Sector	Agriculture
Sub-sector/Category	Crop Management
Technology	Varietal development of saline tolerant crops
Scale of Application	National
Availability	In recent years, varietal development of vegetable crops has gathered momentum, encouraged by the need to promote crop diversification and build resilience to climate change. However, globally, this technology has had limited success in the other crops group for various reasons. According to a study at Michigan State University, "the lack of success of breeding programs in developing commercially successful salt-tolerant crops is also often the result of breeders' preference for evaluating their genetic material under idealized conditions" (Loescher,W et al, 2011). In Guyana, the National Agricultural Research and Extension Institute (NAREI) has been developing new strains and conducting field trials aimed at introducing new varieties and strengthening germ plasm of existing varieties. Rice and sugar sub-sectors have been self-contained in terms of technology development and transfer by the Guyana Rice Development Board (GRDB) and the Guyana Sugar Corporation (GuySuCo) respectively (FAO, Not dated).
Technology Characteristics	
Introduction	Salinity can have significant effect on crop quality and yield. Breeding new and improved crop varieties enhances the resistance of plants to a variety of stresses that could result from climate change (Haggar A and Torres, 2011). Breeding salt-tolerant crops requires consideration of (1) the technical aspects of genetic manipulations, (2) the interactions between salt tolerance and management of soil and water, and (3) the effects of salt on food and feed quality. According to Loescher et al (2011) "salt tolerance is quite complex, and perhaps not amenable to simple approaches to breeding problems, both classical and non-traditional (''biotechnological'') approaches are now common. Strategies for enhancing salinity stress tolerance in crop species include traditional breeding with selection for yield, mutation breeding, screening within phenotype, and introducing germplasm from wild species into the crop species". While approaches differ according to the special characteristics of the environment, crop type and resources, according to the USDA, the salt tolerance of a crop may be appraised according to three general criteria: • Ability of the crop to survive on saline soils; • Yield of the crop on saline soils; and • Relative yield of the crop on a saline soil as compared with its yield on a non-saline soil under similar growing conditions. Rejuvenation of germplasm lines and maintaining genetic purity of commercial varieties and production of sufficient quantity of seeds of high genetic purity is also a priority, as well as, hybridization to create variability for increased yield potential, salt tolerance, aroma, and submergence tolerance. In Guyana, sixty-one (61) crosses of rice to create variability were produced during the year 2014 (27 in the first crop and 34 in the second crop). The crosses made in the first crop were successfully raised in the second crop of 2014 (GRDB, 2014). In the sugar sector, although some new varieties have been identified, decisions related to development and implementation of those varieties typically require between 15 to 20 years. In direct response to climate change, and based on planned utilization of new, more climate change -resistant varieties, it is recommended that replanting of new varieties be implemented as soon as feasible.

Institutional /Organizational	Ministry of Agriculture is the leading institution for technology generation and transfer in the agriculture sector in Guyana. This is done through NAREI, which has research stations in Georgetown and Ebini. These, together with the Caribbean Agricultural Research and Development Institute (CARDI), the National Dairy Development Programme (NDDP), the Inter-American Institute for Cooperation on Agriculture (IICA), the Guyana School of Agriculture (GSA) and the Faculty of Agriculture of the University of Guyana (UG/FA), provide a variety of services to the sector. The GRDB (Burma Research Station) and GuySuCo have research programs/facilities with specific focus on rice and sugar crops.
Adequacy for Current Climate	The agriculture sector in Guyana is extremely vulnerable to the impacts of climate change, particularly from flooding, drought and salt water intrusion. Most of the country's fertile lands are situated on the low-lying coastline, which is highly susceptible to salt water intrusion, which will exacerbate with sea level rise. The hinterland locations also experience drought like conditions, a condition which contributes to increased salinity. Climate projections show that Guyana is likely to experience drier conditions and is at increased risk from sea level rise. Hence, there is a need to diversify crop cultivation, through the development of more resilient varieties which will boost Guyana's adaptive capacity in a changing climate.
Size of Potential Beneficiary	This technology is likely to have direct benefits to the general population, where successfully diffused. There are about 25,000 farm households in Guyana of which over 90 percent are located on the more fertile soils of the coastal plain covering some 400,000 ha of arable land and comprising administrative regions 2, 3, 4, 5 and 6. Rice and sugarcane are grown on small farms, as well as large estates. Most farmers practice mixed farming on farms of 2-5 ha. Ninety percent of farms is under 10 ha (on 40 % of farmland); 25 percent is under 1 ha (2 % of farmland); 38 percent is between 1- 4 ha (12 % of farmland); and 5 percent on more than 20 ha (47 % of cropland) (NAREI).
Disadvantages	• High input cost; • Using only native varieties can limit the range of benefits and response; • Slow uptake by farmers; • Unforeseen risks in yield and market conditions; • Risk of introduced varieties becoming pests.
Endorsement by experts	Research into the development of crop varieties is quite advanced globally. However, success in salt tolerant cultivars has been slow. In Guyana, there has been significant research in the rice and sugarcane sub-sectors to develop varieties which are resilient to changing weather conditions. NAREI is actively involved in identifying and researching selected varieties of crops which are tolerant to various climatic stresses, including high temperature, intensive precipitation, flooding, drought, increases in soil and water salinity and pest/disease infestation. At the Rice Research Station (RRS), new varieties are developed to enable farmers' access to plants that are more conducive to providing a better quality and higher volume of grain, as well as greater resistance to pests, diseases and weather fluctuations. Research at the station is done in the plant breeding, entomology, agronomy and plant pathology departments.
Capital Costs	
Cost to implement/Operate/ Maintain	*Implementation:* • A conservative estimate of varietal development in the rice sector over a 5-year period is approximately US$4.2M (GRDB). Estimates take into account costs for laboratory services, equipment/infrastructure seed storage/preservation, breeding (field experiments), purchase of new seed varieties, extension services and training & capacity building.

	• The cost of developing new crop varieties depends on many factors, such as, the type of crop, scale of research and the method employed. *Operation/Maintenance:* • O&M costs would include expenses for maintaining seed stock, demonstration plots, equipment, extension services and training. • Major crop variety development has been taken up by government institutions and with a budget line covering such costs.
Development Impacts – direct/indirect benefits	
Adaptation benefits	• Reduction in crop loss; • Improved food security; • Repository of saline tolerant germplasms; • Strengthen research capacity in crop development; and • Increase awareness of climate stress on crops.
Economic Impacts	It is expected that there will be a significant economic impact from the successful implementation of this technology. Direct benefits include: • Increased farmer's income due to reduced crop loss; • Decreased cost of production; • Increase in productivity per acreage; and • Enhanced market competitiveness.
Social Impacts	• Promote employment in the research sector, as well as communities; • Improve livelihood and strengthen resilience; • Improve household health and wellbeing; and • Increase awareness of climate change.
Environmental Impacts	• Reduce use of chemical neutralizers; • Improve crop quality and yields; • Strengthen crop diversity and resilient cropping system; • Promote ecosystem resilience; and • Secure low land cultivation
Local Context	
Status of Technology	This technology is currently limited in Guyana. The generation and transfer of crop variety has traditionally focused on the rice and sugar sub-sectors. Currently, the GRDB is engaged in work on saline tolerant, drought and flood resistant rice varieties. One of the key objective is to develop high-yielding varieties of rice with tolerance to lodging, salinity, acidity and resistance to blast, among other desirable characteristics (GRDB, 2014). In the sugar industry, GuySuCo has been involved in developing different sugar varieties for decades, but the focus has typically been on disease-resistant cultivars, as opposed to those which tolerate climate change effects. In recent years, research has been directed to the development of flood resistant varieties. One variety of sugarcane, which has already been introduced in response to climate change is sugar 93409 (GoG, 2013).
Market potential	The market potential for this technology is certain for the rice and sugar sectors. However, the success of this technology in the market for other crops would depend on the economic value of the crop. High yields may not necessarily translate into a positive cash flow if the product is not marketable. Globally, there are not many crops that are both tolerant to salinity and have a high

	economic value. Asparagus is tolerant to salinity and has a high economic value, but harvesting is labor-intensive and costly.
Acceptability to stakeholders	Already the impacts of climate change are being felt and policy makers have recognized the need for improved technologies in the sector, such as, crop diversification and germplasms. Transfer of this technologhy will build the capacity of extension workers and research capacity of the country. However, farmers' perception of the economic value of new varieties can slow down the diffusion of this technology among those stakeholders.
Opportunities and Barriers	*Opportunities:* • Market demand may encourage monoculture which can increase vulnerability; • Access to new markets and promote value added products; • Potential for increased profitability and competitiveness; and • Develop/strengthen partnerships with research facilities and farmers/producers. *Barriers:* • High initial investment cost; • Limited knowlege/skill of the techology (not much research globally); and • Willingness to absorb the technolgy due to other priorities.
Time Frame	Medium to long term

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