation 9000 USD (600 USD per day @15 days)
3. Develop measures for project financial risk management	Project Financial Risk Management Plan	18 000	International expert/s on (but not limited to) fiduciary standards, financial management, project risk management – 18 000 USD (600 USD per day @30 days);
4a. Conduct a ESIA of the Project **4b.** Conduct a Gender Assessment of the Project	ESIA Report	32 250	•Local expert/s on Environmental and Social Assessment, Gender and Social

[1] As presented in AFB/PPRC.33/40 Annex 1.
[2] The proposal should include a detailed budget with budget notes indicating the break- down of costs at the activity level. It should also include a budget on the Implementing Entity management fee use.

4c. Develop a management plan for environmental and social risks, in line with the AF Environmental and Social Policy and Gender Policy	Gender Assessment Report ESIA and Gender Management Plan		Assessment, Monitoring and Evaluation – 24,000 USD (600USD per day @40 days). •Implementation of 5-day long stakeholder consultative workshops accompanied with site visits – 8,250 USD (venue, catering, equipment, and printing).
5. Prepare a Project detailed budget including budget notes	Project Budget	18 000	International expert on (but not limited to) fiduciary standards, financial management, project budgeting – 18 000 USD (600 USD per day @30 days)
6a. Prepare a Monitoring and Evaluation Plan with targets and indicators, in compliance with the AF Gender Policy **6b.** Prepare a Budget for the M&E Plan	Monitoring and Evaluation Plan Monitoring and Evaluation Plan Budget	18 000	International expert on (but not limited to) fiduciary standards, financial management, project development, project monitoring and evaluation – 18 000 USD (600 USD per day @30 days)
7. Prepare the M&E Framework including a break-down of how implementing entity IE fees will be utilized	Project Monitoring and Evaluation Framework	12 000	International expert on (but not limited to) fiduciary standards, financial management, project development, project monitoring and evaluation – 12 000 USD (600 USD per day @20 days)
8a. Prepare a project Results Framework aligned with the AF's results framework **8b.** Identify the Core Outcome indicators	Project Results Framework	12 000	International expert on (but not limited to) fiduciary standards, financial management, project development, project monitoring and evaluation – 12 000 USD (600 USD per day @20 days)
9. Prepare a Disbursement schedule with time-bound milestones	Project Disbursement Schedule	7 200	International expert on (but not limited to) fiduciary standards, financial management, project development 7200 USD (600 USD per day @12 days)
10. Completion of the AF Funding Proposal Template and Annexes	Final AF Funding Proposal	5 400	International consultant on project development and project cycle management and climate adaptation (600 USD per day @9 days)
11. Implementing Entity Management Fee (8%)	Implementing Entity Management Fee Budget And Project Management	12 000	Lumpsum for a project management team who will coordinate the consultants and project technical oversight. The CCCCC team will also be responsible for preparing the Implementing Entity Management Fee Budget for the project including explanation, breakdown of execution costs
Total Project Formulation Grant		149 250	

Please describe below each of the PFG activities and provide justifications for their need and for the amount of funding required:

The CCCCC is seeking a PFG to support the preparation of the Funding Proposal for the ***Building Climate Resilience in Barbados - Sustainable Water Management in the Agriculture Sector and Educational Institutions Concept Note***. The budget describes the arrangements for the CCCCC to manage the PFG. The project will be managed in close collaboration with the Ministry of Agriculture and Food Security, Ministry of Education, Technical and Vocational Training, as well as the Barbados Agricultural Marketing and Development Corporation which is a statutory body of the Government of Barbados within the Ministry of Agriculture and Food Security.

The successful completion of the full funding proposal requires the following activities which have been included in the PFG: measures for financial and project risk management; measures for environmental and social risk management; monitoring and evaluation plans and budget; project results framework; project budget and project disbursement schedule. A preliminary ESIA and Gender Assessment was conducted at the Concept Note stage, however a full ESIA and Gender Assessment is required at the Funding Proposal Stage, accompanied by a management plan. The completion of these two assessments represents the largest cost in PFG budget at 32,250 USD, due to the fieldwork that they entail.

The loss of complementary funds from USAID PACCA which were previously used for preparatory studies related to CCCCC Adaptation Fund projects, has necessitated the increased request for funds from 30 000 USD to 149 250 USD to support this project. The elimination of UASID funds is due to policy changes at the donor level; USAID PACCA funds were allocated for strengthening climate resilience in countries in the East and Southern Caribbean.

C. Implementing Entity

This request has been prepared in accordance with the Adaptation Fund Board's procedures and meets the Adaptation Fund's criteria for project identification and formulation

Implementing Entity Coordinator, IE Name	Signature	Date (Month, day, year)	Project Contact Person	Telephone	Email Address
Mark Bynoe		February 7th 2025	Dr. Claire Durant	+501 822 1104/1094	cdurant@caribbeanclimate.org

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[151] 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. [152] 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) 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. [153]Barbadian women are more likely to be living in poverty even though more women than men are graduates of tertiary level education institutions.[154]

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[155]. 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.[156]

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[151] World Population Review (Barbados 2020)

[152] CEPALSTAT Databases and Statistical Publications ECLAC.

[153] IDB 2018 Report – Barbados Country Development Challenges

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

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

[156] *ibid*

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%.

[157]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[158] 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[159].

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[160.] The report further highlights that in addition to social assistance, the Government of Barbados, places strong emphasis on facilitating and supporting women 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[161.] 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. 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[162]. 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.

Agriculture

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

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

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

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

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

[162] *Ibid,*

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. "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%)"[163]. 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.

Initial Stakeholder Consultations

In addition to state and non-state representatives, farming groups and organizations 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 1 highlights a list of stakeholders consulted in the development of this project. Key gender inputs were derived from some of these consultations.

Table 11: 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.

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. Both women and men are farmers and engage in planting, growing and selling agricultural produce to consumers. In Barbados, a larger percentage of women (67%) are involved in the retailing of vegetables and the production of agricultural derived products such as pepper sauces, fruit juices and cooked items. Both men and women farmers require increased training and exposure to climate resilient agricultural practices in order to improve the volume and quality of their crops. With regard to the provision of irrigation water and agricultural extension services, these resources are currently provided equitably to all farmers and will continue under the project to be given in the same way. Additional agriculture services are rendered by the BADMC upon farmer request. 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. Gender segregated 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

[163] 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

their homes and sometimes they would visit plantations to harvest sweet potatoes, yams, cassava and peas to sell in the market. Women farmers 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 on water conservation specifically in schools are informed by unique approaches to learning of persons with disabilities, boys, male youth, girls and female youth. The Barbados Water Authority has an established unit[164] which engages students in an interactive session, sharing essential tips on saving water and highlighting their critical role in the water conservation movement. Expanding the multimodal communication and learning approaches used by the BWA with their branded slogan "Every Drop Counts!", e.g. Water pumping station visits, show and tell, water mascot, flyers (**Figure 6**) "Water Wednesdays" and fun branded tokens (pencils, pencil cases, rulers) will be explored. The project will seek to align water conservation 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. Agriculture Extension will continue to support gender-sensitive activities for farmers including: separate workshops for women on climate smart agriculture practices, training sessions on post-harvest handling and value added processing techniques and niche market access for women farmers; encouraging participation from women in farmer commodity and facilitating discussions on gender dynamics and decision-making within groups; promoting access to technology and infrastructure for both genders. The Ministry of Agriculture's and Food Security Agriculture Extension Unit with support from the project team, promote awareness on diversity and social inclusion and specific needs of female farmers. Most male and female smallholder farmers will continue to face hardships and increasing vulnerability based on adverse climate projections for Barbados, therefore this project is promoting the adoption of climate-resilient agricultural practices, investing in water management infrastructure and enhancing access to timely and accurate climate information. These interventions can reduce poverty for men and women, and enhance Barbados' agricultural and environmental sustainability.

[164] https://www.facebook.com/bwa.bb/videos/bwas-outreach-program/496186103351763/