NATIONAL ADAPTATION STRATEGY

TO ADDRESS CLIMATE CHANGE IN THE AGRICULTURE SECTOR OF GUYANA

STRATEGY AND ACTION PLAN



Prepared for the

Caribbean Community Climate Change Centre

Belmopan, Belize

by the

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The views and opinions expressed in this report are those of the Authors and do not necessarily represent the views and opinions of the Government of Guyana, the Caribbean Community Climate Change Centre or the World Bank.

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List of Acronyms

ACP	African Caribbean and Pacific
AEDP	Agricultural Export Diversification Programme
AO-GCM	Atmosphere –Ocean Global Circulating Models
ASDU	Agricultural Sector Development Unit
ASSP	Agriculture Support Services Programme
CARDI	Caribbean Agricultural Research Institute
CARICOM	Caribbean Community
CCCCC	Caribbean Community Climate Change Centre
CDC	Community Development Councils
CDC	Civil Defence Commission
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CET	Common External Tariff
CIDA	Canadian International Development Agency
CS	Competitiveness Strategy
DFID	Department for International Development
EC	European Commission's
ECLAC	Economic Commission for Latin America and the Caribbean
EDMI	Enumeration District Marginality Index
EDWC	East Demerara Water Conservancy
ENSO	El Nino Southern Oscillation
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agriculture Organization
AR4	Fourth Assessment Report
FCPF	Forest Carbon Partnership Facility
GAP	Good Agricultural Practices
GDP	Gross domestic product
GEF	Global Environment Facility
GFC	Guyana Forestry Commission
GHG	Greenhouse Gas
GLSC	Guyana Lands and Surveys Commission
GMP	Good Manufacturing Practices
GNAP	Guyana National Action Plan
GNI	Gross National Income
GNIFC	Guyana National Initiative of Forest Certification
GoG	Government of Guyana
GRDB	Guyana Rice Development Board
GRPA/RPA	Guyana Rice Producers Association
GSA	Guyana School of Agriculture
GTIS	Guyana Trade and Investment Support
GuySuCo	Guyana Sugar Corporation
GWI	Guyana Water Incorporated
HD	Hydrometeorological Department
IADB/IDB	Inter- American Development Bank
IAST	Institute of Applied Science and Technology
ICZM	Integrated Coastal Zone Management Plan
IDS	Institute of Development Studies

IFAD	International Fund for Agricultural Development
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
JI	Jagdeo Initiative
LCI	Living Condition Index
LEDC	Less Economically Developed Country
MACC	Mainstreaming Adaptation to Climate Change
MDGs	Millennium Development Goals
MFN	Most Favoured Nation
MIP	Multi-Annual Indicative Programme for Sugar
MLA	Ministry of Legal Affairs
MMA-ADA	Mahaica Mahaicony Abary- Agriculture Development Authority
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoF	Ministry of Finance
MPW&C	Ministry of Public Works and Communications
NAAG	National Aquaculture Association of Guyana
NARI	National Agricultural Research Institute
NCC	National Climate Committee
NCSA	National Capacity Self Assessment
NCU	National Climate Unit
NDCs	Neighbourhood Democratic Councils
NDIA	National Drainage and Irrigation Authority
NDS	National Development Strategy
NFP	National Forestry Policy
NGMC	New Guyana Marketing Corporation
NGO	Non-Governmental Organizations
NIS	National Insurance Scheme
NREAC	Natural Resources & Environment Advisory Committee
OAS	Organization of American States
OP	Office of the President
PRSP	Poverty Reduction Strategy Paper
RDC	Regional Democratic Council
REDD	Reducing Emission from Deforestation Forest Degradation
RTP	Regional Transformation Programme
SCP	Support for the Competitiveness Programme
SEES	School of Earth and Environmental Science
SLR	Sea Level Rise
SRDD	Sea and River Defence Department
SRES	Special Report on Emission Scenarios
T&HD	Transport & Harbours Department
TNAs	Technology Needs Assessments
TSA	Timber Sales Agreement
UG	University of Guyana
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WUAs	Water Users Associations
WWF	World Wildlife Fund

1. Introduction

Natural systems and less wealthy populations are often the most vulnerable to climate change, being exposed directly to impacts, but unable to respond well, particularly if changes occur very rapidly. Natural disasters, like floods and droughts associated with climate change, have a strong impact on agriculture, ruining households, and draining fiscal resources out of developing countries like Guyana.[1]

This study, commissioned by the Caribbean Community Climate Change Centre (CCCCC) under the Mainstreaming Adaptation to Climate Change (MACC) project, sets out to identify and understand the extent and ways in which climate change is being integrated into agricultural development practices and decision making in Guyana. From that enquiry, this Strategy and Action Plan was devised for the sector to adapt to climate variability based on the downscaled model applied.

The Strategy concentrates on three broad areas of focus:

1. *Locating the landscape*: A description of the agricultural sector, and the current global and local context and knowledge linking climate change and its projected impacts on the Guyanese agricultural sector. Additionally, it identifies the institutions and stakeholders involved, or who should be involved, in the associated adaptation activities.
2. *Barriers and opportunities to adapting to climate change*: The challenges posed to the agricultural sector from climate change, and opportunities that can be exploited through adapting contextually relevant techniques.
3. *Adaptation recommendations*: The identification of options and opportunities for improving the adaptation responses to climate variability.

Adaptation to climate variability is not new, but climate change is expected to present heightened challenges, exposing certain vulnerabilities[2] nationally and locally, and increasing the combinations of risks[3] and potentially grave consequences. This is particularly true for the agricultural sector in Guyana where direct dependence on this sector for livelihood support, particularly in the rural coastal and hinterland areas, combined with its contributions to employment creation, export earnings and gross domestic product (GDP) remain central to the Government of Guyana's (GoG) economic development thrust and will have cascading impacts. Accordingly, the Strategy focuses on the need for "anticipatory adaptation", that is, the proactive rather than the reactive management of climate change risk and relies on the best available information concerning the nature of future climate risks.[4]

The central challenge for the agricultural sector, therefore, is to sustain and even expand the varied functions it currently performs directly and indirectly, without compromising the sector's ability to perform these functions in future. This cannot be achieved without the systemic integration of the social, economic, and environmental pillars of the sector. The agricultural sector remains pivotal to

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[1] United Nations Environment Programme (2006): *Global Environment Outlook*, UNEP, Nairobi.

[2] Vulnerability to climate change in this Strategy is viewed as the degree to which the agricultural sector is susceptible to, and unable to cope with, potential adverse impacts (Schneider, S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A. Suarez and F. Yamin, (2007): Assessing key vulnerabilities and the risk from climate change. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, pp 781.

[3] The concept of risk, which combines the magnitude of the impact with the probability of its occurrence, captures uncertainty in the underlying processes of climate change, exposure, impacts and adaptation.

[4] Food and Agricultural Organization of the United Nations (2007): *Adaptation to Climate Change in Agriculture, Forestry, and Fisheries – Perspective, Framework and Priorities*, FAO, Rome.

Guyana's economic growth in terms of its generation of trade and foreign exchange earnings, which creates employment opportunities in non-agricultural sectors, which in turn reduces poverty and improves the quality of life of many rural households. The sector is also at the core of environmental concerns over the management of natural resources – land degradation, water scarcity, deforestation, and the threat to biodiversity. Agriculture essentially concerns the relationship between the natural environment and human society. Securing the inherent vulnerabilities of the sector has to be central to efforts in seeking to adapt to climate change and achieving future development. The risks of therefore taking a "business-as-usual" (BAU) approach are enormous and include: (i) decimation of much of the agricultural base on the coast; (ii) destruction of livelihoods on the coast and in many hinterland areas, (iii) increased flooding and the public health impacts that this will have, (iv) loss of jobs, incomes, and revenue that will substantially set back the country's development, and (v) possible increase land use conflicts (*see Appendices 1 & 2*).

The content of this Strategy is structured as follows:

Section 2 outlines the process in developing the Strategy, while Section 3 provides a description and importance of the agricultural sector. In Section 4 an overview is given of climate change at the global and national levels to set the context within which the agricultural sector operates, paying particular attention at the cost of adaptation. It also presents background information on issues around the production and use of climate science.

Section 5 deals with the impacts of climate change on agricultural development and the potential for adaptation nationally, with Section 6 being devoted to the challenges and Section 7 to the opportunities presented to the sector by climate change.

Section 8 outlines the Strategy, while Sections 9 and 10 outline the Plan of Action for the Strategy. Specifically, Section 9 examines the implementation arrangements, while Section 10 looks at the conditions necessary for financing the Actions identified. The Strategy is expected to be read in conjunction with the sector assessments conducted, referred to in this Strategy as appendices.

2. Strategy Development Process

The Strategy was constructed from a plurality of methodologies that were both qualitative and quantitative in nature. These included:

- Client interview - Key policymakers in the MoA, including the Minister of Agriculture, the Chairman of the National Climate Committee and the Coordinator of the NCU were interviewed in the planning phase of the project to determine their objective and expectations of the output of the project and to ascertain what type of logistical support and literature could be provided to assist in the completion of the sector assessments that informed this Strategy.

- MACC/CCCCC interview - In a meeting separate and distinct from that with the Minister, the Coordinators of the NCU and the MACC project were interviewed to determine, with much certainty, the context of the study in the formulation of the National Country Strategy, their expectations as to the deliverables and their proposed level of involvement in the study. Within the backdrop of this meeting, the project's work plan was presented to the Coordinator of the NCU.

- Collection and study of reports and relevant documents - The consultant collected and studied existing capacity assessment studies that focus on sectoral and country capacity to respond to the impacts of climate change. These documents were consulted to glean other relevant background and supporting information that could have easily lent to the institutional assessment. Key documents reviewed include:

    1. The draft "Vulnerability and Capacity Assessment: Impacts of Climate Change on Guyana's Agriculture Sector" (2007) study prepared by the Guyana Sugar Corporation (GUYSUCO);
    2. "Guyana's First National Communication" (INC 2002) report prepared in response to its commitments under the United Nations Framework Convention on Climate Change (UNFCCC);
    3. "Guyana's Climate Change Adaptation Policy and Implementation Strategy for Coastal and Low- lying areas" (2002) report prepared by the National Climate Committee (NCC).

- Stakeholder consultations/survey analysis – Detailed stakeholder interviews were conducted over the period July 14 – August 28, 2008 to assist in the completion of the sector assessments annexed to this Strategy and to directly inform the Strategy. These consultations covered a wide range of persons within the public and private sectors, non-governmental organizations (NGOs), regional organizations and international organizations.
- Sector Assessments – Detailed sector assessments were conducted that included an economic review, and technical, institutional and policy assessments of the sector (*see Appendix 1 – 4*). These assessments formed the core of this Strategy and informed the interventions proposed.
- Seminar/Workshops – Four (4) seminar/workshops were held; one with the Minister of Agriculture, two (2) with the NCC (see *Annex S1*), and one (1) with a wider cross-section of stakeholders (see *Annex S2*) to advance the socialization process, but also to receive feedback on preliminary drafts of the Strategy. The comments from these interactions have assisted in advancing this Strategy to its present state.
- Modeling analysis – Various quantitative models, inclusive of regression analysis and forecasting were carried out in the technical assessment and economic review reports. These have aided the robustness of the Strategy and informed the interventions proposed.

- Stakeholders Workshop – A stakeholders' workshop was held on December 4, 2008 at which the Strategy was present, along with a draft Plan of Action.

Based on the feedback from the stakeholders' workshop and the findings of the main reports (composed of various appendices and referred to in this Strategy), the Action Plan was finalized. The Action Plan contains the main recommendations, along with the responsible agencies, proposed costs, and timelines in which the interventions should be carried out. The main recommendations are grouped under the following broad headings:

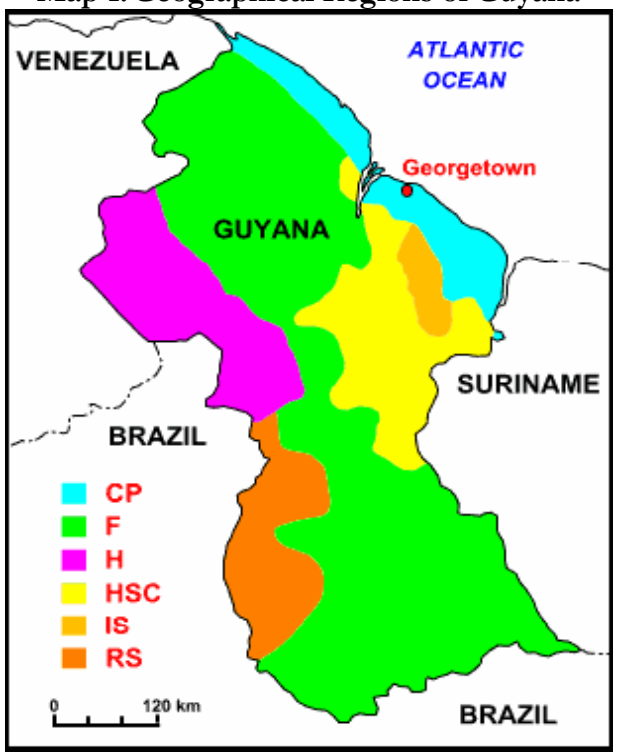
- Capacity Enhancement (both technical and institutional),
- Infrastructure Management,
- Policy and Legislation,
- Research and Development, and
- Awareness and communication.

3. Description of the Agricultural Sector

Historically, Guyana's agricultural sector has been dominated by two crops, rice and sugarcane (see *Appendix 1*). In recent times, the government has made a conscious effort to diversify the agricultural base, placing greater emphasis on non-traditional crops,[5] and the fisheries and forestry industries. Further measures to support the sector, and responding to the challenges and opportunities presented by current global events such as globalization of free trade, climate change and the drive for food security, which included rehabilitating some drainage and irrigation schemes and sea defence structures, installing new drainage pumps, rehabilitating sections of the East Demerara Water Conservancy (EDWC) dam, developing a marketing database, and encouraging research in developing more adaptive plant and animal species to climatological changes.

With a mid-year population of approximately 766,183[6] inhabitants in 2008 occupying 21.5 million hectares, Guyana is a sparsely populated country by any standard. However, approximately 90% of this population occupies the narrow coastal strip that is no more than 1.5 million hectares (*Map 1*) and is also the main area of commercial agriculture (*Map 2*). This coastal area lies below the mean high tide mark and is prone to flooding from the Atlantic Ocean due to breaches in the seawall or over topping of the sea defences, as well as during the raining season, when most of the water from the elevated hilly sand and clay belt region is released on the coastal plain given that gravity flow is the main means utilised for draining excess water in the country (*see Appendix 2*).

Map 1: Geographical Regions of Guyana

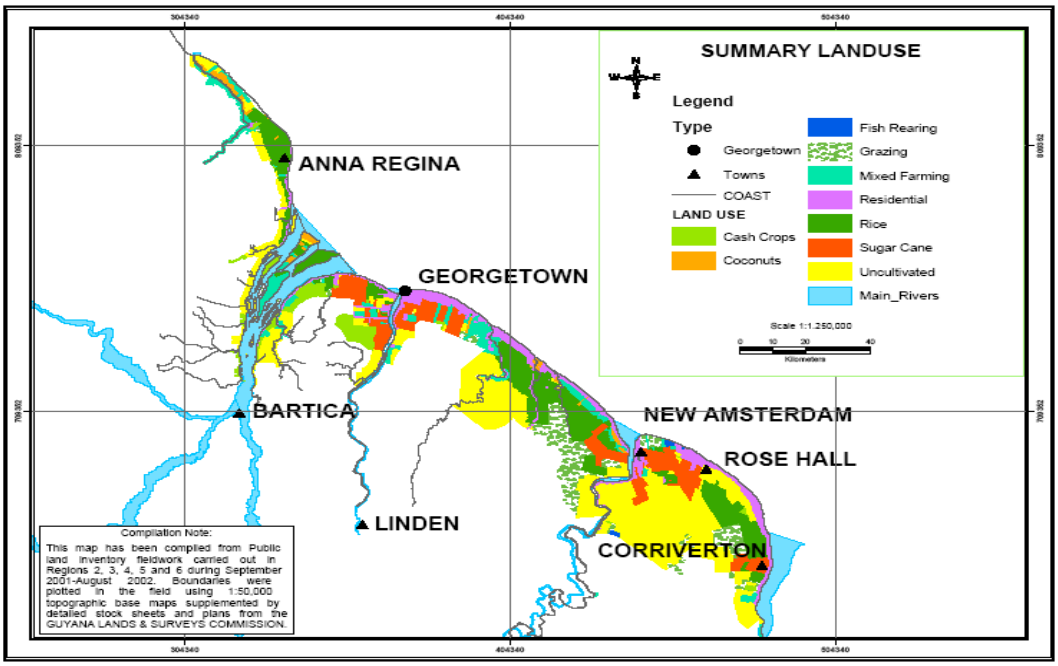


Source: Ministry of Agriculture (2002) Guyana Initial National Communication, pp 34 (*CP – Coastal Plain, F – Forest Region, H – High Land Region, HSC – Hilly Sand and Clay Belt Region, IS – Intermediate Savannahs, RS – Rupununi Savannahs*

[5] These include all crops (fruits and vegetables) other than rice and sugar.

[6] Bureau of Statistic (2008). Statistical Bulletin: Sept 2008), Statistical Bureau, Georgetown.

Map 2: Summary of Land Use along the Coastal Plain



Source: Guyana Lands and Surveys Commission (2008)

Most of the remaining population is scattered mainly in the hinterland regions, some of which are difficult to access and others which are themselves affected by floods during the rainy season.[7] Hinterland residents are engaged mainly in small-scale, subsistence type agriculture, mining, logging, and/or serving as tour guides.

Guyana is one of the few remaining countries globally without major population pressure on its natural resources. More than 16 million hectares of the country is covered by tropical forests, many of which are not economically feasible to exploit with current levels of technology, about 1.2 million hectares are in permanent pastures, mainly in the Rupununi and Intermediate Savannahs and 500,000 hectares are suited for cultivation with current levels of technology. Guyana has about 25,000 farm households; with some 90% of these concentrated along the narrow coastal plain farming approximately 140,000 hectares. For the remaining 10% of the population living in the hinterland, agriculture is a critical livelihood activity, on a subsistence level for most households, but also as a commercial activity in other instances (see *Appendix 1*).

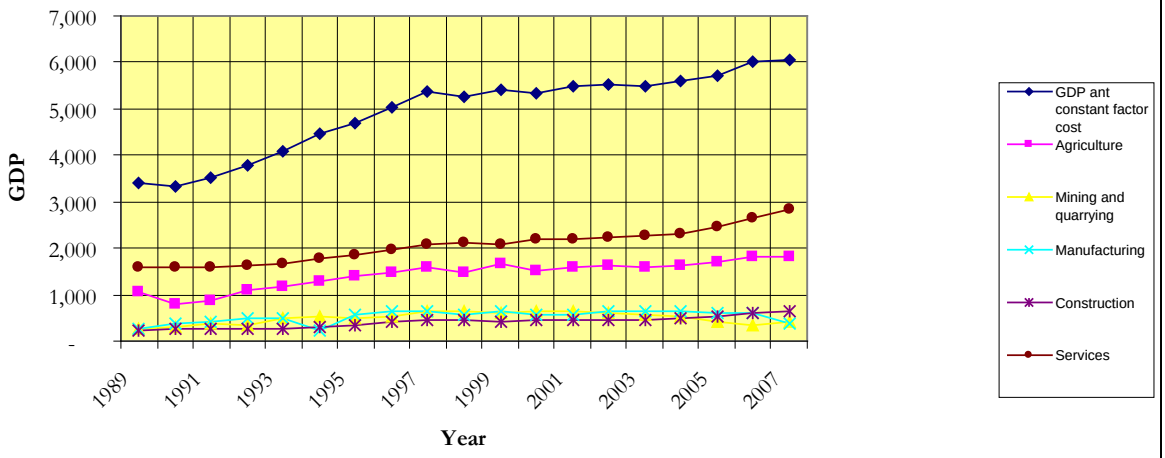
3.1 Importance of the Agricultural Sector

Although the features of the agricultural sector are often envisaged as a sector dominated by poor rural households, most producing on lands on which they are barely able to eek out a living, the essence of the sector is more in function than form. Furthermore, the sector is more complex than this often trite description, with a number of complementary activities occurring to support a vibrant rural sector, supply food to an ever expanding urban industrial and service sector, and export the remainder.

[7] This is particularly a problem in the Rupununi Savannahs.

Further, the agricultural sector (inclusive of fisheries and forestry) remains one of the most important sectors in the economy where between 2004 and 2007 it contributed approximately 35% of the country's GDP (inclusive of value added from the rice and sugar sub-sectors) and employed between 30-35% of the labour force (Bureau of Statistics, 2008) (see *Appendix 1*).

Figure 1:Value Added by Sector at Constant Prices (1988), 1989 - 2007



Source: Bank of Guyana (2008) Annual Report, Financial Statement of Accounts 2008, Table 9-II, and the Bureau of Statistics, Statistical Bulletin, September 2008, Table 10.2

At the sectoral level the sugar and rice industries, cultivated commercially exclusively along the coast, have remained dominant contributing a combined total of 14.6% of GDP in 2007. The fisheries sub-sector has also grown in importance in this regard.[8] Other important crops include: ground provisions, plantains, pineapples, citrus and coconuts. Despite Guyana's expansive forests, this sector accounts for less than 4% of overall GDP. Given that Guyana is a small open economy, most of the products from these sectors are exported. For example, in 2007, the sector accounted for nearly 40% of the country's export earnings.[9]

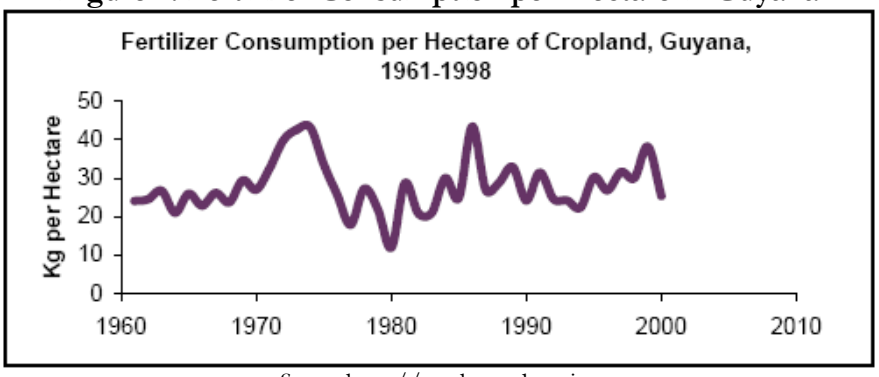
Though a less economically developed country (LEDC), Guyana's Gini Index of 43.2 (CIA World Factbook, 2008), indicates that income distribution is better than that of many other South American countries. However, it glosses over some significant regional variations. For example, both of the recent poverty indices, i.e., the Living Condition Index (LCI) and the Enumeration District Marginality Index (EDMI)[10] have identified Regions, 1, 9, 7 and 8 as the poorest regions in Guyana. Thus, any change in climate variability that may threaten the food supply of these regions will increase their vulnerability.

Guyana remains a net exporter of agricultural products within the Caribbean Community (CARICOM) and wider afield (see *Appendix 1*), providing a source of income for many rural households in areas said to have the highest level of critical poverty.[11] National crop production grew by more than 10% per year in the 1990s and early 2000s, of which yield increases contributed significantly to this growth. The

[8] Sugar and rice combined accounted for 47.2% of agriculture's GDP in 2007 and fish a further 22.7%.
[9] Bureau of Statistics (2008*): Statistical Bulletin*, Bureau of Statistics, Georgetown.
[10] See Skoufias, Emmanuel (2005) *A Poverty Map for Guyana: Based on the 2002 Population and Housing Survey*, World Bank, Washington for an explanation about the construction and rudiments of these indices.
[11] Thomas, Clive (2000): *Guyana Survey of Living Standards*, Institute of Development Studies, Georgetown.

balance came from area expansion and more intense cropping. At the same time, increased agro-chemical use also increased (Figure 2).

Figure 2: Fertilizer Consumption per Hectare in Guyana



Source: http://earthtrends.wri.org

The economic challenge for Guyana therefore is to identify specific agricultural and rural development needs and opportunities, and to focus investment in areas where the greatest impact of adaptation, food security and poverty will be achieved.

Agriculture is more than an economic activity in Guyana. For many communities it is a way of life and an 'institution' around which social and cultural ties remain strong. For example, the Guyana Sugar Corporation (GuySuCo) alone reports employing approximately 18,500 persons at all levels, with most of these employees coming from the rural areas of Guyana where poverty is greatest.[12] Additionally, GuySuCo has also been involved in providing a number of allied services, such as medical centres and primary health care services, provision and maintenance of community grounds and facilities, training to private cane farmers, maintenance of some rural infrastructure, and transport services.[13] Thus, any impact of climate change that may negatively affect this corporation such as destruction of crops forcing the Corporation to down-size its operations, will also impact the quality of services it can offer, the quality of life in some communities, and a source of revenue for other social service schemes like the National Insurance Scheme (NIS). Similarly, the rice and fisheries sub-sectors employ an estimated 50,000 persons directly and indirectly, with most of those within the fish processing plants being women, many of whom are single parents. Hence the multipliers can be significant should climate change affect the spawning and survival rates of shrimp.[14]

These vulnerable populations have only limited capacity to protect themselves from environmental hazards, in particular from extreme events such as drought as witnessed in Region 9 in 1997/98 when a state of emergency was declared in this region; and floods along the coast in 2005 and 2006 that cost the country more than US$453 million and US$250 million respectively (see *Appendix 1*). They are also likely to bear the brunt of the consequences of large-scale environmental change, such as climate change.

Lastly, the sector is also a vital source for nutritious agricultural output in the fight against food insecurity in pockets of Guyana. While commercial agriculture remains an imperative for many households on the coast, small-scale agriculture is more central to the survival strategy of many rural

[12] See the Statistical Bureau's Living Condition and Marginality Indices (2007)

[13] Shutt, Harry, Moore, David and Bynoe, Mark (2007) Social Impact Assessment of the Guyana National Action Plan on Sugar (Final Report), Georgetown

[14] FAO (2008) Climate Change and Food Security: A Framework Document, FAO/UN, Rome.

and hinterland households.[15] In particular, Amerindian communities remain heavily dependent on the sector to provide cassava, their main staple, which is then converted into various food items. In fact, even along the coast, it is quite common to find vegetables being cultivated along the embankment of rice fields, as rural families seek to bolster their incomes and diversify their production base, thus spreading their risks.[16]

As such, while the vast majority of agricultural activities take place on the coastal plain of Guyana, which is likely to be hardest hit from climatological changes unless appropriate actions are taken, it is a misnomer to think that this is the only area that is likely to be affected. In fact, the interior locations are likely to suffer even more severe from a sociological standpoint and these impacts need to be captured and studied in a comprehensive manner..

At the same time, it is imperative to note that coastal soils are fertile but extremely vulnerable to flooding due to their low-lying nature. As such, drainage and water control remain major challenges. Furthermore, agricultural development and expansion has always been tied to the defence against saltwater intrusion from the sea and rainwater runoff and is likely to continue with climate change.

In the main, crops and livestock production (with the exception of sugarcane) are characterized by the predominance of small farmers, farming less than 15 hectares of land.[17] It is estimated that about 60% of these small holdings are geared toward rice production, with the remainder producing food crops. Many of these small farms combine their crop production with some cattle rearing. There are several large farms, however, that include private rice growers, some medium-and large-scale forest and fishing operations, and large public-sector enterprises. The most important parastatal is the GuySuCo.

Growth in the agriculture sector has been highly volatile, alternating between periods of stagnation, pronounced declines, and rapid growth. Over the period 1993-2007, agricultural activities expanded at an average annual rate of 3%, compared with average GDP growth of 4.2%. Agricultural exports are dominated by traditional products, especially sugar and rice, which accounted for over 30% of Guyana's total merchandise exports in 2007. Additionally, exports of shrimp have gathered importance in recent years. But traditional agriculture faces major competitive challenges in the global market since it has been sustained largely by preferential access to the CARICOM and EU markets. Recently, the Government has been seeking to improve productivity in the traditional sectors while also promoting non-traditional crops. Greater attention and emphasis are being given to the cultivation of crops such as oil palm, coconuts, green vegetables, ground provisions, fruits, and flowers. The authorities report that while a significant amount of these products would be utilized locally, the greater proportion would be destined for the tourist resorts of the Caribbean, and the niche markets of North America and Europe.

Various projects emanating from the Food and Agriculture Organization (FAO) have been designed to encourage increased diversification away from traditional crops. The different projects come under the FAO umbrella project, the Regional Transformation Programme (RTP). The RTP is designed to achieve international competitiveness and food security for the region and to redress the balance between food imports and exports.

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[15] Sustainable Agriculture and the Development of the Amerindians in Guyana: *The case of the Mabaruma/Hosororo Organic Cocoa Project*

[16] Shutt, *et al* (2007).

[17] Mott MacDonald (2004) Guyana Drainage & Irrigation Systems Rehabilitation Project Feasibility Study of Principal Areas, Georgetown

3.2 Economic Policies and Sectoral Performance

Since 1989 the government has followed a liberalized, free-market model of development, with the private sector being touted as the main source of growth. Under this model, public enterprises, such as, the Guyana Rice Board (GRB) were divested, foreign exchange regimes were liberalized making it easier for the farming sector to access resources for retooling and investment purposes. Price controls were removed, import and export licenses were eased, and an environment for investment created. In the agricultural sector, some of the most important aspects of the economic reforms have been the managerial changes in GuySuCo and the liberalization of the rice market coupled with the liberalization of the exchange rate regime.

3.2.1 Main Commodities

3.2.1.1 Sugar and Sugar-Derived Products

Sugar and sugar-derived-products accounted for 9.2% of Guyana's GDP and 30% of its agricultural GDP in 2007. The industry is the largest net earner of foreign exchange and the biggest contributor to public revenue and employs 7% of Guyana's labour force directly (Bank of Guyana, 2008) and an estimated 25,000 indirectly (Shutt *et al*, 2007). Within Guyana, sugar production has enormous spillover effects on the rest of the economy, for example, in retail and distribution and in maritime transport services.[18]

The sugar industry is export-oriented. In 2007, exports accounted for almost 92% of production. The main export markets are the in the European Union (EU), CARICOM countries, and the United States (US), all under some type of preferential scheme that has come under increasing pressure from globalization and free trade initiatives. Sugar exports totalled US$137 million in 2006.[19]

In recent years the corporation has been able to increase yields per hectare and tripled the output from the level it was in 1990. The yields have reached 75-80 MT/hectare and the company is currently the most competitive in the region. However, production costs have remained high and are above the global market prices.[20]

The sugar industry suffered a period of crisis in the late 1980s and early 1990s, with output dropping from some 395,000 tons in the early 1970s to about 130,000 tons by 1990. Since then, however, production has increased. Production reached 331,057 tons in 2002, a 16.4% increase over 2001; and earnings from sugar exports reached US$119.5 million.[21] However, since that time the sector's performance has been sluggish. The authorities report that the target for 2010 is to have production increased to 450,000 tons and a reduction in costs of production to a level where Guyanese sugar could be competitive in the world market.

Due to its relatively high costs, the industry has depended heavily on its preferential access to foreign markets. The ACP/EU Sugar Protocol[22], the EU Special Preferential Sugar Agreement[23], and the U.S.

[18] Ministry of Agriculture (2006) Guyana National Action Plan for the Sugar Industry, Ministry of Agriculture, Georgetown

[19] Ministry of Finance (2008): *Budget Speech*, Ministry of Finance, Georgetown.

[20] World Bank (2003) Guyana Development Policy Review, World Bank, Washington.

[21] Ministry of Finance (2003a), pp. 7 and 9.

[22] This protocol is being phased out and replaced by the Economic Partnership Agreement, which allows for duty free quota free access to the European market but void of the preferential prices. The phasing out of the SP is 2009.

Sugar Programme all grant access to imports from Guyana at prices higher than world-market prices. Guyana's exports of sugar also benefit from duty-free access to CARICOM markets, where Most Favoured Nation (MFN) imports of sugar face a 40% tariff. In 2002, direct exports to the EU accounted for more than half of the volume and nearly two thirds of the value of Guyana's sugar exports (GuySuCo, 2008). The EU was responsible for another 11.9% (by volume) under the Special Preferential Sugar Agreement. Other major export markets, by volume, were CARICOM (21.2%), the United States (4.3%), and Haiti (2.7%). Despite these special conditions, about one fifth of GuySuCo's output was not profitable and needed cross subsidization (within the company).[24]

3.2.1.2 Rice

Rice has been trading places with the fisheries sector in terms of its importance to Guyana's economy. There are an estimated 30,000 farm families involved in rice cultivation and thousands more in milling, exporting, transportation and other activities linked to the industry (Guyana Transport Sector Study, 2005).[25] It is further estimated that 20% of the population depend directly on the rice industry. In 2007 rice accounted for 4.2% of GDP (a decline of 17.6% over the 2005 figure) and approximately 10% of total exports.

During the 1990s, the rice industry showed major increases in the acreage harvested, and the quantity produced and exported. Much of this success is attributed to the removal of price controls, and the privatization of the milling and export industries. The authorities also credit an increase in drainage and irrigation activity after 1992, better marketing, the freeing up of foreign exchange controls and improved land tenure. In 2007, Guyana produced 298,128 tons of rice, representing a 9.1% increase of the 2005 level, but a decline by 3% over the previous year's total of 307,037 MT. At the same time, exports value in current US dollar increased by 63% between 2005 and 2007 attributed mainly to rising commodity prices.[26]

The domestic market absorbs around 60,000 MT of rice equivalent; the remaining 150-250 MT (according to the harvest fluctuation) are exported. About a half of exports are of low priced semi-milled rice (cargo); white rice has a share of one third and the higher priced parboiled rice a share of only one eighth of total rice exports (in 2007).[27]

Productivity in the rice industry has improved considerably; per-acre yield rose by 55% between 1975 and 2007. These improvements, however, appear to have reached a plateau in recent years. Furthermore, while the volume of rice exports has been fairly steady, the prices obtained in foreign markets declined sharply until the later part of 2007 and 2008 due to global commodity shortages. Whether these prices will remain buoyant is a moot point but they do seem to be encouraging persons who had abandoned lands to return to paddy cultivation as the venture has once again become feasible for some persons (see *Appendix 1*). Despite the spike in prices though, average yields still seem to be

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[23] The conditions of the SPS agreement include a minimum delivered price to be paid by EU refiners, equivalent to approximately 85% of the ACP guaranteed price for raw sugar. The minimum delivered price is calculated by deducting 8.1 euros per 100kg from the ACP guaranteed price for raw sugar fixed under the ACP/EU Sugar Protocol.

[24] European Union (2005), Guyana Transport Sector Study, Working Paper #4, pp 18-19, Georgetown

25 The Study estimates that approximately 100,000 persons depend on the sector directly and indirectly.

[26] Trostle, Ronald (2008) *Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices*, United States Department of Agriculture, Washington.

[27] US$232/ton for cargo rice, US$ 310 for white rice and US$ 415 for parboiled rice (in 2000, FOB), Agrotec SPA: Feasibility study of CARIFORUM Rice Industry. 2002, p.40

well below potential and are lower than those of other countries in the region.[28] Furthermore, low processing efficiency remains a major concern.[29]

With an average yield of 4.19 MT/ha[30], the yields are lower than in competing countries in the region. Moreover, wages are reported to be some 4-5 times higher than in low-cost Asian countries[31]. However, given the hike in commodity prices, our estimates indicate that the average price received for paddy exports was US$324 in 2007. Thus, rice production, which was at the edge of the profitability in the former years, has become profitable again, but this should not gloss over the need to reduce field costs and improve productivity levels.

In the future, some cost reduction can be achieved by improving the reliability of water supply and dispersal of drainage outflows, both areas projected to be significantly impacted by climate change.[32] According to a World Bank study completed in 2003, it was estimated that a substantial improvement in the sector's profitability would require an injection of between US$60 million and US$65 million for the rehabilitation of drainage and irrigation infrastructure, improvement of farm to market roads, and storage facilities.[33] Since that time, Government has embarked on a massive drainage and irrigation programme under the Agriculture Support Services Programme (ASSP), as well as under an EU-funded programme to support the sector. The need for these improvements was made even more urgent after the 2005 and 2006 rainy seasons, where poor drainage in some areas exacerbated the situation, resulting in substantial losses in each year in excess of US$50 million (ECLAC 2005 & 2006).

3.2.1.3 Livestock

Livestock production has remained sluggish. Between 1998 and 2002 there was a significant upswing in the poultry industry. This led to the country being self sufficient in eggs and nearly 90% in poultry meat. [34] While the country is still able to meet much of its local demand, some of the companies that emerged at that time have since ceased operations for a variety of reasons. But at the same time, other smaller producers have been investing in the sector. The poultry industry comprises about 3,400 enterprises including about 500 pluck shops, four processing plants, 50 commercial farms, 3,000 small farmers, 12 hatcheries, 80 trucks, and four stock-feed factories. It employs some 5,000 people.

Livestock production in Guyana is currently oriented completely to the domestic market, which means that there is almost no export activity to serve as a signal that such export activity could be potentially profitable. Nevertheless, the cost of meat production in Guyana is low and Guyana has several advantages as a beef exporter including abundant land and water resources necessary for raising grass fed cattle, and having been certified Foot and Mouth Disease free since 2001. These characteristics position Guyana as one of the few players with the comparative advantage required to be a potential long-run player in the export of beef. Presently, beef is not exported from Guyana because of a number of constraints that include the need to implement appropriate animal health legislation, develop veterinary diagnostic facilities, establish an abattoir of international standards, utilize improved quality

[28] The yield in the Dominican Republic is 5.2ton/ha,while in Latin America it is above 6 ton/ha.
[29] World Bank (2003): *Guyana Development Policy Review*, World Bank, Washington.
[30] Guyana Rice Development Board (2008) Annual Report: 2007, GRDB, Georgetown
[31] The World Bank estimates this costs at US$ 340-400 per MT; World Bank: Guyana Development Policy Review, 2003, p.48.
[32] Agrotec SPA (2002). Feasibility study of CARIFORUM Rice Industry. 2002, p.65.
[33] World Bank (2003). Guyana Development Policy Review, 2003, p.47
[34] Ministry of Fisheries, Crops and Livestock with Responsibilities for Forestry online information. Available at: http://www.sdnp.org.gy/minagri/moa_mfcl/mfcl/index.htm.

forage, introduce improved cattle breeds, promote improved husbandry techniques and develop measures to tackle the problem of rustling.

The Ministry of Agriculture has implemented a Livestock Development Programme to promote efficiency in the rearing of poultry, cattle, swine, sheep, and goats. The aim is to increase production and productivity and attain self-sufficiency of livestock and livestock products. Furthermore, under a recently signed Agricultural Export Diversification Programme (AEDP), the government is providing substantial breeding material and technical assistance to farmers, with the aim of lifting sanitary and phytosanitary standards, improving the disease surveillance system, as well as pasturage for the beef/cattle industry.

As regards the poultry sector, Guyanese producers have concerns over the competitiveness of the industry *vis à vis* major producers in North America with increasing globalization. A regional study concluded that, on the basis of the importance of the broiler industry in CARICOM and given its vulnerability to low priced imports, a clear case existed for treating the industry as sensitive in a global trade context.[35] In this regard, imports already face relatively stringent market-access conditions since, in addition to the 100% tariff imposed on most chicken cuts, imports of poultry into Guyana require a sanitary permit.

3.2.1.4 Non-traditional and Processed Products

The non-traditional sector includes all components of the agricultural sector with the exception of rice, sugar, forestry and fishing. The National Development Strategy (NDS) conveniently identifies the major non-traditional crops as the following: Cereals and Legumes: corn, blackeye, Oilseeds: peanut and coconut; Ground Provisions: cassava, sweet potatoes, eddoes, yam, tania/dasheen, plantains; Vegetables and Greens: tomatoes, cabbage, pumpkin, bora, ochro, boulanger, squash, cucumber; Herbs, Spices and Seasonings: eschallot, hot pepper, ginger, tumeric; Fruits: banana, pineapple, pear, carambola and watermelon; Other Fruits: mangoes, genip, cherry, awara: Citrus: lime, grapefruit, orange: Other Crops: coffee, cocoa and cotton; pasture/forage, ornamentals and floriculture. The major producers in this sub-sector are poor rural households, many depending directly on the sub-sector for their livelihood, while others are supplementing their income from the output produced in this sub-sector.

This sub-sector has been experiencing substantial growth of late under government's 'Grow More Food' campaign, but also due to the increased emphasis placed on the sector and the assistance provided by the New Guyana Marketing Corporation (NGMC). As detailed later in this assessment, the fruits and vegetables supply chain has strong potential for growth. Guyana's non-traditional agricultural exports (mainly of vegetables and fruits) grew by 35% in value in 2007 over the 2005, accounting for just above 2% of total exports (New Guyana Marketing Corporation, 2008). In recent years non-agricultural products have increased both in terms of output and exports. As before, products with the most promising marketing opportunities include coconut base products, pineapple, pepper, plantain, pumpkin and passion fruit.

The Government has repeatedly espoused its plans to introduce sustainable cut-flower, honey, and integrated fish and crop farming industries.[36] At the same time, efforts have been made o exploit the organic niche markets for pineapple, sugar, cocoa, peanuts, cashew nuts and heart of palm. In this respect, a peanut production programme has been put in place with the aim of improving the volume and quality of the product to suit local and overseas markets. Organic farming programmes have been

[35] Singh et al. (2001), p. xi.

[36] Ministry of Finance (2002a), p. 27.

started, with the rehabilitation of 40.5 hectares of cocoa plantations, and an export target of 2.2 MT per year, mainly to Europe. Also, the company processing heart of palm in Guyana, has secured certification for its operations and is now seeking to extend this into the area of pine apple cultivation. Its pineapple operations are mainly done with indigenous communities in the Mainstay/Whyaka area of Region 2.

3.2.1.5 Fisheries

Fisheries in 2001 accounted for some 3% of GDP, but grew to some 7% by 2006. Exports have been rivalling the rice sector as the second most important agricultural export sub-sector. Exports from the sector have consistently surpassed US$50 million since 2004, with shrimp being the main export from the industry.

Guyana's fishing fleet consists of around 120 trawlers based in Port Georgetown; they exploit the waters in the continental shelf. Their main objective is the smaller shrimp and fin fish that are found in depths of 13 to 30 metres. Another 65 ships are based in Guyana but are foreign-owned, and fish for larger prawns at depths of 25 to 90 metres. Guyana also has a fleet of some 1,200 artisanal boats that fish in river mouths, and near the shore at shallow depths and are an important source of employment in these rural areas.[37]

Some aquaculture projects have been developed in recent years and the cultivated acreage has risen from approximately 1 hectare in 1997 to over 1,619 hectare in 2006. A freshwater aquaculture demonstration farm and training centre has been set up at Mon Repos, East Coast Demerara, to promote freshwater aquaculture development by providing on-site training of farmers. The project is funded by the Canadian Development Agency (CIDA), Food and Agricultural Organization (FAO), and the Government of Guyana.

Commercial aquaculture is one of the most promising economic activities in Guyana with high potential for rapid export and job creation growth. Aquaculture also has great potential for improvements in food security status of rural communities, especially as other farming systems (in particular rice) can be adapted to incorporate aquaculture production, thereby increasing production endowments.

At present aquaculture is a nascent sub-sector in the initial stages of development, though with potential for strong growth. It is estimated that some 2,000 hectares are cultivated. This land area produced a production value of US$1.2 million in 2006, experiencing average annual growth of 14.4% since 1995.

However, in the wider context of regional production, Guyana's output is still low and made up only 0.02% of the total production of Latin American and Caribbean Countries in 2006. There are a number of pioneer investors operating in the sub-sector. Of these *New Line Aqua Farm*, based in the West Demerara Zone is the most advanced, and has been the only company to begin small scale exports in 2006.

[37] *Guyana Review* "Fishing in Troubled Waters," Volume 10, No. 116, August 2002.

3.2.1.6 Forestry

Forestry products over the past 7 years, the annual average contribution of the forestry industry to Guyana's GDP have been 3.49%, with 2006 being an exceptional year. It is estimated that Guyana has 22,400 square kilometer of commercial forest; another 64,000 square kilometer of forest are potentially commercial.[38] Export earning in 2006 was US$59.5 million, representing a 67% increase over the 2000 figure.[39]

The Ministry of Agriculture with responsibilities for forestry oversees policies in the sector; it is trying to promote value-added activities. The GFC monitors forest operations to ensure compliance with its operational and environmental standards. It has established a 24-hour monitoring unit to reduce the incidence of illegal activities by loggers, and is aiming to have Guyana certified internationally as an exporter of wood and wood products in accordance with environmentally friendly practices. In this regard, it is working with the Guyana National Initiative of Forest Certification (GNIFC), established in 2003 to take the process forward.

The Guyana Forestry Commission produced a National Forest Plan in 2001. The overall objective of this plan is the conservation, protection, management, and utilization of Guyana's forest resources, while ensuring that the productive capacity of the forests for both goods and services is maintained or enhanced.[40] Among the points emphasized in the plan is the need to promote greater conservation of the country's forest resources. In 2002, Conservation International, under a Timber Sales Agreement (TSA), undertook to conserve and protect approximately 80,000 hectares of State Forest Estate over a period of 30 years. In this concession, no logging is permitted and the GFC is to be compensated on the basis of a timber valuation of the concession. The NFP also promotes export trade and underpin this with research and development aimed at both processing and marketing as well as offering training and extension programmes. The plan called for the approval of a new Forests Act which was passed in 2007.

Additionally, Guyana is one of 14 states that have been selected to receive funding to engage in programmes that help combat tropical deforestation and climate change.[41] The country will receive funding from the Forest Carbon Partnership Facility (FCPF) in an innovative approach to finance efforts to combat climate change. Guyana will receive grant support as it seeks to build its capacity for Reducing Emission from Deforestation and Forest Degradation (REDD).

[38] Bernard (1999).

[39] Guyana Forestry Commission (2008) *Forestry in Guyana: 2007*, p. 4

[40] Guyana Forestry Commission (2001), p. 1.

[41] The others are the Democratic Republic of Congo, Gabon, Ghana, Kenya, Liberia, Madagascar; Bolivia, Costa Rica, Mexico, Panama and Nepal, Lao PDR, and Vietnam.

4. Climate Change Scenarios

4.1 The Global Context

Global climate change and possible sea level rise can have profound impacts on the development prospects of a number of developing countries[42], Guyana included, even though even some developed countries will also be seriously threatened. According to the Inter-Governmental Panel on Climate Change (IPCC) increasingly, the scientific data in the form of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea levels indicate that climatic changes remain real (IPCC, 2007). Furthermore, IPCC projections of a temperature rise of between 0.15 to 0.3 degrees centigrade per decade are supported by an observed global value of 0.2 degrees centigrade per decade (IPCC, 2007).

Further, the projection of global sea level rise of 0.51m towards the Century will necessitate appropriate adaptation responses. The immediate cause for concern is the extremely high vulnerability of low lying coastal states, whose coastal areas tend to accommodate the main population centres, social and physical infrastructure, and are sources of livelihoods and high economic importance; and those other vulnerable sectors of which agriculture is a highly weather sensitive one. As a result of climate change there will be impacts on rainfall, water resources, heating effects on plants and animals, leading to higher evapo-transpiration rates leading to stress in both organisms. The increase in temperatures will add to the energy budget in the atmosphere and oceans, this will create more intense storms occurring at more regular intervals.

Against the preceding background and based on projections, global adaptation costs are estimated to range between US$20 - 25 trillion annually (Watkiss *et al.*, 2005; Ackerman and Stanton, 2006; European Environmental Agency, 2007). However, even these figures it is argued, often under-estimate the impact of climate change. While the World Bank (WB) has argued that the funds available to developing countries like Guyana via the Clean Development Mechanism (CDM) and the Global Environment Facility (GEF) Special Climate Change Fund are technically adequate[43] to respond to the challenges of achieving climate resilient development, others have argued that the sums of money flowing through these instruments need to be substantially increased (CARICOM Draft Regional Strategy, 2008).

For the next two decades, a warming trend of about 0.2 degrees centigrade is projected for a range of greenhouse gas (GHG) emission scenarios (Brandt and Farrell, 2007). As such, the IPCC has contended that even if the concentration of all greenhouse gases and aerosols was to be kept constant at year 2000 levels, a further warming of about 0.1 degrees centigrade per decade is expected (IPCC, 2007).

Concomitantly, the projections anticipate that changing climatic conditions will lead to rising sea-levels and an increase in global sea water temperature; weather patterns will become more erratic, with more frequent extreme events, such as droughts, floods, and hurricanes. In fact, more recent evidence

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[42] A developing country is for the purposes of this strategy and action plan will be defined as a country which has an undeveloped or developing industrial base, and an inconsistent varying human development index (HDI) score and per capita income, but is in a phase of economic development. Conversely, the term developed country will be used to categorize countries with developed economies in which the tertiary and quaternary sectors of industry dominate.

[43] As of April 2007 the GEF had reserve allocations and pledges totaling approximately US$200 Mn, while the Adaptation Fund under the Kyoto Protocol of the UNFCCC is estimated to total between US$100 and US$500 Mn by 2012.

suggests that the economic impacts can be debilitating on a global scale with damages ranging between 5% and 7% of gross domestic product (GDP) (Stern, 2006; Garnaut, 2008).

4.2 National Context of Climate Change

Against this global context one can conclude that climate change poses challenges for all sectors of the Guyanese economy, but particularly those dependent on natural resources, such as agriculture. According to the IPCC Fourth Assessment Report (AR4) (2007) many social, biological and geophysical systems are at risk from climate change. These risks are even more profound given that they are occurring within an evolving socio-economic baseline (IPCC, 2007).

In Guyana, there is a bi-modal pattern of rainfall annually, the intervening periods are dry. In order to maximize the land resources for crops and livestock production, then a source of water must be in place to supplement the variable rainfall in sufficient quantities. Hence, water resources are stored for use in reservoirs or extracted from flowing rivers, to support agriculture. The projected scenarios and modeled data (INC 2002) indicate that there will be increased intensity of storms, leading to higher runoff resulting in flooding, leaching of soils which do not have good cover or may have been cleared for planting, leading to increase of sedimentation of waterways. Almost all drainage and irrigation depend on gravity flow; as such, any changes in elevation or bed profile of streams will result in inefficiency in operation or create additional costs due to the need to pump water for drainage and/or irrigation (*see Appendix 2*).

But at the same time, climate change also presents some short term opportunities for Guyana, and the agricultural and forestry sectors more specifically, if the country continues to seek efforts and investments to position itself strategically in an increasingly food insecure world in the face of escalating commodity prices (Trostle, 2008), and to take advantage of its standing forests (World Bank, 2006). Furthermore, under the Guyana Bagasse Cogeneration Project nearly 890,000 $_{-e}$ over a 14-year period will be mitigated and the project will receive Certified Emission Reductions (CERs), often referred as carbon credits. In the context of the Clean Development Mechanism (CDM), these carbon credits are based on the difference in greenhouse gas (GHG) emissions between the most likely future practices (known as the baseline scenario) and proposed practice due to project activities (known as the project scenario). This difference is defined as "additionality". By displacing fossil fuel use in energy generation, the Project will contribute to a reduction in the impact on climate change and is therefore eligible to receive carbon credits.

This National Agricultural Sector Adaptation Strategy to Address Climate Change (2009-2018), commissioned by the MACC project out of the CCCCC, is based on a plan by the GoG to develop a coordinated framework for climate change policy in agriculture. This framework will contribute to the development of a competitive, diversified, sustainable, and technologically advanced agricultural sector leading into the future. Further, it will provide the GoG, mainly through the Ministry of Agriculture (MoA), research and development (R&D) organizations and academic institutions with practical tools to develop effective and efficient contextually relevant policies to overcome the challenges posed by climate change and take advantage of the opportunities presented. The objectives, strategies and proposed interventions presented in this document builds on the issues and needs identified through previous and on-going processes and documents that include:

- The establishment and re-organization of the National Climate Committee (NCC) (1995);
- The establishment of the Natural Resources & Environment Advisory Committee (NREAC) (1995);
- National Biodiversity Action Plan (1999);

- Integrated Coastal Zone Management Action Plan (2000);
- National Environmental Action Plan 2000 – 2004 (2000);
- Guyana Climate Change Action Plan (2001);
- Mangrove Management Plan (2001)
- Guyana Initial National Communication in Response to its Commitment to the UNFCCC (2001);
- The preparation of Guyana Climate Change Adaptation Policy and Implementation Strategy for Coastal and Low-lying Areas (2002);
- Draft National Disaster Preparedness Plan (1985);
- The completion of Guyana's National Vulnerability Assessment to Sea Level Rise (GNVASLR) (2002);
- The completion of the National Capacity Self Assessment (NCSA) Project in response to its commitment to the UNFCCC (2006);
- Establishment of the National Climate Unit (2008);
- Commencement of Guyana's National Communication (2008);
- Conducting a pilot Vulnerability and Capacity Assessment (VCA) for the agricultural sector (2008); and
- The Conservancy Adaptation Strategy.

The Strategy provides an overview of the priority strategies and proposed actions requiring national cooperation to adapt to climate change. It includes recommendations on capacity building measures, policy and legislation and communication and awareness building gleaned from the sector assessments conducted. It identifies sources of possible assistance to support the implementation of the proposed actions.

5. Climate Change Impacts Nationally

There is evidence suggesting significant changes in global climate have occurred over the past century and that this phenomenon will continue throughout the century due to anthropogenic activities as well as natural cycles. The risk of extreme events and abrupt changes in climatic patterns is also increasing. It is likely that Guyana will face some degree of climate change over the next 30 to 50 years irrespective of global efforts to reduce greenhouse emissions with some of the projected impacts shown in Table 1 below (*see Appendix 2*)

Table 1: Global and local climate scenarios with some recommended adaptations

Global Climate Scenarios Assessment Report of the IPCC, models and data.	National Climate Scenarios, data analysis	Adaptation responses of the agricultural and allied sectors.
Warming of South American Continent inclusive of low latitudes of 0.2 to 1.0 from1970 and-2004. Models have indicated best estimate of 3.4 , with a likely range of 2.0 to 5.4 at 2090 to 2099. (A2)	i) An increase of the maximum temperature by 0.8 , from ii) Minimum temperature has shown an increase of 1.2 . A mean annual increase of 1.0 over the same period. (INC 2002).	a) Develop heat resistant varieties, diversify crops. b) Use shade & greenhouse to control heat exposure. b) Improved infrastructure to ensure irrigation in dry season. c) Better designs of animal pens, to allow for more airflow.
Global sea level is expected to rise by 0.23m to 0.51m by 2090, even with mitigation measures of reduction of GHG emissions. This does not take into account melting of ice caps.	Current sea level rise is at least several times the global average, in Guyana it is 10.2 mm/year. (Guyana's National Vulnerability Assessment to Sea Level Rise 2002)	a) Salt tolerant varieties. b) Increased water management to prevent saline intrusion. c) Improved sea and river defences protection. d) Land use change e) Increased public awareness about climate change, the role of mangroves and efficient waste management techniques
Impacts on Rainfall: By mid-century, annual average river runoff are projected to increase by 10-40% at high latitudes during wet seasons. Fresh water resources are projected to be less including a reduction of groundwater recharge. Other impacts are intense storms and regular ENSO events	Increasing rainfall intensities will contribute to higher runoff and increase flooding. The data supports the former; the latter is supported by the frequency of occurrences in floods currently, such as in 2005 and 2006 along the coast, but also in segments of Region 9.	a) To improve drainage capacity. b) To accommodate more storage in conservancies. c) Acquisition and deployment of more pumps. d) Recirculation of water. e) Better maintenance of drainage outfalls

Sources: IPCC Assessment report, GNVSLR 2002, INC 2002, Survey information of Agriculture Sector Agencies

5.1 Sea Level Rise

Guyana's coastal plain that lies below mean high tide level extends for about 430 km east to west and varying in width from 26 km to 77 km. This flat plain is protected from the sea by a mixture of natural defenses, sand banks, earthen embankments within mangrove stands, and a combination of concrete walls and rip-rap structures known collectively as sea defences. The rip rap structures are a strategic response to the threat of rising sea levels associated with climate change, as the crest level can be raised relatively easily to accommodate future rises in sea level.

The coastal plain, representing about 7% of the total land area, occupied by about 90% of the population and where most of the economic activity in the form of agriculture and commerce takes place, remains vulnerable to the impacts of climate change and its associated sea level rise. These impacts include flooding, storm surges, saline intrusion into freshwater aquifers and coastal rivers, and

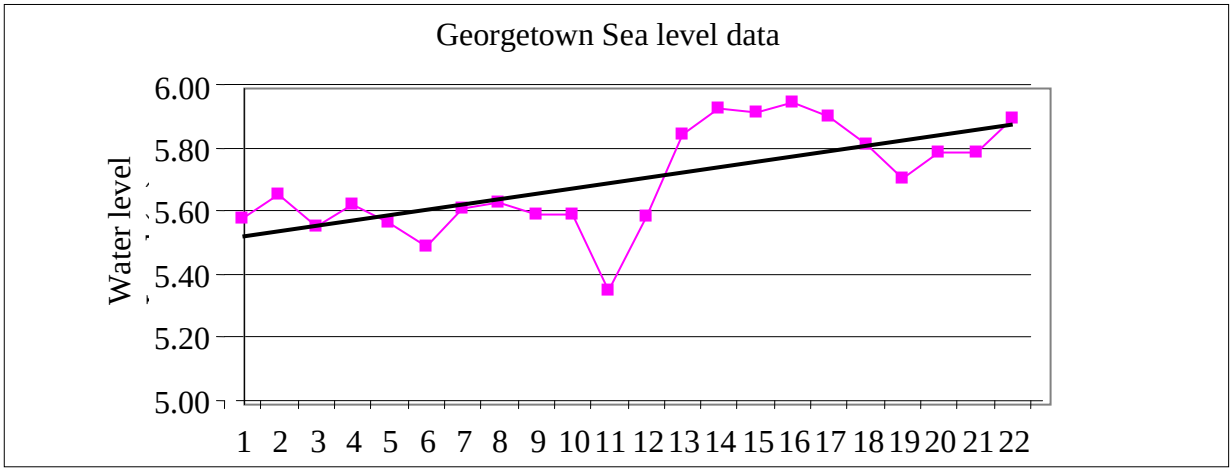
rising water tables. In the intermediate savannahs and hinterland areas there is projected to be increases in temperature, for a doubling of carbon dioxide () of 1. by 2040 and a projection of a 4. increase for a tripling of for the century (INC, 2002). Additionally, rainfall is projected to decrease for a doubling and a tripling of . (INC, 2002). However, some crops are expected to benefit from these increased temperatures, e.g., maize in some studies (Hatfield, 2008; Smith and Martino, 2007) particularly in the Intermediate Savannah areas, but without any irrigation system in place crops can only be grown during the rainy season, which can produce highly variable yields.[44] The success of subsistence and commercial farming in these areas will have to be based on plant breeding and sound agronomic practices to withstand high temperatures.[45] Heat and drought tolerance will be the key mitigating factors.

Further, the Caribbean Agricultural Research and Development Institute (CARDI) found that UF 717 *Brachiariha humidicola* was suitable for growth to support livestock in the savannah region which may provide some opportunities under Guyana's diversification plan and grow more food campaign.

Coastal land loss due to a combination of inundation and coastal erosion is projected to have widespread adverse consequences in the low-lying coastal plain of Guyana (see *Appendix 2*). Land loss from sea level rise especially in coastal locations is likely to be of a magnitude that can disrupt virtually all economic activity and impact the social sectors in the country. For example, recent estimates indicate that with a 1m sea level rise, up to of land could be lost, solely on account of inundation. (GNVASLR, 2002) This figure would increase more than threefold to 37 (14%) with storm surge superimposed on a 1m sea level rise scenario. Similarly, based on the Brunn rule, a retreat of up to 100m is projected with a 1m elevation of sea level (GNVASLR, 2002).

A plot of available sea level data 1960 to 1981 from the Transport & Harbours Department (T&HD) showed an increase of sea level of the magnitude that is about 5 times that of global average (Figure 3), which could be attributed to the probability of land subsidence (Bassier 1976).

Figure 3: Plot of sea level data from Georgetown



Source: Transport and Harbours Department, Plot of annual data, departures from the mean red line, and a trend line, black, showing rate of rise of sea level over two decades, in the Port of Georgetown (T&HD and Hydromet2002).

The Initial National Communication Report (2002) based on available tide gauge data for the period 1951 to 1979 for Port Georgetown, found mean relative sea level rise, using a linear extrapolation as

[44] While there has been some discussion on installing drip irrigation in areas such as the Intermediate Savannahs of Guyana, this remains an expensive undertaking that may then make agricultural products from such areas price uncompetitive.

[45] It will also be necessary to improve nutrient use, tillage, and residue management to ensure that agricultural practices do not contribute to the GHG problem facing the world.

10.2 mm yr^{-1}. This rate of relative sea level rise is about 5 times the global average and close to that observed in Trinidad, albeit for a later time period. This is therefore suggestive of some mechanism other than eustatic sea level rise, such as subsidence due to water extraction, ocean floor sediment loading or plate tectonics. Plate tectonics, however, does not appear to be contributing to this problem (INC, 2002).

Subsidence and sediment loading may both be contributing to the high rises noted in Guyana. The high rises observed in Trinidad and in Guyana may suggest a generalized increase of sea level in the region, supported by the Working Group (WG)1 AR4 to the IPCC in 2007, which states that sea level rise will not be uniform globally. In Narayan's (2002) biophysical impacts on saline intrusion up the three coastal rivers, it was calculated that saline intrusion from the sea level rise scenarios of 0.2m, 0.5m, and 0.9m up the Demerara, Essequibo and Mahaica Rivers is projected to be as in Table 2. From the projected impacts, this would increase the salinity content of between a tenth to a third of the soils on the coastal plain, reducing productivity and output, increasing cost of production, make Guyana's agricultural exports less price competitive and increase the vulnerability of a number of rural households that are already living on the margin of poverty (see *Appendix 1*). This will have impacts on the withdrawal of water in these areas for agricultural purposes as well as the likelihood of salinisation of the soil whenever the rivers flood their banks. The water table which is also projected to rise will create water-logging of soils onshore within the areas of influence of the river.

Table 2: Calculated saline intrusion for three future scenarios of sea level rise

River	Sea level rise (m)	Salt water intrusion (river mouth km)	Extent (km)
Mahaica River	0.2	2.2	23
	0.5	2.5	25
	0.9	2.8	28
Demerara River	0.2	4.4	55
	0.5	5	58
	0.9	5.6	64
Essequibo River	0.2	6.6	65
	0.5	7.5	72
	0.9	8.5	80

Source: Narayan's Biophysical Impacts in Guyana's National Vulnerability Assessment to Sea Level Rise 2002

From an adaptation standpoint, the Guyana sea defenses are currently designed to accommodate sea level rise of 6 mm y^{-1}, and the Sea and River Defence Department (SRDD) is using the rip-rap design, which can facilitate raising of the crest level easily, as protection of the coast is seen as a viable option. Agricultural losses could be as high as 20% of GDP in low lying coastal states (IPCC, 2007). Furthermore, given agriculture's contribution to the Guyanese economy the effects may be even more severe (see *Appendix 1*).

Under the European Union (EU) funded Shorezone Management System Project (EDF) the SRDD is collecting data on water levels, coastal morphology, waves, wind and current and undertaking mangrove restoration studies. The data collected will be used in the next phase under the EDF to undertake rehabilitation of the sea defences, adding to previous efforts undertaken by the Environmental Protection Agency (EPA) under the Integrated Coastal Zone Management Plan (ICZM) (2000). Another component is the development of a strategy and Master Plan for the continued maintenance of the sea defences. This phase has been completed and will restart under the EDF (Dalrymple per comm., 2008).

5.2 Tidal Impacts

The coastal plain is particularly vulnerable at high tides since the elevation of the surface of the sea is usually above the land level, thus the need to maintain the sea defences and other protection, such as mangroves, for the continued occupation of the coastal areas. In the event of high tides accompanied by high winds there could be storm surges that could overtop the walls, and cause flooding, similar to what which occurred during 2008 between the Montrose to Better Hope area in Region # 4 (Guyana Chronicle March 23, 2008), and at several other places such as on the Island of Leguan in Region # 3 and Crane on the West Coast of Demerara in Region #4. In her paper on the vulnerability of the coastal areas, Dalyrmple examined two areas, at Hope and Vreed-en-hoop and concluded that it is necessary to incorporate sea level rise and coastal topography into the design of sea defences. In addition in an earlier study it was also recommended that it was necessary to institute better sea defence management, involve local communities in the programmes, and minimize the destruction of mangroves[46] as possible solutions to alleviate flooding due to tidal impacts and sea level rise on coastal areas.

5.3 Drainage

Drainage structures were designed to accommodate 38.1mm of rainfall over a 24 hour period. In the past and in normal conditions these structures were functioning adequately in the drainage and irrigation (D&I) areas. However, annual rainfall intensities have increased (see *Appendix 2*). Thus in the recent past the existing designs of drainage structures have been unable to cope with the resulting demand causing more frequent flash and prolonged flooding and losses, estimated to be in excess of US$453 million and US$160 million in 2005 and 2006 respectively (ECLAC 2005 & 2006). These significant impacts were partly responsible for real GDP declining by 2.5% and 1.6% over the 2004 figure (ECLAC, 2005; Ministry of Finance, 2007).

The rate of sea level rise has consequences for drainage in Guyana that is currently mainly done via gravity flow. This flow is accommodated by the difference in elevation of the water levels in the upstream canals to the sea and river levels. Since the coastal area is below mean high tide level, ranging from 0.5m to 1.0m, then the sea or river has to be lower in elevation for drainage to take place. Higher intensity rainfall will require efficient drainage either through sluices or pumps, with the latter still being largely driven by fossils in Guyana. Hence there are two areas of concern; energy consumption in an atmosphere of increasing fuel costs[47] of energy and the increase in GHG emissions. In the case of the former, the NDIA has begun to modify the design of the drainage system to increase discharge capacity as one of their adaptive mechanisms. For example, where resources are available, they have sought to widen the sluice doors and have a shallower depth of the drainage canals to take care of the same or greater volume of water being drained as if there was a deeper channel (Wordsworth, per comm. 2008). However, this system is still largely dependent on the fall of the tide to be effective.

5.4 Rainfall

This segment of the Strategy utilizes recent Atmosphere – Ocean Global Circulating Models (A-O GCMs) that adequately couple the atmospheric and oceanic circulations and in some cases emission scenarios of future greenhouse gases, and tropospheric aerosols, and assumptions on population and economic growth, and energy availability and fuel mix (*see Appendix 2*). The climate simulations derived

[46] Bynoe, Paulette and Bynoe, Mark. (2000): *Final Report on a Socio- Economic Assessment of the Vulnerability of Guyana's Coast'*, Georgetown.

[47] Guyana remains a net importer of fossils.

from these A-O GCMs have been extensively used in the development of scenarios of regional climate change for impact assessments.

In this case, we used the results generated by the most recent A-O GCM of the Canadian Climate Centre (CGCM 1) run in transient mode with increasing by the observed values to the present and then by 1% per year into the future, to create regional climate change scenarios for the region in and around Guyana. This information is cross-referenced with other modeling analysis using the Hadley Climate Model (HAD CM). For each of the grid cells, Climatological data for 3 time slices: 1975 – 1995 (past), 2020 – 2040 (2 x) and 2080 – 2100 (3 x) are selected. For each of these time periods, changes in near-surface rainfall, temperature, evaporation, and water deficit, as simulated by CGCM 1 are extracted in monthly groupings corresponding to the First Dry Season (FDS: February to April), the First Wet Season (FWS : May to July), the Second Dry Season (SDS : August to October) and the Second Wet Season (SWS : November to January) of Guyana.

The rainfall deficits in the model for the doubling of concentrations going into the 2040's will be more pronounced in Southern regions of Guyana and the lower part of Region 6, while Regions 4, 5 and part of 6 will have the largest deficit in the SWS. This is also borne out using the data generated by the HADCM for rainfall data plotted over the various periods (see *Appendix 2*). Similarly, for a tripling of concentrations going into the century Regions 4, 5 and part of 6 will also have the largest deficit of rainfall. This will have serious implications for continued coastal agriculture.

Water resources availability therefore is projected to be adversely affected due to the impacts of climate change. The models, A-O GCM and HAD CM have predicted that there will be higher temperatures, increased evaporation and more intense storm events. The need to provide irrigation, coupled with the highly variable occurrence of rainfall has led to the creation of Conservancies. There are, from the west, the Tapakuma, Boeraserie, East Demerara and the Mahaica Mahaicony Abary /Agriculture Development Authority (MMA/ADA). In the projections of future climate scenarios, resulting water deficits due to changes in precipitation and higher temperature leading to increasing evaporation, it implies that these Conservancies would have to be maintained efficiently. It will therefore be necessary to maintain/increase storage, if possible, reduce losses, and be able to supplement supply when needed. All these Conservancies serve dual purposes, flood control and storage of irrigation water for their respective areas based on the agricultural sector's water needs.

5.5 Temperature Increase

Guyana's climatic pattern can be tracked using meteorological readings in the Botanical Gardens, Georgetown, where temperature data reaches back to 1909, and rainfall records go up to 1884. Recent research using linear extrapolation, has found that the maximum temperature has increased by 0.8°C, while the minimum temperature increased by 1.2°C with a mean annual increase of 1°C since records were made. Further, researchers noted that a greater increase in night-time temperatures has been contributing to the observed global warming elsewhere in the Caribbean. This observed trend also corresponds to a decrease in the diurnal temperature range of about 0.5°C, which is taken by researcher to be indicative of global warming (EPA, 2002). A plot of the modeled minimum temperature data over the period 2011-2030 for Wales and Leguan combined show that there will be an increasing rise of the minimum temperature. The same period of minimum data for MARDS and also the 2031-2050 period indicates that a similar trend of increase is projected (see *Appendix 2*).

5.6 El Nino Southern Oscillation (ENSO)

Guyana suffers acute droughts during the El Nino phase and oppositely, heavy rainfall accompanied by flooding during La Niña phase. Recently, the El Niño phase has been relatively more frequent or persistent than La Niña. This phenomenon (ENSO) is the primary mode of climate variability on the 2 -5 year time scale. Currently it is difficult to prove that there will be any significant change to the amplitude or frequency of ENSO in the future. Thus, the current large inter-annual variability in the rainfall associated with ENSO is likely to dominate over any effects attributable to global warming.

In his paper Khan (2002) noted that in terms of cyclones, Guyana has not experienced much impact during the hurricane seasons that the Caribbean sees each year. However, recently turbulent wind conditions have been experienced in both coastal and inland areas. In light of this new trend it is likely that as climate change advances Guyana will experience changes in this direction, as well as increased effects of sea swells and tidal surges. It is also possible with any shifts in hurricane numbers, patterns and intensities in the North Atlantic and Caribbean Sea to the north of Guyana will occur. Recent studies indicate a possible increase of about 10% to 20% in intensity of tropical cyclones under enhanced conditions. Khan found in other studies that during ENSO events, tropical cyclones and hurricanes are likely to be more severe, but no significant change in hurricane frequency or geographical extent for the North Atlantic under a 2 x climate. His concern for Guyana was the possibility of hurricane spiral bands that pass to the north affecting Guyana with more frequency than in the past (Ibid).

Upon exploring the ENSO phenomenon, Khan found that particularly in regional climate events, the ENSO has been very pronounced in the 1990s. While from 1982-3 the El Nino had an impact on Guyana's rainfall, it was not intense enough to cause concerns for agriculture. However, during the 1990s it has become apparent that convective storms have become more intense but fewer. The result was high intensity rainstorms leading to short-period flooding. The clusters in the Inter Tropical Convergence Zone off the Guianas are smaller and fewer but more intense. The monthly rainfall is therefore being accounted for by fewer days and higher rainfall. In 1997/1998 El Niño events produced widespread drought with accompanying forest fires and a significant impact on the economy of the country. The La Niña of 1996 caused severe flooding to affect several parts of the country. In 1999, 2000, 2005 and 2006 La Niña brought on sporadic flooding especially of coastal regions (Ibid).

5.7 Potential Impacts on Agriculture

As far as agriculture in Guyana is concerned, the prediction is that there will be an increase in temperature, a decrease in total rainfall together with a decrease in the length of the rainy period. This therefore means that there will be more intense rainfall during the wet season. In coastal Guyana where much of the agricultural sector is concentrated the resilience is likely to be tested by several climate change events notably rising levels, flooding, high temperature, high relative humidity, more pests and diseases incidence, salt intrusion, high evaporation rates and greater plant stress.

It is projected that there will be higher rates of photosynthesis. Despite the increase in photosynthesis the changes in temperature may have a far greater detrimental effect, resulting in a general trend of reduction in productivity for even small increases (1-) in temperature. This is because there will be an increase in plant transpiration rates and evaporation, leading most likely to deficits in soil moisture supply.

Climate change and sea-level rise are expected to result in greater risk of coastal erosion. Our mangroves may be negatively affected by sea-level rise, and thus threaten fertile agricultural lands behind these defences.

5.7.1 Aquculture

The species used are tilapia (*Oreochromis niloticus*), hassar (*Hoplosternum littorale*), freshwater pacu (*Colossome macropomum*), and swamp shrimp (*Mesopenaeus tropicales*). One effect of climate change, saltwater intrusion, can have a debilitating impact on aquaculture production since the hassar and pacu will not be expected to survive under saline conditions. Tilapia has been known to withstand salinity levels of up to 28 parts per thousand (ppt)(sea water); however, there is need for freshwater for reproduction and survival of the fries. High salinity is also expected to affect predator fishes e.g. houri (*Hoplias malabaricas).*

Changing rainfall patterns may also impact the spawning activity of hassar. In Guyana it is expected that the intensity of rainfall will increase, leading to a sharp change in conductivity of the water, and thus probably, an increased rate of spawning.

High temperature and increased rainfall should dilute the brackish water where swamp shrimp are reared, resulting in faster rates of growth. A rise of up to one foot of water in the pond will not have any detrimental effects on the crop.

A major problem for the expansion of aquaculture is that suitable lands (class I) are in direct competition with crop production. This is because the pH of the land is crucial. Only pacu can be reared on lands unsuitable for many crops. Class II and III lands also need much infrastructure and inputs. Farmers should therefore be encouraged to adopt fish/rice culture of production to offset detrimental changes on the soil.

5.7.2 Response to Flooding

GuySuCo has developed and installed extensive drainage and irrigation system throughout its cultivation. GuySuCo works very closely with the National Drainage and Irrigation Authority (NDIA) to ensure that there is adequate drainage for many of the lands contiguous to its cultivation.

However, with climate change there will be the need for additional drainage structures to offset the anticipated increase in surface runoff. This water may reach its cultivation whether directly from rainfall or via overflows from rivers and the EDWC and Boerasirie Conservancy.

5.7.3 Response to Flooding

Salinity has not been a major problem for GuySuCo or NARI, but has affected the rice and vegetable industries. With climate change it is projected that there will be sea-level rise and further saltwater intrusion that will affect the sector adversely. The rice and livestock sectors likely to be hardest hit as soils become more saturated with salt and pasture establishment and production may be a problem because none of the recommended pasture grasses (tanner, antelope or para) are very tolerant to high salinity.

5.7.4 Livestock Improvement

Imported semen is used for improvement of the cattle industry. The Holstein off-springs are not performing well under high temperature and high relative humidity conditions, thus semen from the Jersey and Brown Swiss breeds are now used for better adaptation.

There are three anticipated problems that may arise as a result of climate change:

- nutrition - reduced food (forage) and lower quality of forage especially for beef
- diseases – respiratory and digestive diseases may increase especially for Holstein off-springs.
- Availability of food for human consumption – there is likely to be increased incidence of mastitis which will lead to lower levels of milk production.

5.7.5 Crop Improvement

NARI is responsible for the development of all crops with the exception of rice and sugar cane, which are the responsibility of the Guyana Rice Development Board (GRDB) and GuySuCo respectively.

At NARI lines/strains are introduced and evaluated extensively for suitability to Guyana's growing conditions, response to pests and diseases, general growth, development and yields. GuySuCo is engaged in developing its own cultivars for at least one of three characteristics i.e. sugar, fibre and alcohol content. High fibre content is known to be closely linked with increased resistance to borers. This is essential since there has been a new borer (*Elasmopalpus lignocella*) emerging. The response of this insect pest to changing climatic conditions is still to be ascertained.

An emerging disease is ratoon stunting disease. In its breeding programme there is selection for resistance to smut and leaf scald. With this new disease becoming more prevalent, then the objective of the breeding programme may very well have to be adjusted to include an evaluation for resistance to this new disease.

Burma Rice Research Station is involved in the development of new rice lines. To offset climate change effects the plant materials intended to be the precursors of new rice varieties are being evaluated for salt tolerance and to tolerate increasing levels of water especially during vegetative growth.

A consideration of climate change is that the rice plant may physiologically be unable to have higher yields. This is because of the impact of growing degree days. With higher predicted temperatures the crop cycle will most probably be shortened, hence there may not be enough sink available to maintain current yields.

5.7.6 Plant Responses to Carbon Dioxide

Plants grow and develop in response to a range of stimuli but especially to the availability of carbon dioxide, water and mineral nutrients and to the quality and quantity of light. Most of these stimuli will be affected directly or indirectly by climate change, except that light quality and the natural rhythm of variation in day length will remain unaltered.

Current carbon dioxide concentrations limit plant photosynthesis. If other factors remain favourable, increased carbon dioxide concentrations will lead to greater rates of photosynthesis in plants.

Carbon dioxide is important because carbon atoms form the structural skeleton of the plant. A doubling of carbon dioxide levels may increase plant growth by 40-50% though continuous high levels saturate the plant's ability to use carbon dioxide and the benefits decrease with time. Higher carbon dioxide levels also allow the plant to use water more efficiently and may make the plant sturdier, more fruitful and more resistant (or less appetising) to pests.

Stomatal opening decreases in response to increased carbon dioxide concentrations, leading to an increased resistance to water loss from leaves. Thus, as carbon dioxide concentration increases, the water use efficiency (carbon dioxide gained in relation to water lost) also increases.

5.7.7 Temperature and Growth and Development

Since rates of plant development increase linearly with temperatures above a threshold, events such as germination, leaf appearance and flowering often occur after a fixed accumulation of heat above a base temperature (called day degree).

With an estimated increase in temperature by 1.2 for Guyana then there will be accumulation in the growing degree day. For instance a 105-110 day maturing rice variety will now mature in 100-105 days. The crop cycle will be shorter for all our crops and they will have a shorter time in which to accumulate their storage products. Hence, overall uptake rate will have to increase; if water deficit becomes a problem then there is likely to be drastic reduction in yields.

5.7.8 Plant Responses to Water

Water availability to the plant depends on the relative rates at which water is taken up from the soil by the roots and lost from the leaves. If water is in short supply in the soil, or water loss from the leaves is too high because of increasing temperatures and increasing light levels, the plant will suffer water stress. It will react by closing its stomata (leaf pores) to conserve water and will therefore shut off its carbon dioxide supply. Growth will suffer. Prolonged stress will cause loss of leaves and hardening of the plant. Extreme stress will kill it.

5.7.9 Responses of Pest, Disease and Weed to Climate Change

Effects on pest, diseases and weeds are among the most difficult to extrapolate from climate change scenarios because of the complexity of interactions, particularly in relation to specialised feeding relationships of pests.

Temperature is probably the single most important environmental factor influencing insect behavior, distribution, development, survival, and reproduction. An increase in the mean annual temperature of 1.2°C (Guyana by the 2040s) will mean that many insects will be active for a longer period of time. The range and distribution may also shift since the regions which have cooler nights (Hilly Sand and Clay region) may now experience more of these insects as a result of a rise in the minimum temperature.

Higher average temperatures will mean shorter intervals between generations of pests. Thus, just one more generation over a growing season can have a profound effect on population numbers. This effect will be exacerbated in the case of many sucking pests, as higher temperatures will be accompanied by increased water stress, leading to increased uptake of increasingly concentrated plant sap.

Thrips, aphids and mites are likely to be most responsive to the effects of climate change as they produce many generations in a single season. One of the most important natural controls of aphid populations is rainfall, as the impact of raindrops dislodges the aphids or damages their feeding parts.

On the other hand, reduced water supplies will lead to increases in cell sap concentration. Sucking insects and mites will have a more concentrated food supply and may increase more rapidly.

The general impact of climate change on diseases can be summarised as follows:

- wetter and warmer seasons will favour diseases such as *Phytophthora* that need water to spread;
- drier seasons will favour disease such as powdery mildew that can spread in dry conditions;

Pests and diseases are likely to be more troublesome as a result of climate change, because higher temperatures will allow increased survival and activity. Some pests (mites, aphids) and diseases (powdery mildews, rusts) will be favoured by hot, dry seasons. Leaf eating pests may be slightly disadvantaged by the higher carbohydrate status (and therefore reduced protein content) of host plants growing in the higher concentrations of carbon dioxide, and higher light levels associated with climate change.

Higher growth rates of leaves and stems observed for plants grown under high concentrations may result in denser canopies with higher humidity that favour pathogens. Pathogen growth can be affected by higher concentrations resulting in greater fungal spore production. Increased carbon dioxide levels will favour growth of competitive annual weeds more than it will favour plants in general. Higher temperatures and increased water availability, where the latter does not result in water-logging, will allow growth of many annuals. Perennial weeds will grow more quickly and most will flower earlier, if not controlled. Chemical weed control, with glyphosate in particular, will be less effective in hot, dry conditions

Most likely there will be an overall increase in the number of outbreaks of a wider variety of insects and pathogens. For farmers in the riverain areas and coastal Guyana:

- The possible increased use of fungicides and insecticides resulting from an increase in pest outbreaks will likely have negative environmental, health and economic impacts for agriculture;
- Increased temperatures will likely mean higher populations of pathogens; and
- More frequent and more intense rainfall events will tend to favour some types of pathogens over other.

Farmers would incur increased costs as a result of increased frequency of insecticide treatment and the accompanying negative environmental impacts would mount. Resistant varieties are the most effective method for control. Farmers' profitability could thus be impacted by the varieties they grow to combat a disease.

6. Challenges to the Agricultural Sector

6.1 Economic Challenges

Global climate change presents serious challenges to the agricultural sector in Guyana as the sector seeks to become more competitive, diversified and technologically adept to handle the vagaries of the international market place and climate variability (see *Appendix 1*).

While agricultural production nationally has improved since plummeting to an all time low in the early 1990s, the sector is still faced with a number of internal and external supply and demand side challenges that affect its economic viability, reduced farm incomes, increased social and economic vulnerability of poor rural and hinterland households, possible industrial downsizing, and reduced economic growth. Some of these challenges are likely to be magnified by climate change. For example, internally, the agricultural production base is still fairly narrow, making it particularly vulnerable to climate change impacts, external risks, natural disasters, and fluctuations in world market prices. At the same time, immediate challenges to the crops sub-sector (including sugarcane and rice) include: (i) difficulty in accessing fields during the rainy season due to the deplorable state of some farm to market roads, (ii) pests infestations such as '*blast*' and the paddy bug that affect paddy crops, (iii) the high cost of agricultural inputs such as agro-chemicals and fuel, (iv) insufficient production at the farm level, particularly for non-traditional crops; (v) relatively limited knowledge amongst non-traditional farmers about access to markets and to market information even though the NGMC is now seeking to address this issue; (vi) relatively high transportation costs from fields to markets, and (vii) limited access to financial resources for adaptation measures, such as building shade houses or greenhouses, (viii) under-developed agro-processing capacity, and weak research and technology systems.

Coupled with these internal challenges are external constraints, with that of immediacy being the phasing out of the preferential access to the EU market, with the EU beginning to implement their phased price reduction for sugar that should reach the EU (intervention) price of €329 /ton (- 37%) by 2009 (see *Appendix 1*). Such price cuts are projected to reduce revenue from this sector by an estimated 4.5% of the GDP (US$35 Mn).[48] Additionally, high oil prices[49] that, fluctuating commodity prices, and the erection of a number of non-trade barriers in some of Guyana's most important external agricultural market places.

Furthermore, while the government has relentlessly pursued debt-reduction and debt sustainability measures, with a total indebtedness that exceeds 100% of Guyana's Gross National Income (GNI), the country still remains heavily indebted.[50] This forces the government to divert critical resources away from programmes to improve the resilience of the economic fabric of the sector, such as improved rural infrastructure, while pursuing the commitments it signed on to under the Millennium Development Goals (MDGs).

Guyana's agricultural sector is also being undermined by increasing importation of goods into the CARICOM market that exceeds US$3 billion,[51] with often less than effective administration of the Common External Tariff (CET). This reduces the ability of Guyana's agricultural products to compete

[48] Economist Intelligence Unit: Guyana. Country Profile 2004, p.20

[49] A necessary ingredient to assist with pump excess water off the land in some areas, and other cases to lift irrigation water, with climate change, the cost of these activities will increase, making agriculture less competitive.

[50] Sahay R, (2005). Stabilization, Debt and Fiscal Policy in the Caribbean. IMF Working Paper WP/05/26

[51] Bynoe, M (2007) Draft Food Security Strategy for the CARICOM Region.

on a favouable basis with many of these products that often receive substantial subsidies from their home countries.

Guyana has been seeking to deal with some of these challenges via various programmes. For example, it has developed a Guyana National Action Plan (GNAP) for sugar, mainly to respond to the challenges posed by phasing out of preferences. Among the measures to be adopted are:

1) Market oriented expansion of the sales, profitability of production and structural diversification of the sugarcane industry in Guyana – investment budget € 499 million, the main components of which are:
   a) Construction of a new raw sugar factory and establishment of new cane cultivation at Skeldon estate;
   b) Establishment of a cogeneration plant at Skeldon;
   c) Construction of refinery at Skeldon;
   d) Expansion of cane production/upgrading of factories and establishment of cogeneration at Albion, Enmore and Blairmont estates;
   e) Installation of a packaging plant for raw sugar at Enmore;
   f) Construction of a deep water berth at Berbice; and
   g) Ethanol production from cane.
2) Promoting the growth and development of specific non-traditional agriculture sub-sectors; and
3) Providing infrastructural and human resource development support to achieve the above.

Furthermore, under the European Commission's (EC) Multi-Annual Indicative Programme for Sugar (MIP), Guyana is receiving technical assistance to facilitate implementation of some aspects of the Guyana National Action Plan (GNAP) on Accompanying Measures for Sugar Protocol Countries affected by the Reform of the European Union (EU) Sugar Regime.

Also, under an IADB-funded Agricultural Export Diversification Programme (AEDP) many of these constraints are being addressed. At the same time, under various other initiatives, such as the Competitiveness Programme (CP) and the Guyana Trade and Investment Support (GTIS) Programme some targeted interventions will, and have been pursued respectively to aid with the advancement of the sub-sector.

Nonetheless, critical areas for support still remain. As such, adaptation strategies that seek to improve crop efficiency, diversify the production base, and maintain the competitiveness of the sector must include:

- Increased investment in rural infrastructure to reduce the vulnerability, particularly of coastal agriculture, to droughts, rainfall-related floods, and saltwater intrusions and over-topping that can negatively affect agricultural productivity and output.
- Explore the development of a new pricing strategy for drainage and irrigation schemes, to ensure the full-cost of the resource is factored in and the systems are treated as public good.
- Conduct a flood risk assessment (FRA) outlining the main flood risks to Guyana in general, and the sector in particular, presenting recommendations for mitigating such risks.
- Implement economic risk management to combat climate change and reduce crop losses.
- Strengthen the integration and enforcement of environmental and social safeguards in land use planning in Guyana to reduce land-use conflicts and improve output in the face of global climatic changes.

- Improve information gathering and market intelligence to ensure that farmers have the best information available for planning purposes, and

Pursuing these programmes will be necessary if the national agricultural sector is to respond and adapt to the new, and increases in the magnitude of the existing challenges posed by climate change.

6.2 Technical Challenges

The same circumstances that deepen the country's economic, social and environmental vulnerability also impede its ability to acquire and use appropriate technologies to stimulate its agricultural development and to support adaptation to climate change.[52] Much of the technology is developed in the developed world but marketed globally. Guyana's agricultural sector therefore find's itself in a position of having to adapt these technologies to local conditions. Furthermore, while under the UNFCCC funding is available to all developing countries to undertake technology needs assessments (TNAs) and to develop projects to provide these technologies[53], there has often been insufficient attention paid to the development of indigenous technologies and tapping into indigenous knowledge. For example, it is the belief that the Amerindians have been living with climate variability and may have developed adaptive agricultural activities that can be utilized at a commercial level.

The current technologies are likely to be further tested by climate change as: (i) some supply chains are characterized by low productivity and lack of quality standards and processes, (ii) limited research and transfer of technology services, many of which are not linked with specialized networks to facilitate screening and adaptation of new varieties and fingerlings for these agri-business chains; (iii) scarce supply of technical and research-based services; (iv) low awareness on the impacts of agro-chemicals, moreso in an atmosphere of reduced rainfall, coupled with limited monitoring and enforcement capabilities; and (v) weak technological awareness and business practices to meet Good Manufacturing Practices (GMP) and Good Agricultural Practices (GAP) in the livestock chain.

Currently, farmers are engaged in a multiplicity of adaptation techniques, inclusive of the following (see *Appendix 2*):

- The cultivation of flood tolerant high yielding varieties,
- Rehabilitation of nine (9) D&I Schemes under the Agricultural Services Support Programme (ASSP),
- Construction of new water outlet structures on the coast to reduce the incidence of flooding,
- Rehabilitating sectors of the sea defences along the coast, using a flexible rip-rap design,
- Following more mixed farming methods,
- Establishing of adequate infield drainage systems,
- Excavating external drainage systems,
- Diversification of income generating activities,
- Increasing the size of holdings so as to benefit from the economies of scale, particularly in the rice industry, and
- Merging farms into Co-ops so as to share administrative expenses.

[52] Draft CARICOM Adaptation Strategy (2008).

[53] Additionally, under the Clean Development Mechanism (CDM) of the Kyoto Protocol of the UNFCCC countries are able to apply technologies to reduce their emissions of greenhouse gases and such emission reductions are tradable under the global carbon markets as in the case of the Guyana Begasse Cogeneration Project.

To further the approaches to adapt to climate change the country must utilize adaptive techniques that are informed by the requisite information to determine, not only what is physically possible, but also what is economically feasible and socially acceptable. In this regard, therefore, it is necessary to improve data collection on coastal and interior morphology, sea level, wind and current and water quality, surface and groundwater. Rainfall and runoff data in the watersheds of the major river basins and the Conservancies are vital to capture and retain to allow for informed decisions to be made about these freshwater bodies. Also, every effort must be made to move towards a low carbon sector, through seeking more energy efficient ways of operating.

Additionally measures include:

- Conduct investigations on the most notable and important pests and diseases affecting the sector, inclusive of weeds such as the Antelope grass, to climatic changes. A proper understanding can help combat these scourges that impact farm budgets and ultimately, farm households' income.
- Engage the main stakeholders on the implications of climate change, encouraging them to pursue best farm management practices, inclusive of water use efficiency, plant breeding, agrochemicals and fertilizer application.
- Showcase best management practices through the establishment of public funded demonstration farms to research and demonstrate cutting edge technologies, in areas such as plant breeding, plant breeding, agrochemicals and fertilizer application, plant husbandry, and water conservation and management.
- Explore the genetic diversity within crop types that may be better adapted to climatic changes.
- Undertake a comprehensive freshwater management programme that will determine peaks and troughs of water demand and supply in the sector and recommend measures to best deal with these scenarios.
- Explore the feasibility of instituting crop insurance,
- Better communication strategies and a more timely and targeted diffusion of results from the researchers to the stakeholders and to the general public is necessary to adapt to climate change.
- Education and awareness of potential climate change impacts and adaptation strategies for stakeholders, researchers and decision makers are felt to be lacking.
- Accurate pricing strategies are necessary to be put in place to account for the real cost of adaptation.

The Bali Accord negotiated in December 2007 highlights the importance of developing and transferring new technologies to adapt to and mitigate adverse effects of climate change. Such technologies will require considerable new and additional financial resources to be devoted to research and development. However, the country must be prepared to seek to mainstream its research programmes into areas that are strategic and advantageous to Guyana. Furthermore, it will be important for Guyana to propose and negotiate for the best terms and conditions in a new climate change regime and seek from now to enhance its institutional mechanism to access those resources when they become available in 2012.

6.3 Institutional Challenges

Many institutions that support agricultural development in Guyana operate from a *limited human resource base*, especially at the professional level, even though staff members from more than 50% of agencies examined had received either academic or technical training in climate change or were in the process of

receiving training in areas related to climate change. However, limited human resources, made more acute by emigration[54], may constrain the effective implementation of the Adaptation Strategy.

At the same time, the informational needs to allow for effective climate change modeling analysis are now being addressed. As such, the ability to monitoring and map the effects of climate change on the agriculture sector is lacking. Furthermore, the information necessary to influence the policy framework for adaptation planning is often incomplete.

The lack of such data can lead to inappropriate interventions or actions being taken, resulting is destruction of crops, loss of income, loss of tax payers' money and excessive cost over-runs. Thus, the data and information needed for climate change adaptation measures in the agricultural sector itself needs to be researched in relation to the operational needs of those concerned. In conducting such an assessment, the following questions are pertinent: (i) What data is needed, both now and in the future? (ii) What are the benefits of having these data? (iii) To what extent are these data already available? (iv) How can the data be collected? and (v) In what form should the data be stored and presented? Collecting this information can assist in:

- Improved analytical techniques requiring more accurate or different data.
- Assessing climatic change leading to more extreme hydraulic loading conditions.
- Improved accuracy of predictions as a result of using a longer time series of data.
- Meeting the needs of the insurance industry for more accurate assessments of risk.
- An increased demand for real-time data for use in flood forecasting and warning stakeholders.

It is very important that organisations involved in climate change have an approach to data acquisition which is targeted and cost-effective. Consequently, the following questions need to be addressed.

While some effort has been made via the establishment of the National Climate Committee (NCC) to enhance inter-agency collaboration, modalities for the sharing of information, relevant for the agricultural sector and its response to climate change outside this framework, still needs to be worked out. This will allow for there to be greater cohesiveness of efforts and mainstreaming of the Adaptation Strategy and go some where towards ensuring the success of the activities planned.

Additionally, through the establishment of the Agricultural Sector Development Unit (ASDU) within the Ministry of Agriculture to act as the executing arm of the Ministry's programmes, some effort is being made to better streamline the Ministry's human resources and respond to the limited pool of these resources. Despite this and other initiatives, the Government must continue to aggressively pursue all available opportunities via the UNFCCC and other mechanisms, to seek to enhance the human, informational and technical capacity within the agencies in the agricultural sector and those responsible for managing climate change information and impacts (*see Appendix 4*). Furthermore, the recently established National Climate Unit (NCU) should be a legislative body, equipped with the resources to carry out its functions.

Lastly, public awareness and education have unanimous support as a technique for changing attitudes and building support for improved farming practices. The role of public education in farm management to adapt to climate change should be to promote awareness, understanding, and new attitudes regarding the role of innovation and technology against pests, diseases, floods and droughts; values in following efficient water management regimes and appropriate uses of the natural resources available to the sector. The audience for this message is diverse in its education levels and socio-economic status, as

[54] International Monetary Fund (2006). Mishra, Prachi. Emigration and Brain Drain: Evidence from the Caribbean. January 2006. http://www.imf.org/external/pubs/ft/wp/2006/wp0625.pdf

well as in the part individuals and groups play--consciously or unconsciously-in determining present and future adaptation measures. Thus, a broad-based approach to education is required, since people must make decisions at many levels in order for new or strengthened adaptation policies to take effect. At the national level, the policy-makers seem to be fairly well engaged. However, at the local and grassroots level, there is need for a concerted effort in disseminating the message. As such, demonstration plots, talks by technical experts, and specific interventions in key decisions-can raise consciousness and prepare farmers to give serious consideration to management proposals.

6.4 Policy and Legislative Challenges

The policy edicts within agencies to address climate change issues are often tangential and are either vague or have no provisions in the Agencies' mandates that relate directly to climate change adaptation. However, semi-autonomous agencies do have some flexibility to incorporate climate change into their mandate. An analysis of agencies' mandates reveals that at least 50% of (semi-autonomous) agencies have scope within their mandate to address climate change adaptation. This is associated with four (4) factors:

1. *The institution's mandate has an open-ended objective* for the agency to address other issues of importance to its sub-sector, such as in the case of the Guyana Rice Development Board (GRDB) and the Guyana Rice Producers Association (GRPA).
2. *The institution is a research-oriented or academic organization,* such as the Guyana School of Agriculture (GSA) or the National Agricultural Research Institute (NARI).
3. *The institution's mandate relates to the management of the country's natural resources and the maintenance of infrastructure,* such as the Mahaica Mahaicony Abary- Agriculture Development Authority (MMA-ADA), Sea and River Defence Division (SRDD), National Drainage and Irrigation Authority (NDIA) and the Guyana Forestry Commission (GFC).
4. *The institution's mandate relates to environmental/disaster management,* such as the Environmental Protection Agency (EPA) and Civil Defence Commission (CDC).

At the sectoral (and national) level current policies and laws governing the agriculture sector do not directly address climate change (see *Appendix 3*). In fact, even where these do in a tangential manner, in many instances the laws are not enforced due to limited man-power and technical resources, or the penalties are so insignificant that they do not act a deterrent to perpetrators. It is therefore contingent upon policymakers to modify existing laws to mainstream climate change issues within existing agricultural and other sectoral policies. Furthermore, there is the need to resuscitate the ICZM Committee.

6.5 Energy Challenges

Guyana, like the rest of the world, is confronted with an escalating fuel bill as a net importer of this product that rose to US$147 per barrel in 2008, though it has fallen back to less than US$50 per barrel in recent months but is projected to rise again.[55] This high cost of oil has been occasioned by rapid industrial growth in China, India, Brazil and South Africa propelling demand. This increase in demand has been contributed to by an expanding global population who require food, shelter and transportation. At the same time, most projections indicate decline fuel reserves, those that cannot be tapped or carried out on a feasible scale with current levels of technology, and those that cannot be

[55] New York Mercantile Exchange (NYMEX), 10 March 2008. Oil prices briefly rose to a record $108.21 per barrel in afternoon trading on 10 March (settling to $107.90 by close of trading). The report suggested oil supplies are tightening even as demand remains strong. http://www.nymex.com/lsco_fut_cso.aspx

extracted without causing irreparable damage to some sensitive ecosystems.[56] The cumulative effect of these factors is to restrict supply in the face of an expanding demand, causing fuel prices to remain high. Fossils remain a vital input in Guyana's agricultural sector, particularly in the rice mills, sugar factories, and operating tractors, combine harvesters, and water pumps.

The energy challenge is exacerbated by the need to provide energy services in a context of Energy Security, Energy and Development, and Energy and Climate Change.[57] Although Guyana is responsible for a miniscule percentage of global GHG emissions there is an opportunity for the country to put its agricultural sector through energy sector reforms on a much more sustainable footing through investments in supply and demand side management and renewable energy possibly with support from the Clean Development Mechanism (CDM).

[56] Greenspan, A (2007) *The Age of Crisis*, Blackwell, New York.
[57] World Bank, 2005. Seminar, "Global Energy Challenges," 13 January 2005, Eigtveds Pakhus, Denmark http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/WBEUROPEEXTN/DENMARKEXTN/0,„contentMDK:20779525~menuPK:394044~pagePK:64027988~piPK:64027986~theSitePK:394038,00.html

7. Opportunities

As noted above, Guyana has a competitive advantage in land and freshwater, and with the appropriate infrastructure and management, the agricultural sector can exploit these advantages in the face of climate change. For example, it is projected that greater concentrations of will result in higher photosynthesis rates and may also reduce water losses from some plants. Photosynthesis is enhanced when additional carbon is available for assimilation and so crop yields generally rise. The actual response to increased differs among crops. Most commercial crops in Guyana, including rice, sugar cane, and most vegetable crops, tend to respond favorably to increased , with a doubling of atmospheric concentration leading to yield increases in the range of anywhere between 5-20% (Reilly et al, 2007). This projection is based on the assumptions of fertilization effect and that there will be sufficient nutrients and water available to support these increases. If one is to assume that food prices are to maintain their 2007 levels, this would result in an increase in export earnings from agriculture in the vicinity of US$11.7 to US$46.8 million annually (see *Appendix 1*). However, this carbon fertilization effect may be counteracted by reduced water availability and soil fertility.

From the above projections/scenario, it is unlikely that climate change will imperil the ability of Guyana to feed its population and to export agricultural products. Results from the technical assessment suggest that, at the national level, productivity of many major crops will likely increase under the climate scenarios used in these crop models. Crops showing generally positive results include corn for grain, soybeans, and citrus fruits, while with the construction of shade houses, the yield for some crops such as tomatoes are projected to increase under some conditions and decrease under others. However, for these projections to be realized, the fertilization effect would have to be substantial. In the crop yield models, a limited set of on-farm adaptation options are considered, including changes in planting dates and changes in varieties. These contribute substantial gains in yields of irrigated crops, indicating the need for better freshwater management locally.

The economic assessment considered adaptations in response to changing productivity, prices, and resource use, as well as changes in crops and the location of cropping, irrigation, use of fertilizer and pesticides, and a variety of other farm management options. The assessment indicated that economically, both consumers and producers benefit, the former through increased commodities, wider choices and even seasonal lowering in the price of some products, while producers' profits increase due to seasonal scarcities, increasing demand and relatively high international commodity prices (see *Appendix 1*).

Additionally, climate change is likely to affect the food supply in some regions of the world, with many in the poorer countries likely to slip further into food insecurity. However, demand drivers such as, the rate of population growth, the size of disposable income in fast growing economies like China, India, Brazil, Argentina and South Africa, taste, cultural issues, government policies and natural conditions such as floods and droughts associated with climate change, are all expected to both keep food prices buoyant and provide a boon to the Guyanese agricultural sector. At the same time, the quality of the products and ease with which they can be obtained will remain important considerations in the demand for agricultural products

Another area which Guyana stands to benefit from in the face of climate change is in the area of carbon credits acquired through pursuing more renewable energy sources, such as bagasse energy in the sugar sector, paddy and wood husk in the rice sector, and windmills to pump water. Furthermore, with an expansive standing forest, the opportunities to be exploited here are immense, with Guyana being used as a major source for the development of mitigation technology. This remains an expanding area

of research and private sector expansion and an area that Guyana needs to explore the option of becoming involved in immediately.

8. The National Adaptation Strategy and Action Plan

8.1 Rationale for the Strategy

Guyanese farmers and natural resource managers face a number of challenges in maintaining a profitable, competitive, diversified and sustainable agricultural sector. These challenges have or are being addressed through various policy initiatives in the form of the National Development Strategy (NDS) 2001 – 2010, the Poverty Reduction Strategy Paper (PRSP): 2000 – 2005, the Competitiveness Strategy (CS) of 2006, and the Jagdeo Initiative (JI), the last initiative being a CARICOM proposal to reposition the region's agricultural sector. However, as indicated in the INC Report (2002), climate change is considered the most serious long-term threat to agriculture. Responding to climate change, through adaptation strategies will create new challenges, but also bring opportunities for rural enterprises and the national economy with further strategic positioning of the country's investment resources. Understanding a changing climate, recognizing Guyana's social, economic and environmental vulnerabilities, identifying potential risks and seeking opportunities to respond proactively to minimize those risks is a collective challenge for the GoG, research and development institutions (nationally and regionally), industry, rural communities and natural resource managers.

Underpinning the critical role for the government are the development policies and frameworks that mitigate vulnerabilities, support risk management and sustainable practices by farmers and promote a culture of innovation and responsiveness to change to deal with factors affecting agricultural businesses in the future.

Forward-looking policy can reduce the effects of climate change by anticipating the future regime of SLR and weather, in order to capitalize on opportunities and minimize harm. Conventionally, this means identifying the planning horizons for key impact areas and industries, developing plans and planning capability, selecting the best options, and implementing them well. It also entails contingency planning to deal with impacts, and responding effectively to climatic disasters. A fundamental new dimension is emerging: the need to integrate adaptation policies with policies for sustainable economic development and disaster management, to achieve a "triple dividend" from scarce resources.

Furthermore, effective adaptation implies making vulnerable people resilient, and able to return to normal status quickly, even after a major jolt. This means dealing with other causes of vulnerability like low incomes, no title to assets, lack of education, resource depletion, governance, economic instability, disease, demographic factors and poor risk management. For the agricultural sector, the critical factors are adequate infrastructure and communications, public services, scale, and access to finance.

Similarly, to deal with disasters, the policy makers will need to ensure that the basics of food, water and shelter are available. However, the normal post-event response of disaster relief is unpredictable, often slow, and does not tackle the underlying factors that make communities and businesses vulnerable. The key economic strategies are economic diversification, technical training like soil and water conservation, secure communications and infrastructure and hazard reduction.

The solution, therefore, would appear to be one that builds local capacity and resilience in a way that links sustainable development, risk management, and adaptation for a win-win-win situation. This yields a "triple dividend" in the payback for the scarce resources that are available to invest. Each dollar takes care of climate impacts, disaster recovery and economic growth. In addition, there may be opportunities to incorporate emissions reduction measures.

The Strategy, while it is unable to deal with the myriad issues surrounding the agricultural sector and the rural poor, provides a framework for mainstreaming climate change imperatives in the agricultural sector. It is a cost-effective approach that seeks to mainstream many of the proposed actions through existing programmes or initiatives. It achieves this through a combination of strategies and actions under each focus area to manage multiple risks to sustainable agriculture in an environment of climate change. The strategies and actions have been drawn from an assessment of the available technical, economic, institutional and policy information on climate change and how climate change will impact the Guyanese agricultural sector. The Strategy recognizes the role of farmers in primary production and resource stewardship, and seeks synergies and cost-efficiencies to streamline climate change considerations in natural resource policy.

8.2 Goal of the Strategy

The goal of this Strategy is to more effectively reduce the risks posed by climate change and position the agricultural sector to adapt through technical innovation and diversification to increase its competitiveness and sustainability by 2018.

8.3 Objectives of the Strategy

The Strategic objectives are:

- To enhance the capacity within the agricultural sector to adapt to climate change and position this Strategy to foster a nationally consistent policy framework.
- To build resilience and adaptive capacity within the sector.
- To assist the GoG in providing primary producers with a policy framework that embraces research and development and promotes climate change adaptation techniques in agriculture.
- To build greater awareness about adaptive techniques.

8.4 Key Enablers of the Strategy

Supporting the effective formulation and implementation of measures in this Strategy necessitate some focus on the following key overarching enablers:

1. ***Mainstreaming Adaptation:*** The Strategy recognizes that climate change is a cross-cutting issue and, therefore, seeks to build partnerships, complement existing programmes, and harmonize development assistance being provided to the sector.
2. ***Research and Development:*** It is crucial that policy decisions and actions of stakeholders are informed by analytical/technical assessments, given the highly complex nature of climate change.
3. ***Awareness and Communication:*** The group likely to be most severely affected by climate change is the poor and vulnerable in rural coastal and hinterland areas. It is therefore essential that not only the threats are identified and communicated widely, but also the opportunities and adaptive techniques, and research findings.
4. ***Policy Coordination:*** To ensure ongoing sustainable agricultural policy development and implementation requires policy leadership to both monitor and coordinate the development of an adaptation policy and to ensure that the goals of this Strategy are adhered to, the interventions and actions are implemented according to a strict timetable, the results are

monitored, actions are altered in light of changing realities, and new actions are taken as necessary.

5. ***Public-Private Partnership:*** Strategic collaboration between the private sector and the Government is crucial to uncovering where the most significant obstacles to competitiveness lie, determining what type of interventions are most likely to remove them, and engaging public and private sector stakeholders in the implementation of activities that strengthen the competitiveness of the economy.

8.5 Guiding Principles of the National Agricultural Adaptation Strategy

The Strategy has identified a number of principles and parameters that should be followed in pursuit of the above stated objectives. These are:

- The strategies and actions need to build capacity for priority setting in key areas of vulnerability within the agricultural sector.
- The strategies and actions need to build resilience and adaptive capacity in the agricultural sector.
- The strategic objectives must aim to support profitable and sustainable agriculture.
- The strategic objectives should seek to enhance research and development capabilities for the agricultural sector to adapt to climate change.
- The strategic actions should be tailored to addressing specific issues in the agricultural sector.
- That the policies are coordinated and cohesive, thus increasing the possibility of resulting in beneficial outcomes through establishing synergies and complementarities with other policy initiatives.
- The strategies and actions should enhance communication of climate change implications for the agricultural sector.

These principles led to the development of strategies and actions under five (5) focus areas:

- Capacity Enhancement (both technical and institutional),
- Infrastructure Management,
- Policy and Legislation,
- Research and Development, and
- Awareness and communication.

The Strategy presented focuses on on-going activities, as well as immediate, short-, medium- and long term actions. It provides a framework for mainstreaming climate change concerns within the agricultural sector and is proposed as a cost-effective approach. It is set to achieve its objectives through a combination of strategies and actions under each focus area to manage and adapt to the challenges posed by climate change to sustainable agriculture in Guyana. The strategies and actions have been drawn from the national stakeholders workshop, economic review, and assessments of the technical, institutional and policy needs to address the more pertinent issues presented by climate change and mainstream these within existing development programmes and strategies.

8.6. Strategies and Actions

As demonstrated in Sub-section 5.7 and Section 6, some level of climatic changes is inevitable. This is projected to result in: (i) more intense rainfall leading to increased flooding, particularly along the low coastal plain, (ii) droughts and more ENSO related weather patterns leading to possible saltwater intrusion and increases in the pest population, (iii) sea level rise leading to move over-topping at high-tides and putting both the man-made and natural sea defences under severe strain, and (iv) changes in the national climatic conditions, such as temperature, wind speed, and evaporation rates. The agricultural sector remains severely vulnerable to these threats.

To reduce the agriculture sector's vulnerability to these threats, it will be necessary to adapt a coordinated, cohesive and pro-active approach for the sector. This will involve mainstreaming the concerns of the sector within existing development plans and programmes to ensure they are given due attention. The following focus areas seek to capture on-going efforts and identify gaps for action.

8.6.1 Capacity Enhancement

While not a net emitter of greenhouse gases, Guyana's agricultural sector must adapt to confront the likely changes associated with climate variability through enhancing its capacity if it is to remain viable in regional and global markets. In responding to climate change, efforts at enhancing the sector's capacity must focus on improving the technical, institutional, and informational dimensions with which stakeholders operate. Climate change, therefore, may be providing an opportunity for the sector to adjust farm management practices that may not have otherwise occurred, in supporting the sustainability of agriculture. Such adjustments could better prepare Guyana's agricultural sector to cope with climate change by enhancing its capacity and, hence, the resilience of human and natural systems.

Bringing climate change into focus as an additional element in strategic planning for the sector requires among other things, the development of science, knowledge and management tools for application in practical solutions across a range of decision scales and for different levels of stakeholders, inclusive of resource managers, extension officers and farmers. Capacity enhancement is seen as critical to supporting longer term strategic adaptation interventions in the sector, including tools for flexible management and disseminating innovations to contain costs. Farmers, in particular, need to be convinced that the one sharing information with them is qualified to do so. Additionally, they seek practical options and tools to cope with climate change at the farm level.

Adequate capacity, in terms of institutions, technical skills, human and financial resources, is essential if the principles and theory of a sustainable agricultural sector management are to be translated into practice and result in successful programmes to adapt to climatic changes. The complexity of climate change issues and how it impacts the agricultural sector means that those involved must have an understanding of both the ecological and socio-economic characteristics of the areas in which agriculture is practiced in Guyana, so that they appreciate the interdisciplinary nature of the management intervention, and the dynamic and inter-linked characteristics of the diverse environments.

At the same time, the informational needs to allow for effective climate change modeling analysis are now being addressed. As such, the ability to monitor and map the effects of climate change on the agriculture sector is lacking. Furthermore, the information necessary to influence the policy framework for adaptation planning is often incomplete.

The planning, design and implementation of effective adaptation strategy is dependent on the availability of accurate, relevant and current data and information. Understanding hydrological, climatological, and coastal processes, which underpins government policies for the agricultural sector is

compromised unless an adequate surveillance, monitoring and evaluation mechanism is created and continue to collect the necessary data.

8.6.2 Policy and Legislation

The policies governing the agricultural sector in terms of the National Development Policy (NDS) and the Poverty Reduction Strategy (PRS) while identifying the need for rehabilitating Guyana's rural infrastructure to*, inter alia*, place the agricultural sector on a more sustainable foundation are silent on climate change implications for the sector. However, some sectoral policies, such as the Sea and River Defence Act and the National Drainage and Irrigation Act identify the threat posed by climate change and the need to protect, for example, the mangrove forests and maintain an efficient D&I system.

At the same time, existing laws governing the agricultural sector generally encapsulate statutory powers in existing legislation to respond to the potential or likely effects of climate change. However, there are some gaps and weaknesses that need to be addressed in order to make them more responsive and position the sector to respond appropriately. Undoubtedly, an adequate policy environment is necessary to mainstream climate change concerns. Additionally, instituting the relevant laws will allow the responsible agencies to enforce the necessary stipulations to maintain the integrity of natural resources that support the agricultural sector which may come under threat from climatological changes.

Currently, some of the laws are too outdated to offer any significant influence and require amending. This is reflected vividly in the inadequacy of fines and penalties legislation. Furthermore, there is a lack of coordination among agencies, inadequate institutional arrangements, the absence of modern day principles such as the precautionary principle and reliance upon alternative enforcement and compliance methods. More importantly, the legislative process has not kept pace by passing the required implementing legislation. In the isolated circumstances where regulations were made, they have become rigid and inflexible and their application to the issues presented by sea level rise and climate change is generally inadequate.

8.6.3 Research and Development

Climate change and increased climate variability will present a number of challenges and opportunities for the agricultural sector in Guyana. As such, farmers and natural resource managers will need to make decisions that allow the sector to adapt by increasing resilience and seeking opportunities, where possible, to move towards a low carbon sector. This will necessitate research and development (R&D) that promotes innovation in science, and tools for adaptation and policy development. Furthermore, R&D must seek to address climate change as an important component of future business and risks facing agriculture, and recognise adaptation measures undertaken in response to past climate variability by, for example, indigenous peoples. This will require a comprehensive approach to problem solving.

Guyana has taken some steps toward understanding climate variability in R&D via the NARI and the GRDB Research Station. However, there are still substantial areas for R&D, more so, on a spatial basis. It is therefore critical that there be continued investment in this area. This is important to enable farmers and natural resource managers to be resilient in the face of climatological changes. To achieve this objective would require enhanced participatory involvement of stakeholders, especially collaboration between the research-based institutions like NARI, Institution of Applied Science and Technology (IAST) and the University of Guyana (UG).

There is also the need to have downscaled scenarios at the regional level and meteorological data collected at a micro-level to allow for better modeling analyses and germplasm trials to be undertaken. Such modeling and trial plots are crucial for decision making by farmers, resource managers and the

GoG. But this is only likely to occur if research institutions, industry, farmers and other stakeholders collaborate to develop a systems approach to understanding climate change effects, drawn from diverse models of the physical climate system, agricultural systems, ecosystems, social processes and economic systems, validated with representative data. This Action Plan articulates the role R&D will play in equipping farmers and natural resource managers to face the challenges of climate change.

8.6.4 Awareness Building and Communication

Guyana's climate is changing as part of a global trend, with potentially substantial implications for agriculture. Therefore, farmers and natural resource managers need to understand these trends and implications for their businesses and implement strategies to adapt to these changes.

In responding to climate change, the GoG has a significant, ongoing role in supporting the efficient allocation of resources, managing distribution of costs and benefits proportionally amongst those potentially affected and facilitating efficient decision-making by providing information, institutional support and policy advice.

In a setting where the cumulative impact of past changes and future climate trends may expose farming systems to conditions not experienced before, the scale and significance of climate risk and appropriate response strategies may vary significantly across industries and individuals. Industries and individuals are therefore best placed to make relevant investment decisions, enterprise choice and similar business decisions within the context in which they operate. To be able to meet these challenges effectively, farmers and other decision-makers need to be kept informed of on-going developments, including opportunities for innovation and investment. This Action Plan aims to enhance communication to climate change implications for the agricultural sector by:

- Fostering an increased understanding and integration of scientific knowledge into farm management decisions
- Incorporate issues of climate change into education and training packages directed at agricultural industries.

8.7 Recommended Actions

FOCUS AREA AND STRATEGY	ACTIONS		TIMEFRAME	FUNDING		COLLABORATING AGENCIES
				Amount (US$)	Possible Source(s)	
1a. Capacity Enhancement (Technical)						
1.1 Integrate climate management considerations into programmes for developing farm management systems.	1.1.1	Engage the main stakeholders on the implications of climate change, encouraging them to pursue best farm management practices, inclusive of water use efficiency, plant breeding, agrochemicals and fertilizer application, and integrated pest management (IPM).	Long term	T.B.D.	FAO/UNDP/GEF	MoA, NARI, WUAs, Farmers Associations
	1.1.2	Conduct hazard and vulnerability mapping nationally to identify and prioritize agricultural regions/areas that are most vulnerable to the impacts of climate change, and integrate these considerations into planning and investment programmes for the sector.	Immediate	1,000,000	WB/IDB/GEF	MoA & GLSC
	1.1.3	Explore the genetic diversity within crop types that may be better adapted to climatic changes.	Immediate and Ongoing	T.B.D	FAO/UNDP/IDB	NARI, GSA, UG & GRDB
	1.1.4	Develop dynamic farm/agricultural management tools that integrate climate change risks into existing and emerging management systems to facilitate adaptation.	Short to Medium-term	200,000	FAO/UNDP/IDB	NARI, GSA, UG & GRDB
	1.1.5	Identify and build on successful strategies and indigenous knowledge of adaptation by the agricultural sector to climate change already being implemented.	Immediate and Ongoing	100,000	FAO/CCCCC	MoA, NARI, NDIA & GWI
	1.1.6	Develop, where possible, environmental management systems for agriculture.	Short-term	30,000	UNEP/UNDP/GEF	MoA &EPA
	1.1.7	Conduct assessment on ground water availability.	Medium term	T.B.D	WB/IDB	MoA, GWI & NDIA
	1.1.8	Provide economic incentives to reduce wasteful freshwater practices in the sector.	Short term	Minimal	N/A	MoA & MoF
	1.1.9	Conduct feasibility study of instituting crop insurance.	Immediate	100,000	IDB	MoA & PSC
1.2 Integrate the pest, weed and disease implications of climate change into strategies to minimise their impact on agricultural and natural resource systems.	1.2.1	Conduct investigations on the impacts of climate change on the most notable and important pests and diseases affecting the sector.	Short- to Medium-term	500,000	FAO/IDB	NARI, GRDB, GSA & UG
	1.2.2	Showcase best management practices through the establishment of public funded demonstration farms to research and demonstrate cutting edge technologies, in areas such as plant breeding, agrochemicals and fertilizer application, plant husbandry, and water conservation and management.	Medium-term	200,000	FAO	NARI, GRDB & MoA
1.3 To improve the capacity of models to predict climate impacts	1.3.1	Strengthen the Hydrometeorological Department (HD), inclusive of installing early warning systems and providing	Immediate and Ongoing	T.B.D	IDB/EU/WB	MoA & HD

FOCUS AREA AND STRATEGY	ACTIONS		TIMEFRAME	FUNDING		COLLABORATING AGENCIES
				Amount (US$)	Possible Source(s)	
on agriculture at scales relevant to farmers and agricultural managers.		technical expertise, to improve its weather forecasting ability so that farmers can better plan field activities.				
	1.3.2	Establish routine monitoring and data collection and storage procedure for the conservancies/reservoirs.	Immediate and Ongoing	T.B.D	IDB/EU	HD & NDIA
	1.3.3	Establish and improve calibration of hydrological model to synthesize conservancy flows.	Short-term	100,000	IDB/EU	NDIA, MMA-ADA, EDWC & RDCs
	1.3.4	Use reservoir model and simulated historic flows to determine appropriate operation rules for the conservancies/reservoirs.	Short-term	100,000	IDB/EU	NDIA, EDWC & MMA-ADA
	1.3.5	Maintain tidal gauges to monitor sea level rise and other parameters.	Ongoing	T.B.D	IDB/EU/WB	SRDD & HD
1b. Capacity Enhancement (Institutional)						
1.4 Develop the necessary capacity within the MoA, natural resource agencies and farmers' associations to respond to climate change.	1.4.1	Conduct a comprehensive review on human resource policies within the agricultural sector to include provisions for skills development through training on climate change and climate risk reduction to staff who are at the forefront of the supply chain, job recruitment and the compensation packages for key positions that remain vacant.	Immediate	200,000	UNEP/GEF/GoG	MoA, GFC, GLSC, SRDD & Farmers' Associations
	1.4.2	Prioritize endogenous capacity constraints within the agricultural sector in terms of urgent and immediate needs for adaptation.	Immediate and ongoing	20,000	UNEP/GEF/GoG	MoA
	1.4.3	Conduct regular and appropriate adaptation training exercise for local engineers, i.e., in coastal hydrology and geotechnical analysis, extension officers, farmers' associations, and natural resource managers.	Short- to Medium-Term	T.B.D	GoG/CCCCC/FAO	MoA, GFC & Farmers' Associations
	1.4.4	Develop and maintain a regular information management system on human resource capacities of the various community groups and institutions.	Short- to Long-term	T.B.D	GoG	MoA
	1.4.5	The MoA and related institutions should establish a memorandum of understanding with the University of Guyana for UG to provide technical support, in terms of its course offerings and research agenda.	Immediate	Minimal	N/A	MoA & UG
	1.4.6	Resuscitate the ICZM Committee and upgrade and implement the Action Plan	Immediate	T.B.D	EU/IDB/IDB	EPA, OP & SRDD
	1.4.7	Assist farmers to establish proper information management systems.	Immediate and ongoing	100,000	FAO/UNEP	MoA, GRDB, & Farmers' Associations
	1.4.8	Collect climate data at a variety of scales (spatial and temporal) and downscaled to better inform policy and management decisions.	Ongoing	T.B.D	CCCCC/EU	HD, UG & CCCCC

FOCUS AREA AND STRATEGY	ACTIONS	TIMEFRAME	FUNDING		COLLABORATING AGENCIES
			Amount (US$)	Possible Source(s)	
2. Infrastructure Management					
2.1 Build resilience and adaptive capacity to climate change in the agricultural sector	2.1.1 Develop a Public Investment Plan that will provide a single guide and reference to rural infrastructure investment in Guyana over the next 10 years, and building on the ASSP, AEDP and Sea Defence Rehabilitation. This will make public investment in the sector more stable and sustainable.	Immediate	100,000	EU/WB	MoF, MoA & MPW&C
	2.1.2 Survey command areas of all outlet structures and establish demand patterns, and scope for improved water use efficiency and recycling of drainage water.	Immediate and ongoing	T.B.D	IDB/EU/WB	NDIA
	2.1.3 Reconstruct and retrofit approximately forty (40) km of the most critical sea and river defences in coastal regions.	Immediate and ongoing	10,000,000 (Under EDF 9)	EU	SRDD
	2.1.4 Conduct a study to determine the feasibility of completing Phases II and III of the MMA/ADA Scheme.	Short-term	200,000	CDB/EU/WB/IDB	MoA & MMA-ADA
	2.1.5 Establish a year based routine maintenance plan for major rural physical infrastructure.	Immediate	T.B.D	GoG	MoA, MPW&C & RDCs
	2.1.6 Explore the possibility of declaring all D&I areas public goods and moving towards a full cost pricing for the services provided by these areas.	Short – to Medium-term	T.B.D	GoG	MoA & NDIA
3. Policy and Legislation					
Policy					
3.1 Ensure that climate change issues are integrated, where relevant, in policies pertinent to the agricultural sector	3.1.1 Develop a National Agriculture Strategy and mainstream adaptation mechanisms regarding climate change.	Short-term	30,000	GoG/IDB	MoA & related agencies
	3.1.2 Revise various Acts pertinent to the agricultural sector, such as the Water Commission Act and the Sea Defence Act to take into account climate change considerations.	Short-term	30,000	GoG/CCCCC/GEF	MoA & related agencies
	3.1.3 Link the national Climate Change Policy with the national Water Policy.	Short-term	Minimal	GoG	MoA & GWI
	3.1.4 Implement the National Climate Change and Adaptation Policy.	Immediate and ongoing	T.B.D	GoG/CCCCC/GEF	MoA, NCU & NCC
Legislation					
3.2 Ensure that climate change issues are integrated, where relevant, in the laws pertinent to the agricultural sector to better manage and protect the natural resources on which the sector depends.	3.2.1 Develop and implement a national land use plan	Medium-term	500,000	GoG/IDB/DFID	GLSC
	3.2.2 Reduce impacts from sea-level rise through land-use restriction in coastal areas, control of building in low-lying areas, industry transformation assistance, wetland protection, flood protection, and sand dune protection.	Medium-term	T.B.D	IDB/DFID/WWF	GLSC, MH&W & EPA
	3.2.3 Develop national disaster management legislation.	Short-term	50,000	CDB/DFID/EU	CDC & MLA
	3.2.4 Update and implement the draft Disaster Management Plan.	Immediate	20,000	GoG/UNEP/GEF	CDC
Research and Development					
4.1 Develop approaches, tools and	4.1.1 Build on existing R&D capability present in the NARI,	Long-term	T.B.D	FAO/DFID	MoA, NARI, IAST &

FOCUS AREA AND STRATEGY	ACTIONS		TIMEFRAME	FUNDING		COLLABORATING AGENCIES
				Amount (US$)	Possible Source(s)	
improved participatory engagements that enhance the research and development capabilities to adapt to climate change.		IAST and UG to improve tools to manage climate risks while at the same time drawing on indigenous knowledge and expertise in managing climate variability.				UG
	4.1.2	Undertake specific research on how carbon dioxide will affect the growth, productivity and yields of specific crops, fisheries, and livestock.	Medium- to Long-Term	T.B.D	FAO	NARI, GRDB & UG
	4.1.3	Conduct research to determine various genetic strains in the livestock industry, and crops that may be best suited to specific areas in Guyana.	Medium-Term	T.B.D	FAO/DFID/EU	NARI, GSA & NDDP
	4.1.4	Conduct research on the risk of changing disease and pest patterns.	Medium-Term	T.B.D	FAO	NARI, GRDB, & UG
	4.1.5	Conduct pilot research on growing specific high value crops in shade houses and greenhouses.	Immediate and ongoing	200,000 (FAO Funded)	FAO/IDB	NARI, GSA & UG
	4.1.6	Pursue the opportunities provided by biotechnology for introducing salt tolerant, pest resistant species.	Medium- to Long-term	T.B.D	IDB/WB/OAS	IAST, NARI, UG & GSA
	4.1.7	Introduce fiscal measures to promote the use of climate risk reduction technologies and practices in the agricultural sector.	Long-term	T.B.D	FAO/GEF/IDB	MoA & MoF
Awareness Building and Communication						
5.1 Enhance communication and awareness of climate change implications for the agricultural sector and adaptive techniques available.	5.1.1	Assess the level of understanding of climate change issues in the agricultural sector and identify barriers to communication.	Immediate and ongoing	T.B.D	GoG/CCCCC/GEF	MoA, EPA, NCU
	5.1.2	Develop a comprehensive public awareness programme, that links with the national education strategy, to educate the public and private sector particularly with regard to its role in preventing or mitigating the impacts of climate change e.g. land-clearing, erosion, emissions as a means to promoting compliance with the legislative regime for climate change.	Short-term	T.B.D	GoG/CCCCC	MoA, NCU, EPA & MoE
	5.1.3	Identify priority messages to increase climate change awareness amongst stakeholders.	Immediate and ongoing	T.B.D	GoG/GEF	MoA, NCU & NCC
	5.1.4	Train farmers to access information via the internet.	Ongoing	T.B.D	GoG/GEF/IFAD	MoA
	5.1.5	Provide framework to encourage partnerships between the scientific research and agricultural extension officers.	Ongoing	T.B.D	GoG/CCCCC	MoA, UG,GSA & IAST
	5.1.6	Enhance the capacity of extension officers to be trainers and dissemination agents.	Short-term	T.B.D	GoG/FAO/IFAD	MoA
	5.1.7	Develop a communication strategy for timely and targeted diffusion of results from the researchers to the stakeholders and to the general public is necessary to adapt to climate change.	Short-term	T.B.D	GoG/IFAD/GEF	MoA & NCU

FOCUS AREA AND STRATEGY	ACTIONS	TIMEFRAME	FUNDING		COLLABORATING AGENCIES
			Amount (US$)	Possible Source(s)	
	5.1.8 Establish mechanism for information sharing amongst the MoA and related agencies.	Short-term	T.B.D	GoG	MoA
	5.1.9 Develop an information clearinghouse facility in the HD and make basic weather, agro-meteorological and hydrological data easily available and accessible.	Short-term	T.B.D	GoG/CCCCC	HD & MoA

Legend On-going Immediate Short-term = 1 – 3 years Medium-term = 3 – 5 years Long-term = > 5 years

Acronyms

CCCCC	Caribbean Community Climate Change Centre
CDC	Civil Defence Commission
DFID	Department For International Development
EDWC	East Demerara Water Conservancy
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agricultural Organization
GEF	Global Environment Fund
GFC	Guyana Forestry Commission
GLSC	Guyana Lands and Surveys Commission
GoG	Government of Guyana
GRDB	Guyana Rice Development Board
GSA	Guyana School of Agriculture
GWI	Guyana Water Incorporated
HD	Hydrometeorological Department
IAST	Institute of Applied Science and Technology
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development
MLA	Ministry of Legal Affairs
MMA-ADA	Mahaica, Mahaicony, Abary – Agricultural Development Authority
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoF	Ministry of Finance
MPW&C	Ministry of Public Works and Communications
N/A	Not Applicable
NARI	National Agricultural Research Institute
NCC	National Climate Committee
NDIA	National Drainage and Irrigation Authority
OAS	Organization of American States
OP	Office of the President
RDC	Regional Democratic Council
SRDD	Sea and River Defence Department
TBD	To be determined
UG	University of Guyana
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WB	World Bank
WUAs	Water Users Associations
WWF	World Wildlife Fund

9. Implementation and Delivery of the Strategy

This Strategy presents a set of strategies and actions to address climate change issues across the agricultural sector in Guyana in a coordinated way. The Strategy complements a number of other initiatives being undertaken to address climate change, such as the resuscitation of the National Climate Committee (NCC), the establishment of the National Climate Unit (NCU) and the implementation of the Second National Communication (SNC) Project. Collectively, these efforts cover a substantial area of the Guyanese landscape where Guyana's natural resource capital is being managed for sustainable use and production of benefit for all Guyanese.

Implementation of the strategic direction and actions to manage climate change across the Guyanese agricultural sector are the responsibility of the Government of Guyana, farmers and their associations, and the private sector.

The Strategy provides a framework to coordinate activities to manage the impacts of climate change within the institutional, legislative and budgetary frameworks that exist in the country. The Ministry of Agriculture is expected to oversee the implementation of this Strategy. The strategy is envisaged as embracing a ten (10) year time frame. Furthermore, the MoA in collaboration with national stakeholders will develop a detailed implementation plan including timelines for implementation of the different components and a budget for implementation. In further developing its implementation plan the focus will need to be on the following steps:

Actions	Date
Review existing activities against the Strategy	April 2009
Commend the Strategy to Cabinet as an action to address climate change issues in the agricultural sector	June 2009
Identify any gaps in coordination required to achieve the Strategy and determine resource implications for addressing those gaps	October 2009
Recommend to the Ministry of Agriculture the specific actions to address identified gaps	November 2009
Review effectiveness of the Strategy in generating specific actions that are addressing the challenges to climate change.	April 2011

Genuine partnership will be an essential part of identifying measures to adapt to climate change. Strategic collaboration between the farmers and the Government is the best way to uncover where the most significant obstacles to adaptation lie and what type of interventions are needed to remove these obstacles. But the foremost payoff of partnership is that reforms become actualized, adaptation becomes real, and public, private and other stakeholders become mutually engaged in the implementation of activities that strengthen the resilience of the sector.

9.1 Roles of Stakeholders in the Agricultural Sector

The agricultural sector of Guyana accounts for the largest component of GDP, employment, and export earnings of all the natural resources in the country. It underpins the economy at all levels, is a source of livelihood, and supports a number of other life forms. Every Guyanese is a stakeholder in guarding against the agricultural sector being ravaged by impacts associated with climate change either

because they depend on the sector in a variety of ways, it shapes or affects their lives in some way or the other, or their livelihood is impacted upon by the sector. This is true irrespective of whether that person is a farmer, fisherman, or other member of society. The involvement of each individual, corporation, government organisation, or group in taking action and responsibility would therefore contribute in significant ways towards maintaining, safeguarding and adapting to the vagaries of climate change. By extension of this responsibility, each stakeholder will have a role to play in supporting the implementation of this Strategy, and his/her own contribution towards the achievement of the objectives of national policy relating to climate change adaptation measures.

9.1.1 Public Agencies

Public agencies have a responsibility to promote and facilitate the development of policies, programmes and plans relating to the sustainable development of the sector and to build resilience therein. These agencies are expected to take legislative and administrative steps to ensure that a technologically advanced, diversified and competitive agricultural sector is achieved by 2018, and to facilitate the creation of an enabling environment for other partners to play their part. Public institutions also play an important role in the area of monitoring and enforcement, and the maintenance of public infrastructure.

9.1.2 The Private Sector

The private sector has been singled out for mention in the UNFCCC which calls for the encouraging of partnerships between governments and the private sector. Since the sector, apart from sugar, is dominated by private interests, no strategy can adequately plan for adaptation without including this main player. In meetings held with private farmers and their associations in the compilation of this Strategy, there were clear signs of interest from these individuals in the Strategy that would allow them to participate and to benefit from its implementation. These include financing, institutional and human resources capacity building, research, information and monitoring, and incentive measures.

9.1.3 Regional Bodies

As part of the integration objectives of the Strategy, Regional Bodies will be responsible for integrating climate change issues into their regional plans. These authorities can play a very important role in the effort to bring about higher awareness, adaptation and mitigation efforts, and responsible use at the fundamental levels of the sector.

9.1.4 The General Public

Arising from the participatory principle, each citizen would have a role and responsibility to contribute to decisions taken to increase the sector's adaptive capacity. The public is the largest stakeholder group and has a powerful voice which can be very effective in achieving the goal of a sustainable and flexible agricultural sector.

10 Financing the Implementation of the Strategy

Many of the actions recommended by this Strategy do not represent an additional burden on existing budgets as many of the activities can be mainstreamed, even though there will be need for some additional funding, particularly for infrastructure management and research and development.

The Strategy presupposes/expects that much of the capacity building programmes can be accommodated within existing efforts by the Ministry to enhance its capacity as well as via a number of donor-funded projects. It is also the expectation that risk reduction initiatives and risk management more generally in the agricultural sector will be treated as a development priority within the budgeting process and that the MoA will seek to impart upon farmers and other stakeholders the need to incorporate risk reduction measures in designing their projects.

The government has also taken the initiative to diversify the agricultural based and is receiving funding in excess of US$15 million for this effort. Similarly, under the ASSP, it is receiving over US$21 million to assist with the rehabilitation of drainage and irrigation schemes in nine (9) agriculturally based areas. At the same time, the country continues to receive support from the European Union to rehabilitate its sea and river defences to the tune of Euro 100 million. All of these efforts are aimed at making the agricultural sector more resilient to climate change impacts and will serve this Strategy well.

At the regional level, various initiatives, inclusive of a technical assistance project to pursue protective agriculture, another US$3 million project to aid in technology transfer, and assistance from the Chinese government on adaptive greenhouse technologies are all expected to complement the Strategy. Also, the World Bank is assisting the region in risk management and mitigation and efforts are being pursued on the possible establishment of crop insurance. Lastly, whatever funds or assistance become available for the Jagdeo Initiative, may also be able to benefit the Guyanese agricultural sector directly. Clearly, all of these initiatives are important to actualizing the actions proposed in the Strategy. However, sustainability of these initiatives and the benefits that can accrue will necessitate a better rates collection system and one that is economically efficient.

The implementation of the strategy will require that financial resources be made available to support the actions and the responsibilities of implementing organizations. The estimated cost of implementation over ten years is still needs to be tabulated. It can be financed from assorted sources including:

- **Innovative Financing Mechanisms** – This will include e.g. REDD, CDM,
- **Existing funds** – This will include regional and international (Multilateral and bilateral and philanthropic) funds such as the Special Climate Change Fund, the Adaptation Fund, the GEF resources and others.
- **Private and public sector financing** (marketing best practices)

Annex S1: Register of Participants

National Adaptation Strategy for the Agricultural Sector to Respond to Climate Change

Stakeholders Workshop – October 7, 2008

Guyana Forestry Commission Boardroom

No.	Name	Organization
1	Peggy Mc Lennan	Ministry of Foreign Affairs
2	H.Dewnath	NCC
3	Jagnarine Singh	GRDB
4	P. Pitamba	MOA
5	Brian Sears	Ministry of Agriculture
6	Pradeepa Bholanath	Guyana Forestry Commission
7	Samuel La Fleur	East Demerara Conservancy
8	Kester Craig	Civil Defence Commission
9	Shyam Nokta	OP
10	Pratima Doodnauth	
11	Jagdesh Singh	Guyana Forestry Commission
12	Annalise Bayney	Iwokrama
13	Mr. Andrew Bishop	Guyana Lands and Surveys Commission
14	Oudho Homenauth	National Agriculture Research Institute
15	S.Razack	Environmental Protection Agency
16	Dominique Saheed	Environmental Protection Agency
17	Elizabeth Ramlall	Ministry of Agriculture
18	Fredrick Flatts	Ministry of Agriculture
19	Denise Simmons	SEES,UG
20	N. Hasan	New-Guyana Marketing Corp.
21	Lennox Wilson	Ministry of Agriculture
22	Eustace Alexander	Conservational International, Guyana
23	Gavin Agard	Guyana Forestry Commission
24	Quacy Bremner	Guyana Forestry Commission
25	Paulette Bynoe	SEES,UG
26	Anton Dey	Guyana Sugar Corp.
27	Harold Davis	Guyana Sugar Corp.
28	Ashley Adams	Guyana Sugar Corp.
29	Bhaleka Seelall	Hydromet
30	Lionel Wordsworth	National Drainage & Irrigation Authority
31	Zainool Rahaman	Hydromet
32	Theodosius Velloza	UG
33	Bernard Carter	Consultant

Annex S2: Register of Participants

National Adaptation Strategy for the Agricultural Sector to Respond to Climate Change

Stakeholders Workshop – December 4, 2008

Regency Suites/Hotel

No.	Name	Organization
1.	Rishi Persaud	Institute of Applied Science and Technology (I.A.S.T)
2.	Ashley Adams	Guyana Sugar Corporation (GuySuCo)
3.	Samuel La Fleur	East Demerara Water Conservancy-MoA
4.	Walter Persaud	Guyana Sugar Corporation (GuySuCo)
5.	Theodosius Velloza	University of Guyana (UG)
6.	Dr. Mark Bynoe	Development Policy and Management Consultants (DPMC)
7.	Andrea Mahammad	Guyana Lands and Surveys Commission (GL&SC)
8.	Bernard Carter	Consultant (Independent)
9.	Dr. Dindyal Permaul	Ministry of Agriculture
10.	Narine Singh	Guyana Rice Development Board (GRDB)
11.	Gitanjali Chandrapaul	National Climate Unit (NCU)
12.	Joseph McGann	CCCCC / MACC
13.	Annie Pitamber	Ministry of Agriculture / NCU
14.	Viviane Baharally	Guyana Rice Development Board (GRDB)
15.	Antonio Peters	Hydromet Department – MoA
16.	Thaeshwari Pooran	Hydromet Department – MoA
17.	Ramnarine Singh	Ministry of Local Government
18.	Latoya Jones	Guyana Red Cross
19.	Dominique Saheed	Environmental Protection Agency (EPA)
20.	Cleavon Cameron	Environmental Protection Agency (EPA)
21.	Bruno Lopes	Delegation of the European Commission
22.	David Fredricks	National Agriculture Research Institute
23.	Maxim Ali	Ministry of Agriculture – Project Cycle Unit
24.	Dr. Dane Hartley	Ministry of Agriculture
25.	James Singh	Guyana Forestry Commission
26.	Andrea Thom	Guyana National Bureau of Standards
27.	Bissessar Persaud	Guyana Rice Development Board (GRDB)
28.	Ravendra Singh	Guyana Rice Development Board (GRDB)
29.	Zainool Rahaman	Hydromet Department – MoA
30.	Brian Sears	Ministry of Agriculture
31.	Jason Fields	Ministry of Foreign Affairs
32.	Giampiero Muci	Delegation of the European Commission
33.	Lucina Singh	Pesticides and Toxic Chemical Control Board
34.	Brian Dey	Ministry of Agriculture
35.	Eva Bachtsetzi	Ministry of Agriculture
36.	S.Jacobs	Guyana Public Service Union
37.	Mahendra Sharma	Guyana Energy Agency

No.	Name	Organization
38.	Vishnu Panday	Guyana Sugar Corporation (GuySuCo)
39.	Jacqueline Nero	Ministry of Agriculture – Statistical Unit
40.	Janice Bollers	World Wildlife Fund
41.	Narda Mohamed	Guyana Agricultural and General Workers Union
42.	Marlon Daniels	Guyana Water Inc.
43.	Chandrawattie Persaud	Guyana Public Service Union
44.	Lynette Cunha	Guyana School of Agriculture
45.	Krishna Sewlall	Ministry of Agriculture
46.	Justin Hecton	United States Agency for International Development (USAID)
47.	Read Porter	Environmental Law Institute
48.	Dharamkumar Seeraj	Rice Producers Association
49.	Dr. Ashok Sookdeo	Ministry of Health
50.	Richard Blair	Inter-American Institute for Co-operation on Agriculture (IICA)
51.	George Jervis	Guyana Rice Development Board (GRDB)
52.	Agnes Dalrymple	Ministry of Public Works & Communication
53.	Dr. Dwight Waldron	National Dairy Development Programme (NDDP)
54.	Nizam Hassan	New-Guyana Marketing Cooperation
55.	Ignatius Jean	Inter-American Institute for Co-operation on Agriculture (IICA)
56.	Marciano Glasgow	Development Policy and Management Consultants (DPMC)
57.	Dianna Da Silva	Development Policy and Management Consultants (DPMC)

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List of Acronyms

ACP	African Caribbean and Pacific
AEDP	Agricultural Export Diversification Programme
AO-GCM	Atmosphere –Ocean Global Circulating Models
ASDU	Agricultural Sector Development Unit
ASSP	Agriculture Support Services Programme
CARDI	Caribbean Agricultural Research Institute
CARICOM	Caribbean Community
CCCCC	Caribbean Community Climate Change Centre
CDC	Community Development Councils
CDC	Civil Defence Commission
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CET	Common External Tariff
CIDA	Canadian International Development Agency
CS	Competitiveness Strategy
DFID	Department for International Development
EC	European Commission's
ECLAC	Economic Commission for Latin America and the Caribbean
EDMI	Enumeration District Marginality Index
EDWC	East Demerara Water Conservancy
ENSO	El Nino Southern Oscillation
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agriculture Organization
AR4	Fourth Assessment Report
FCPF	Forest Carbon Partnership Facility
GAP	Good Agricultural Practices
GDP	Gross domestic product
GEF	Global Environment Facility
GFC	Guyana Forestry Commission
GHG	Greenhouse Gas
GLSC	Guyana Lands and Surveys Commission
GMP	Good Manufacturing Practices
GNAP	Guyana National Action Plan
GNI	Gross National Income
GNIFC	Guyana National Initiative of Forest Certification
GoG	Government of Guyana
GRDB	Guyana Rice Development Board
GRPA/RPA	Guyana Rice Producers Association
GSA	Guyana School of Agriculture
GTIS	Guyana Trade and Investment Support
GuySuCo	Guyana Sugar Corporation
GWI	Guyana Water Incorporated
HD	Hydrometeorological Department
IADB/IDB	Inter- American Development Bank
IAST	Institute of Applied Science and Technology
ICZM	Integrated Coastal Zone Management Plan
IDS	Institute of Development Studies

IFAD	International Fund for Agricultural Development
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
JI	Jagdeo Initiative
LCI	Living Condition Index
LEDC	Less Economically Developed Country
MACC	Mainstreaming Adaptation to Climate Change
MDGs	Millennium Development Goals
MFN	Most Favoured Nation
MIP	Multi-Annual Indicative Programme for Sugar
MLA	Ministry of Legal Affairs
MMA-ADA	Mahaica Mahaicony Abary- Agriculture Development Authority
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoF	Ministry of Finance
MPW&C	Ministry of Public Works and Communications
NAAG	National Aquaculture Association of Guyana
NARI	National Agricultural Research Institute
NCC	National Climate Committee
NCSA	National Capacity Self Assessment
NCU	National Climate Unit
NDCs	Neighbourhood Democratic Councils
NDIA	National Drainage and Irrigation Authority
NDS	National Development Strategy
NFP	National Forestry Policy
NGMC	New Guyana Marketing Corporation
NGO	Non-Governmental Organizations
NIS	National Insurance Scheme
NREAC	Natural Resources & Environment Advisory Committee
OAS	Organization of American States
OP	Office of the President
PRSP	Poverty Reduction Strategy Paper
RDC	Regional Democratic Council
REDD	Reducing Emission from Deforestation Forest Degradation
RTP	Regional Transformation Programme
SCP	Support for the Competitiveness Programme
SEES	School of Earth and Environmental Science
SLR	Sea Level Rise
SRDD	Sea and River Defence Department
SRES	Special Report on Emission Scenarios
T&HD	Transport & Harbours Department
TNAs	Technology Needs Assessments
TSA	Timber Sales Agreement
UG	University of Guyana
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WUAs	Water Users Associations
WWF	World Wildlife Fund

1. Introduction

Natural systems and less wealthy populations are often the most vulnerable to climate change, being exposed directly to impacts, but unable to respond well, particularly if changes occur very rapidly. Natural disasters, like floods and droughts associated with climate change, have a strong impact on agriculture, ruining households, and draining fiscal resources out of developing countries like Guyana.[1]

This study, commissioned by the Caribbean Community Climate Change Centre (CCCCC) under the Mainstreaming Adaptation to Climate Change (MACC) project, sets out to identify and understand the extent and ways in which climate change is being integrated into agricultural development practices and decision making in Guyana. From that enquiry, this Strategy and Action Plan was devised for the sector to adapt to climate variability based on the downscaled model applied.

The Strategy concentrates on three broad areas of focus:

1. *Locating the landscape*: A description of the agricultural sector, and the current global and local context and knowledge linking climate change and its projected impacts on the Guyanese agricultural sector. Additionally, it identifies the institutions and stakeholders involved, or who should be involved, in the associated adaptation activities.
2. *Barriers and opportunities to adapting to climate change*: The challenges posed to the agricultural sector from climate change, and opportunities that can be exploited through adapting contextually relevant techniques.
3. *Adaptation recommendations*: The identification of options and opportunities for improving the adaptation responses to climate variability.

Adaptation to climate variability is not new, but climate change is expected to present heightened challenges, exposing certain vulnerabilities[2] nationally and locally, and increasing the combinations of risks[3] and potentially grave consequences. This is particularly true for the agricultural sector in Guyana where direct dependence on this sector for livelihood support, particularly in the rural coastal and hinterland areas, combined with its contributions to employment creation, export earnings and gross domestic product (GDP) remain central to the Government of Guyana's (GoG) economic development thrust and will have cascading impacts. Accordingly, the Strategy focuses on the need for "anticipatory adaptation", that is, the proactive rather than the reactive management of climate change risk and relies on the best available information concerning the nature of future climate risks.[4]

The central challenge for the agricultural sector, therefore, is to sustain and even expand the varied functions it currently performs directly and indirectly, without compromising the sector's ability to perform these functions in future. This cannot be achieved without the systemic integration of the social, economic, and environmental pillars of the sector. The agricultural sector remains pivotal to

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[1] United Nations Environment Programme (2006): *Global Environment Outlook*, UNEP, Nairobi.

[2] Vulnerability to climate change in this Strategy is viewed as the degree to which the agricultural sector is susceptible to, and unable to cope with, potential adverse impacts (Schneider, S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A. Suarez and F. Yamin, (2007): Assessing key vulnerabilities and the risk from climate change. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, pp 781.

[3] The concept of risk, which combines the magnitude of the impact with the probability of its occurrence, captures uncertainty in the underlying processes of climate change, exposure, impacts and adaptation.

[4] Food and Agricultural Organization of the United Nations (2007): *Adaptation to Climate Change in Agriculture, Forestry, and Fisheries – Perspective, Framework and Priorities*, FAO, Rome.

Guyana's economic growth in terms of its generation of trade and foreign exchange earnings, which creates employment opportunities in non-agricultural sectors, which in turn reduces poverty and improves the quality of life of many rural households. The sector is also at the core of environmental concerns over the management of natural resources – land degradation, water scarcity, deforestation, and the threat to biodiversity. Agriculture essentially concerns the relationship between the natural environment and human society. Securing the inherent vulnerabilities of the sector has to be central to efforts in seeking to adapt to climate change and achieving future development. The risks of therefore taking a "business-as-usual" (BAU) approach are enormous and include: (i) decimation of much of the agricultural base on the coast; (ii) destruction of livelihoods on the coast and in many hinterland areas, (iii) increased flooding and the public health impacts that this will have, (iv) loss of jobs, incomes, and revenue that will substantially set back the country's development, and (v) possible increase land use conflicts (*see Appendices 1 & 2*).

The content of this Strategy is structured as follows:

Section 2 outlines the process in developing the Strategy, while Section 3 provides a description and importance of the agricultural sector. In Section 4 an overview is given of climate change at the global and national levels to set the context within which the agricultural sector operates, paying particular attention at the cost of adaptation. It also presents background information on issues around the production and use of climate science.

Section 5 deals with the impacts of climate change on agricultural development and the potential for adaptation nationally, with Section 6 being devoted to the challenges and Section 7 to the opportunities presented to the sector by climate change.

Section 8 outlines the Strategy, while Sections 9 and 10 outline the Plan of Action for the Strategy. Specifically, Section 9 examines the implementation arrangements, while Section 10 looks at the conditions necessary for financing the Actions identified. The Strategy is expected to be read in conjunction with the sector assessments conducted, referred to in this Strategy as appendices.

2. Strategy Development Process

The Strategy was constructed from a plurality of methodologies that were both qualitative and quantitative in nature. These included:

- Client interview - Key policymakers in the MoA, including the Minister of Agriculture, the Chairman of the National Climate Committee and the Coordinator of the NCU were interviewed in the planning phase of the project to determine their objective and expectations of the output of the project and to ascertain what type of logistical support and literature could be provided to assist in the completion of the sector assessments that informed this Strategy.

- MACC/CCCCC interview - In a meeting separate and distinct from that with the Minister, the Coordinators of the NCU and the MACC project were interviewed to determine, with much certainty, the context of the study in the formulation of the National Country Strategy, their expectations as to the deliverables and their proposed level of involvement in the study. Within the backdrop of this meeting, the project's work plan was presented to the Coordinator of the NCU.

- Collection and study of reports and relevant documents - The consultant collected and studied existing capacity assessment studies that focus on sectoral and country capacity to respond to the impacts of climate change. These documents were consulted to glean other relevant background and supporting information that could have easily lent to the institutional assessment. Key documents reviewed include:

    1. The draft "Vulnerability and Capacity Assessment: Impacts of Climate Change on Guyana's Agriculture Sector" (2007) study prepared by the Guyana Sugar Corporation (GUYSUCO);
    2. "Guyana's First National Communication" (INC 2002) report prepared in response to its commitments under the United Nations Framework Convention on Climate Change (UNFCCC);
    3. "Guyana's Climate Change Adaptation Policy and Implementation Strategy for Coastal and Low- lying areas" (2002) report prepared by the National Climate Committee (NCC).

- Stakeholder consultations/survey analysis – Detailed stakeholder interviews were conducted over the period July 14 – August 28, 2008 to assist in the completion of the sector assessments annexed to this Strategy and to directly inform the Strategy. These consultations covered a wide range of persons within the public and private sectors, non-governmental organizations (NGOs), regional organizations and international organizations.
- Sector Assessments – Detailed sector assessments were conducted that included an economic review, and technical, institutional and policy assessments of the sector (*see Appendix 1 – 4*). These assessments formed the core of this Strategy and informed the interventions proposed.
- Seminar/Workshops – Four (4) seminar/workshops were held; one with the Minister of Agriculture, two (2) with the NCC (see *Annex S1*), and one (1) with a wider cross-section of stakeholders (see *Annex S2*) to advance the socialization process, but also to receive feedback on preliminary drafts of the Strategy. The comments from these interactions have assisted in advancing this Strategy to its present state.
- Modeling analysis – Various quantitative models, inclusive of regression analysis and forecasting were carried out in the technical assessment and economic review reports. These have aided the robustness of the Strategy and informed the interventions proposed.

- Stakeholders Workshop – A stakeholders' workshop was held on December 4, 2008 at which the Strategy was present, along with a draft Plan of Action.

Based on the feedback from the stakeholders' workshop and the findings of the main reports (composed of various appendices and referred to in this Strategy), the Action Plan was finalized. The Action Plan contains the main recommendations, along with the responsible agencies, proposed costs, and timelines in which the interventions should be carried out. The main recommendations are grouped under the following broad headings:

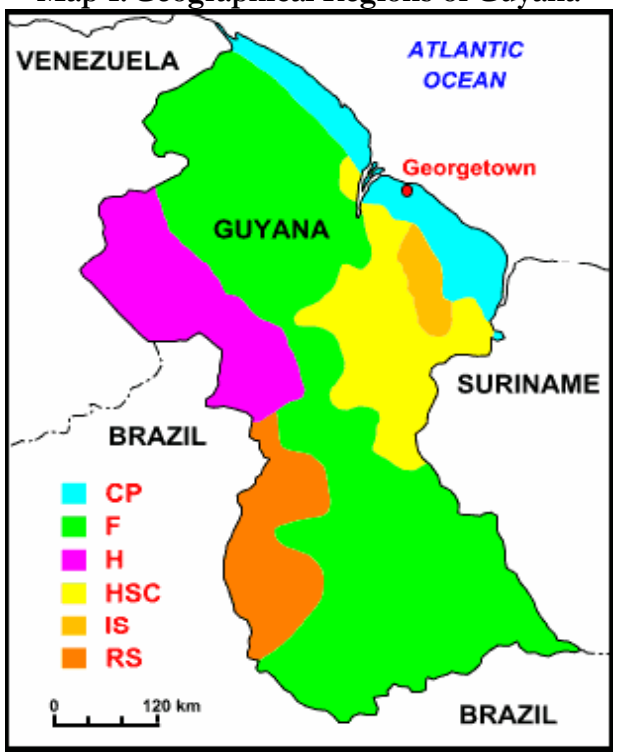
- Capacity Enhancement (both technical and institutional),
- Infrastructure Management,
- Policy and Legislation,
- Research and Development, and
- Awareness and communication.

3. Description of the Agricultural Sector

Historically, Guyana's agricultural sector has been dominated by two crops, rice and sugarcane (see *Appendix 1*). In recent times, the government has made a conscious effort to diversify the agricultural base, placing greater emphasis on non-traditional crops,[5] and the fisheries and forestry industries. Further measures to support the sector, and responding to the challenges and opportunities presented by current global events such as globalization of free trade, climate change and the drive for food security, which included rehabilitating some drainage and irrigation schemes and sea defence structures, installing new drainage pumps, rehabilitating sections of the East Demerara Water Conservancy (EDWC) dam, developing a marketing database, and encouraging research in developing more adaptive plant and animal species to climatological changes.

With a mid-year population of approximately 766,183[6] inhabitants in 2008 occupying 21.5 million hectares, Guyana is a sparsely populated country by any standard. However, approximately 90% of this population occupies the narrow coastal strip that is no more than 1.5 million hectares (*Map 1*) and is also the main area of commercial agriculture (*Map 2*). This coastal area lies below the mean high tide mark and is prone to flooding from the Atlantic Ocean due to breaches in the seawall or over topping of the sea defences, as well as during the raining season, when most of the water from the elevated hilly sand and clay belt region is released on the coastal plain given that gravity flow is the main means utilised for draining excess water in the country (*see Appendix 2*).

Map 1: Geographical Regions of Guyana

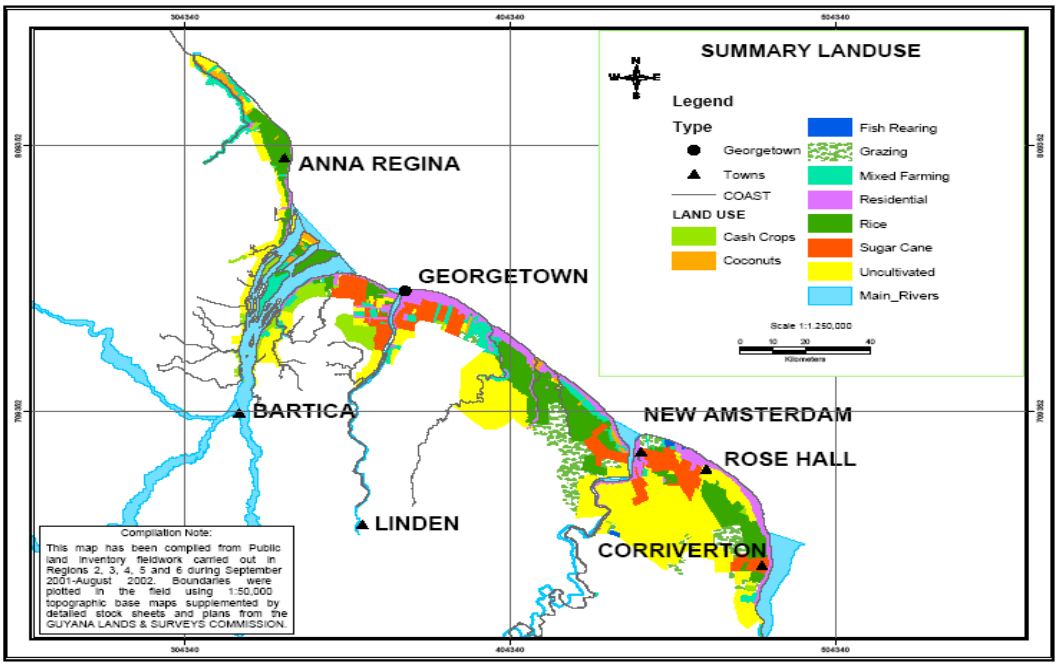


Source: Ministry of Agriculture (2002) Guyana Initial National Communication, pp 34 (*CP – Coastal Plain, F – Forest Region, H – High Land Region, HSC – Hilly Sand and Clay Belt Region, IS – Intermediate Savannahs, RS – Rupununi Savannahs*

[5] These include all crops (fruits and vegetables) other than rice and sugar.

[6] Bureau of Statistic (2008). Statistical Bulletin: Sept 2008), Statistical Bureau, Georgetown.

Map 2: Summary of Land Use along the Coastal Plain



Source: Guyana Lands and Surveys Commission (2008)

Most of the remaining population is scattered mainly in the hinterland regions, some of which are difficult to access and others which are themselves affected by floods during the rainy season.[7] Hinterland residents are engaged mainly in small-scale, subsistence type agriculture, mining, logging, and/or serving as tour guides.

Guyana is one of the few remaining countries globally without major population pressure on its natural resources. More than 16 million hectares of the country is covered by tropical forests, many of which are not economically feasible to exploit with current levels of technology, about 1.2 million hectares are in permanent pastures, mainly in the Rupununi and Intermediate Savannahs and 500,000 hectares are suited for cultivation with current levels of technology. Guyana has about 25,000 farm households; with some 90% of these concentrated along the narrow coastal plain farming approximately 140,000 hectares. For the remaining 10% of the population living in the hinterland, agriculture is a critical livelihood activity, on a subsistence level for most households, but also as a commercial activity in other instances (see *Appendix 1*).

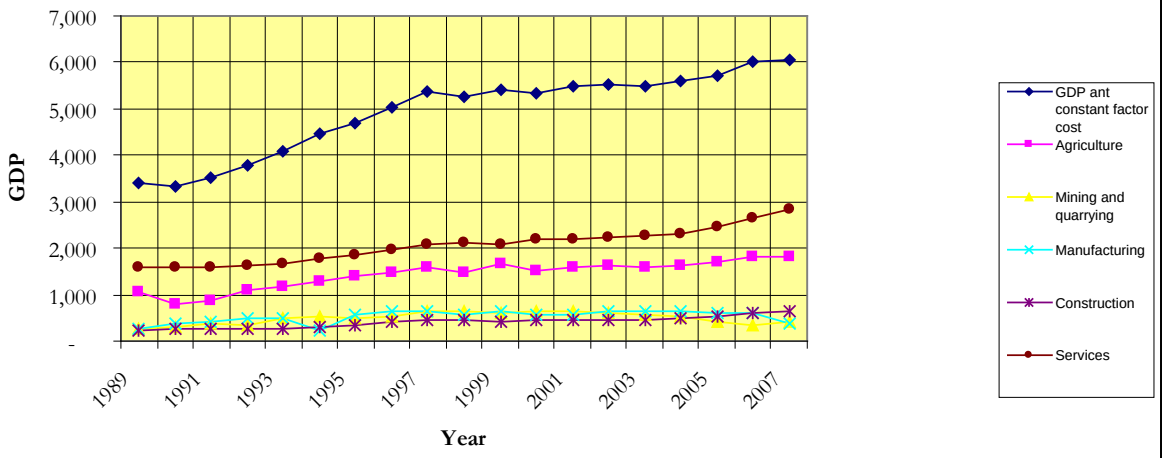
3.1 Importance of the Agricultural Sector

Although the features of the agricultural sector are often envisaged as a sector dominated by poor rural households, most producing on lands on which they are barely able to eek out a living, the essence of the sector is more in function than form. Furthermore, the sector is more complex than this often trite description, with a number of complementary activities occurring to support a vibrant rural sector, supply food to an ever expanding urban industrial and service sector, and export the remainder.

[7] This is particularly a problem in the Rupununi Savannahs.

Further, the agricultural sector (inclusive of fisheries and forestry) remains one of the most important sectors in the economy where between 2004 and 2007 it contributed approximately 35% of the country's GDP (inclusive of value added from the rice and sugar sub-sectors) and employed between 30-35% of the labour force (Bureau of Statistics, 2008) (see *Appendix 1*).

Figure 1:Value Added by Sector at Constant Prices (1988), 1989 - 2007



Source: Bank of Guyana (2008) Annual Report, Financial Statement of Accounts 2008, Table 9-II, and the Bureau of Statistics, Statistical Bulletin, September 2008, Table 10.2

At the sectoral level the sugar and rice industries, cultivated commercially exclusively along the coast, have remained dominant contributing a combined total of 14.6% of GDP in 2007. The fisheries sub-sector has also grown in importance in this regard.[8] Other important crops include: ground provisions, plantains, pineapples, citrus and coconuts. Despite Guyana's expansive forests, this sector accounts for less than 4% of overall GDP. Given that Guyana is a small open economy, most of the products from these sectors are exported. For example, in 2007, the sector accounted for nearly 40% of the country's export earnings.[9]

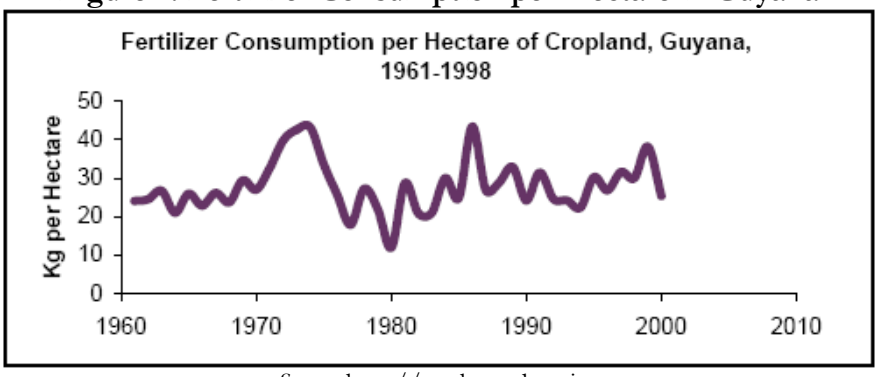
Though a less economically developed country (LEDC), Guyana's Gini Index of 43.2 (CIA World Factbook, 2008), indicates that income distribution is better than that of many other South American countries. However, it glosses over some significant regional variations. For example, both of the recent poverty indices, i.e., the Living Condition Index (LCI) and the Enumeration District Marginality Index (EDMI)[10] have identified Regions, 1, 9, 7 and 8 as the poorest regions in Guyana. Thus, any change in climate variability that may threaten the food supply of these regions will increase their vulnerability.

Guyana remains a net exporter of agricultural products within the Caribbean Community (CARICOM) and wider afield (see *Appendix 1*), providing a source of income for many rural households in areas said to have the highest level of critical poverty.[11] National crop production grew by more than 10% per year in the 1990s and early 2000s, of which yield increases contributed significantly to this growth. The

[8] Sugar and rice combined accounted for 47.2% of agriculture's GDP in 2007 and fish a further 22.7%.
[9] Bureau of Statistics (2008*): Statistical Bulletin*, Bureau of Statistics, Georgetown.
[10] See Skoufias, Emmanuel (2005) *A Poverty Map for Guyana: Based on the 2002 Population and Housing Survey*, World Bank, Washington for an explanation about the construction and rudiments of these indices.
[11] Thomas, Clive (2000): *Guyana Survey of Living Standards*, Institute of Development Studies, Georgetown.

balance came from area expansion and more intense cropping. At the same time, increased agro-chemical use also increased (Figure 2).

Figure 2: Fertilizer Consumption per Hectare in Guyana



Source: http://earthtrends.wri.org

The economic challenge for Guyana therefore is to identify specific agricultural and rural development needs and opportunities, and to focus investment in areas where the greatest impact of adaptation, food security and poverty will be achieved.

Agriculture is more than an economic activity in Guyana. For many communities it is a way of life and an 'institution' around which social and cultural ties remain strong. For example, the Guyana Sugar Corporation (GuySuCo) alone reports employing approximately 18,500 persons at all levels, with most of these employees coming from the rural areas of Guyana where poverty is greatest.[12] Additionally, GuySuCo has also been involved in providing a number of allied services, such as medical centres and primary health care services, provision and maintenance of community grounds and facilities, training to private cane farmers, maintenance of some rural infrastructure, and transport services.[13] Thus, any impact of climate change that may negatively affect this corporation such as destruction of crops forcing the Corporation to down-size its operations, will also impact the quality of services it can offer, the quality of life in some communities, and a source of revenue for other social service schemes like the National Insurance Scheme (NIS). Similarly, the rice and fisheries sub-sectors employ an estimated 50,000 persons directly and indirectly, with most of those within the fish processing plants being women, many of whom are single parents. Hence the multipliers can be significant should climate change affect the spawning and survival rates of shrimp.[14]

These vulnerable populations have only limited capacity to protect themselves from environmental hazards, in particular from extreme events such as drought as witnessed in Region 9 in 1997/98 when a state of emergency was declared in this region; and floods along the coast in 2005 and 2006 that cost the country more than US$453 million and US$250 million respectively (see *Appendix 1*). They are also likely to bear the brunt of the consequences of large-scale environmental change, such as climate change.

Lastly, the sector is also a vital source for nutritious agricultural output in the fight against food insecurity in pockets of Guyana. While commercial agriculture remains an imperative for many households on the coast, small-scale agriculture is more central to the survival strategy of many rural

[12] See the Statistical Bureau's Living Condition and Marginality Indices (2007)

[13] Shutt, Harry, Moore, David and Bynoe, Mark (2007) Social Impact Assessment of the Guyana National Action Plan on Sugar (Final Report), Georgetown

[14] FAO (2008) Climate Change and Food Security: A Framework Document, FAO/UN, Rome.

and hinterland households.[15] In particular, Amerindian communities remain heavily dependent on the sector to provide cassava, their main staple, which is then converted into various food items. In fact, even along the coast, it is quite common to find vegetables being cultivated along the embankment of rice fields, as rural families seek to bolster their incomes and diversify their production base, thus spreading their risks.[16]

As such, while the vast majority of agricultural activities take place on the coastal plain of Guyana, which is likely to be hardest hit from climatological changes unless appropriate actions are taken, it is a misnomer to think that this is the only area that is likely to be affected. In fact, the interior locations are likely to suffer even more severe from a sociological standpoint and these impacts need to be captured and studied in a comprehensive manner..

At the same time, it is imperative to note that coastal soils are fertile but extremely vulnerable to flooding due to their low-lying nature. As such, drainage and water control remain major challenges. Furthermore, agricultural development and expansion has always been tied to the defence against saltwater intrusion from the sea and rainwater runoff and is likely to continue with climate change.

In the main, crops and livestock production (with the exception of sugarcane) are characterized by the predominance of small farmers, farming less than 15 hectares of land.[17] It is estimated that about 60% of these small holdings are geared toward rice production, with the remainder producing food crops. Many of these small farms combine their crop production with some cattle rearing. There are several large farms, however, that include private rice growers, some medium-and large-scale forest and fishing operations, and large public-sector enterprises. The most important parastatal is the GuySuCo.

Growth in the agriculture sector has been highly volatile, alternating between periods of stagnation, pronounced declines, and rapid growth. Over the period 1993-2007, agricultural activities expanded at an average annual rate of 3%, compared with average GDP growth of 4.2%. Agricultural exports are dominated by traditional products, especially sugar and rice, which accounted for over 30% of Guyana's total merchandise exports in 2007. Additionally, exports of shrimp have gathered importance in recent years. But traditional agriculture faces major competitive challenges in the global market since it has been sustained largely by preferential access to the CARICOM and EU markets. Recently, the Government has been seeking to improve productivity in the traditional sectors while also promoting non-traditional crops. Greater attention and emphasis are being given to the cultivation of crops such as oil palm, coconuts, green vegetables, ground provisions, fruits, and flowers. The authorities report that while a significant amount of these products would be utilized locally, the greater proportion would be destined for the tourist resorts of the Caribbean, and the niche markets of North America and Europe.

Various projects emanating from the Food and Agriculture Organization (FAO) have been designed to encourage increased diversification away from traditional crops. The different projects come under the FAO umbrella project, the Regional Transformation Programme (RTP). The RTP is designed to achieve international competitiveness and food security for the region and to redress the balance between food imports and exports.

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[15] Sustainable Agriculture and the Development of the Amerindians in Guyana: *The case of the Mabaruma/Hosororo Organic Cocoa Project*

[16] Shutt, *et al* (2007).

[17] Mott MacDonald (2004) Guyana Drainage & Irrigation Systems Rehabilitation Project Feasibility Study of Principal Areas, Georgetown

3.2 Economic Policies and Sectoral Performance

Since 1989 the government has followed a liberalized, free-market model of development, with the private sector being touted as the main source of growth. Under this model, public enterprises, such as, the Guyana Rice Board (GRB) were divested, foreign exchange regimes were liberalized making it easier for the farming sector to access resources for retooling and investment purposes. Price controls were removed, import and export licenses were eased, and an environment for investment created. In the agricultural sector, some of the most important aspects of the economic reforms have been the managerial changes in GuySuCo and the liberalization of the rice market coupled with the liberalization of the exchange rate regime.

3.2.1 Main Commodities

3.2.1.1 Sugar and Sugar-Derived Products

Sugar and sugar-derived-products accounted for 9.2% of Guyana's GDP and 30% of its agricultural GDP in 2007. The industry is the largest net earner of foreign exchange and the biggest contributor to public revenue and employs 7% of Guyana's labour force directly (Bank of Guyana, 2008) and an estimated 25,000 indirectly (Shutt *et al*, 2007). Within Guyana, sugar production has enormous spillover effects on the rest of the economy, for example, in retail and distribution and in maritime transport services.[18]

The sugar industry is export-oriented. In 2007, exports accounted for almost 92% of production. The main export markets are the in the European Union (EU), CARICOM countries, and the United States (US), all under some type of preferential scheme that has come under increasing pressure from globalization and free trade initiatives. Sugar exports totalled US$137 million in 2006.[19]

In recent years the corporation has been able to increase yields per hectare and tripled the output from the level it was in 1990. The yields have reached 75-80 MT/hectare and the company is currently the most competitive in the region. However, production costs have remained high and are above the global market prices.[20]

The sugar industry suffered a period of crisis in the late 1980s and early 1990s, with output dropping from some 395,000 tons in the early 1970s to about 130,000 tons by 1990. Since then, however, production has increased. Production reached 331,057 tons in 2002, a 16.4% increase over 2001; and earnings from sugar exports reached US$119.5 million.[21] However, since that time the sector's performance has been sluggish. The authorities report that the target for 2010 is to have production increased to 450,000 tons and a reduction in costs of production to a level where Guyanese sugar could be competitive in the world market.

Due to its relatively high costs, the industry has depended heavily on its preferential access to foreign markets. The ACP/EU Sugar Protocol[22], the EU Special Preferential Sugar Agreement[23], and the U.S.

[18] Ministry of Agriculture (2006) Guyana National Action Plan for the Sugar Industry, Ministry of Agriculture, Georgetown

[19] Ministry of Finance (2008): *Budget Speech*, Ministry of Finance, Georgetown.

[20] World Bank (2003) Guyana Development Policy Review, World Bank, Washington.

[21] Ministry of Finance (2003a), pp. 7 and 9.

[22] This protocol is being phased out and replaced by the Economic Partnership Agreement, which allows for duty free quota free access to the European market but void of the preferential prices. The phasing out of the SP is 2009.

Sugar Programme all grant access to imports from Guyana at prices higher than world-market prices. Guyana's exports of sugar also benefit from duty-free access to CARICOM markets, where Most Favoured Nation (MFN) imports of sugar face a 40% tariff. In 2002, direct exports to the EU accounted for more than half of the volume and nearly two thirds of the value of Guyana's sugar exports (GuySuCo, 2008). The EU was responsible for another 11.9% (by volume) under the Special Preferential Sugar Agreement. Other major export markets, by volume, were CARICOM (21.2%), the United States (4.3%), and Haiti (2.7%). Despite these special conditions, about one fifth of GuySuCo's output was not profitable and needed cross subsidization (within the company).[24]

3.2.1.2 Rice

Rice has been trading places with the fisheries sector in terms of its importance to Guyana's economy. There are an estimated 30,000 farm families involved in rice cultivation and thousands more in milling, exporting, transportation and other activities linked to the industry (Guyana Transport Sector Study, 2005).[25] It is further estimated that 20% of the population depend directly on the rice industry. In 2007 rice accounted for 4.2% of GDP (a decline of 17.6% over the 2005 figure) and approximately 10% of total exports.

During the 1990s, the rice industry showed major increases in the acreage harvested, and the quantity produced and exported. Much of this success is attributed to the removal of price controls, and the privatization of the milling and export industries. The authorities also credit an increase in drainage and irrigation activity after 1992, better marketing, the freeing up of foreign exchange controls and improved land tenure. In 2007, Guyana produced 298,128 tons of rice, representing a 9.1% increase of the 2005 level, but a decline by 3% over the previous year's total of 307,037 MT. At the same time, exports value in current US dollar increased by 63% between 2005 and 2007 attributed mainly to rising commodity prices.[26]

The domestic market absorbs around 60,000 MT of rice equivalent; the remaining 150-250 MT (according to the harvest fluctuation) are exported. About a half of exports are of low priced semi-milled rice (cargo); white rice has a share of one third and the higher priced parboiled rice a share of only one eighth of total rice exports (in 2007).[27]

Productivity in the rice industry has improved considerably; per-acre yield rose by 55% between 1975 and 2007. These improvements, however, appear to have reached a plateau in recent years. Furthermore, while the volume of rice exports has been fairly steady, the prices obtained in foreign markets declined sharply until the later part of 2007 and 2008 due to global commodity shortages. Whether these prices will remain buoyant is a moot point but they do seem to be encouraging persons who had abandoned lands to return to paddy cultivation as the venture has once again become feasible for some persons (see *Appendix 1*). Despite the spike in prices though, average yields still seem to be

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[23] The conditions of the SPS agreement include a minimum delivered price to be paid by EU refiners, equivalent to approximately 85% of the ACP guaranteed price for raw sugar. The minimum delivered price is calculated by deducting 8.1 euros per 100kg from the ACP guaranteed price for raw sugar fixed under the ACP/EU Sugar Protocol.

[24] European Union (2005), Guyana Transport Sector Study, Working Paper #4, pp 18-19, Georgetown

25 The Study estimates that approximately 100,000 persons depend on the sector directly and indirectly.

[26] Trostle, Ronald (2008) *Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices*, United States Department of Agriculture, Washington.

[27] US$232/ton for cargo rice, US$ 310 for white rice and US$ 415 for parboiled rice (in 2000, FOB), Agrotec SPA: Feasibility study of CARIFORUM Rice Industry. 2002, p.40

well below potential and are lower than those of other countries in the region.[28] Furthermore, low processing efficiency remains a major concern.[29]

With an average yield of 4.19 MT/ha[30], the yields are lower than in competing countries in the region. Moreover, wages are reported to be some 4-5 times higher than in low-cost Asian countries[31]. However, given the hike in commodity prices, our estimates indicate that the average price received for paddy exports was US$324 in 2007. Thus, rice production, which was at the edge of the profitability in the former years, has become profitable again, but this should not gloss over the need to reduce field costs and improve productivity levels.

In the future, some cost reduction can be achieved by improving the reliability of water supply and dispersal of drainage outflows, both areas projected to be significantly impacted by climate change.[32] According to a World Bank study completed in 2003, it was estimated that a substantial improvement in the sector's profitability would require an injection of between US$60 million and US$65 million for the rehabilitation of drainage and irrigation infrastructure, improvement of farm to market roads, and storage facilities.[33] Since that time, Government has embarked on a massive drainage and irrigation programme under the Agriculture Support Services Programme (ASSP), as well as under an EU-funded programme to support the sector. The need for these improvements was made even more urgent after the 2005 and 2006 rainy seasons, where poor drainage in some areas exacerbated the situation, resulting in substantial losses in each year in excess of US$50 million (ECLAC 2005 & 2006).

3.2.1.3 Livestock

Livestock production has remained sluggish. Between 1998 and 2002 there was a significant upswing in the poultry industry. This led to the country being self sufficient in eggs and nearly 90% in poultry meat. [34] While the country is still able to meet much of its local demand, some of the companies that emerged at that time have since ceased operations for a variety of reasons. But at the same time, other smaller producers have been investing in the sector. The poultry industry comprises about 3,400 enterprises including about 500 pluck shops, four processing plants, 50 commercial farms, 3,000 small farmers, 12 hatcheries, 80 trucks, and four stock-feed factories. It employs some 5,000 people.

Livestock production in Guyana is currently oriented completely to the domestic market, which means that there is almost no export activity to serve as a signal that such export activity could be potentially profitable. Nevertheless, the cost of meat production in Guyana is low and Guyana has several advantages as a beef exporter including abundant land and water resources necessary for raising grass fed cattle, and having been certified Foot and Mouth Disease free since 2001. These characteristics position Guyana as one of the few players with the comparative advantage required to be a potential long-run player in the export of beef. Presently, beef is not exported from Guyana because of a number of constraints that include the need to implement appropriate animal health legislation, develop veterinary diagnostic facilities, establish an abattoir of international standards, utilize improved quality

[28] The yield in the Dominican Republic is 5.2ton/ha,while in Latin America it is above 6 ton/ha.
[29] World Bank (2003): *Guyana Development Policy Review*, World Bank, Washington.
[30] Guyana Rice Development Board (2008) Annual Report: 2007, GRDB, Georgetown
[31] The World Bank estimates this costs at US$ 340-400 per MT; World Bank: Guyana Development Policy Review, 2003, p.48.
[32] Agrotec SPA (2002). Feasibility study of CARIFORUM Rice Industry. 2002, p.65.
[33] World Bank (2003). Guyana Development Policy Review, 2003, p.47
[34] Ministry of Fisheries, Crops and Livestock with Responsibilities for Forestry online information. Available at: http://www.sdnp.org.gy/minagri/moa_mfcl/mfcl/index.htm.

forage, introduce improved cattle breeds, promote improved husbandry techniques and develop measures to tackle the problem of rustling.

The Ministry of Agriculture has implemented a Livestock Development Programme to promote efficiency in the rearing of poultry, cattle, swine, sheep, and goats. The aim is to increase production and productivity and attain self-sufficiency of livestock and livestock products. Furthermore, under a recently signed Agricultural Export Diversification Programme (AEDP), the government is providing substantial breeding material and technical assistance to farmers, with the aim of lifting sanitary and phytosanitary standards, improving the disease surveillance system, as well as pasturage for the beef/cattle industry.

As regards the poultry sector, Guyanese producers have concerns over the competitiveness of the industry *vis à vis* major producers in North America with increasing globalization. A regional study concluded that, on the basis of the importance of the broiler industry in CARICOM and given its vulnerability to low priced imports, a clear case existed for treating the industry as sensitive in a global trade context.[35] In this regard, imports already face relatively stringent market-access conditions since, in addition to the 100% tariff imposed on most chicken cuts, imports of poultry into Guyana require a sanitary permit.

3.2.1.4 Non-traditional and Processed Products

The non-traditional sector includes all components of the agricultural sector with the exception of rice, sugar, forestry and fishing. The National Development Strategy (NDS) conveniently identifies the major non-traditional crops as the following: Cereals and Legumes: corn, blackeye, Oilseeds: peanut and coconut; Ground Provisions: cassava, sweet potatoes, eddoes, yam, tania/dasheen, plantains; Vegetables and Greens: tomatoes, cabbage, pumpkin, bora, ochro, boulanger, squash, cucumber; Herbs, Spices and Seasonings: eschallot, hot pepper, ginger, tumeric; Fruits: banana, pineapple, pear, carambola and watermelon; Other Fruits: mangoes, genip, cherry, awara: Citrus: lime, grapefruit, orange: Other Crops: coffee, cocoa and cotton; pasture/forage, ornamentals and floriculture. The major producers in this sub-sector are poor rural households, many depending directly on the sub-sector for their livelihood, while others are supplementing their income from the output produced in this sub-sector.

This sub-sector has been experiencing substantial growth of late under government's 'Grow More Food' campaign, but also due to the increased emphasis placed on the sector and the assistance provided by the New Guyana Marketing Corporation (NGMC). As detailed later in this assessment, the fruits and vegetables supply chain has strong potential for growth. Guyana's non-traditional agricultural exports (mainly of vegetables and fruits) grew by 35% in value in 2007 over the 2005, accounting for just above 2% of total exports (New Guyana Marketing Corporation, 2008). In recent years non-agricultural products have increased both in terms of output and exports. As before, products with the most promising marketing opportunities include coconut base products, pineapple, pepper, plantain, pumpkin and passion fruit.

The Government has repeatedly espoused its plans to introduce sustainable cut-flower, honey, and integrated fish and crop farming industries.[36] At the same time, efforts have been made o exploit the organic niche markets for pineapple, sugar, cocoa, peanuts, cashew nuts and heart of palm. In this respect, a peanut production programme has been put in place with the aim of improving the volume and quality of the product to suit local and overseas markets. Organic farming programmes have been

[35] Singh et al. (2001), p. xi.

[36] Ministry of Finance (2002a), p. 27.

started, with the rehabilitation of 40.5 hectares of cocoa plantations, and an export target of 2.2 MT per year, mainly to Europe. Also, the company processing heart of palm in Guyana, has secured certification for its operations and is now seeking to extend this into the area of pine apple cultivation. Its pineapple operations are mainly done with indigenous communities in the Mainstay/Whyaka area of Region 2.

3.2.1.5 Fisheries

Fisheries in 2001 accounted for some 3% of GDP, but grew to some 7% by 2006. Exports have been rivalling the rice sector as the second most important agricultural export sub-sector. Exports from the sector have consistently surpassed US$50 million since 2004, with shrimp being the main export from the industry.

Guyana's fishing fleet consists of around 120 trawlers based in Port Georgetown; they exploit the waters in the continental shelf. Their main objective is the smaller shrimp and fin fish that are found in depths of 13 to 30 metres. Another 65 ships are based in Guyana but are foreign-owned, and fish for larger prawns at depths of 25 to 90 metres. Guyana also has a fleet of some 1,200 artisanal boats that fish in river mouths, and near the shore at shallow depths and are an important source of employment in these rural areas.[37]

Some aquaculture projects have been developed in recent years and the cultivated acreage has risen from approximately 1 hectare in 1997 to over 1,619 hectare in 2006. A freshwater aquaculture demonstration farm and training centre has been set up at Mon Repos, East Coast Demerara, to promote freshwater aquaculture development by providing on-site training of farmers. The project is funded by the Canadian Development Agency (CIDA), Food and Agricultural Organization (FAO), and the Government of Guyana.

Commercial aquaculture is one of the most promising economic activities in Guyana with high potential for rapid export and job creation growth. Aquaculture also has great potential for improvements in food security status of rural communities, especially as other farming systems (in particular rice) can be adapted to incorporate aquaculture production, thereby increasing production endowments.

At present aquaculture is a nascent sub-sector in the initial stages of development, though with potential for strong growth. It is estimated that some 2,000 hectares are cultivated. This land area produced a production value of US$1.2 million in 2006, experiencing average annual growth of 14.4% since 1995.

However, in the wider context of regional production, Guyana's output is still low and made up only 0.02% of the total production of Latin American and Caribbean Countries in 2006. There are a number of pioneer investors operating in the sub-sector. Of these *New Line Aqua Farm*, based in the West Demerara Zone is the most advanced, and has been the only company to begin small scale exports in 2006.

[37] *Guyana Review* "Fishing in Troubled Waters," Volume 10, No. 116, August 2002.

3.2.1.6 Forestry

Forestry products over the past 7 years, the annual average contribution of the forestry industry to Guyana's GDP have been 3.49%, with 2006 being an exceptional year. It is estimated that Guyana has 22,400 square kilometer of commercial forest; another 64,000 square kilometer of forest are potentially commercial.[38] Export earning in 2006 was US$59.5 million, representing a 67% increase over the 2000 figure.[39]

The Ministry of Agriculture with responsibilities for forestry oversees policies in the sector; it is trying to promote value-added activities. The GFC monitors forest operations to ensure compliance with its operational and environmental standards. It has established a 24-hour monitoring unit to reduce the incidence of illegal activities by loggers, and is aiming to have Guyana certified internationally as an exporter of wood and wood products in accordance with environmentally friendly practices. In this regard, it is working with the Guyana National Initiative of Forest Certification (GNIFC), established in 2003 to take the process forward.

The Guyana Forestry Commission produced a National Forest Plan in 2001. The overall objective of this plan is the conservation, protection, management, and utilization of Guyana's forest resources, while ensuring that the productive capacity of the forests for both goods and services is maintained or enhanced.[40] Among the points emphasized in the plan is the need to promote greater conservation of the country's forest resources. In 2002, Conservation International, under a Timber Sales Agreement (TSA), undertook to conserve and protect approximately 80,000 hectares of State Forest Estate over a period of 30 years. In this concession, no logging is permitted and the GFC is to be compensated on the basis of a timber valuation of the concession. The NFP also promotes export trade and underpin this with research and development aimed at both processing and marketing as well as offering training and extension programmes. The plan called for the approval of a new Forests Act which was passed in 2007.

Additionally, Guyana is one of 14 states that have been selected to receive funding to engage in programmes that help combat tropical deforestation and climate change.[41] The country will receive funding from the Forest Carbon Partnership Facility (FCPF) in an innovative approach to finance efforts to combat climate change. Guyana will receive grant support as it seeks to build its capacity for Reducing Emission from Deforestation and Forest Degradation (REDD).

[38] Bernard (1999).

[39] Guyana Forestry Commission (2008) *Forestry in Guyana: 2007*, p. 4

[40] Guyana Forestry Commission (2001), p. 1.

[41] The others are the Democratic Republic of Congo, Gabon, Ghana, Kenya, Liberia, Madagascar; Bolivia, Costa Rica, Mexico, Panama and Nepal, Lao PDR, and Vietnam.

4. Climate Change Scenarios

4.1 The Global Context

Global climate change and possible sea level rise can have profound impacts on the development prospects of a number of developing countries[42], Guyana included, even though even some developed countries will also be seriously threatened. According to the Inter-Governmental Panel on Climate Change (IPCC) increasingly, the scientific data in the form of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global mean sea levels indicate that climatic changes remain real (IPCC, 2007). Furthermore, IPCC projections of a temperature rise of between 0.15 to 0.3 degrees centigrade per decade are supported by an observed global value of 0.2 degrees centigrade per decade (IPCC, 2007).

Further, the projection of global sea level rise of 0.51m towards the Century will necessitate appropriate adaptation responses. The immediate cause for concern is the extremely high vulnerability of low lying coastal states, whose coastal areas tend to accommodate the main population centres, social and physical infrastructure, and are sources of livelihoods and high economic importance; and those other vulnerable sectors of which agriculture is a highly weather sensitive one. As a result of climate change there will be impacts on rainfall, water resources, heating effects on plants and animals, leading to higher evapo-transpiration rates leading to stress in both organisms. The increase in temperatures will add to the energy budget in the atmosphere and oceans, this will create more intense storms occurring at more regular intervals.

Against the preceding background and based on projections, global adaptation costs are estimated to range between US$20 - 25 trillion annually (Watkiss *et al.*, 2005; Ackerman and Stanton, 2006; European Environmental Agency, 2007). However, even these figures it is argued, often under-estimate the impact of climate change. While the World Bank (WB) has argued that the funds available to developing countries like Guyana via the Clean Development Mechanism (CDM) and the Global Environment Facility (GEF) Special Climate Change Fund are technically adequate[43] to respond to the challenges of achieving climate resilient development, others have argued that the sums of money flowing through these instruments need to be substantially increased (CARICOM Draft Regional Strategy, 2008).

For the next two decades, a warming trend of about 0.2 degrees centigrade is projected for a range of greenhouse gas (GHG) emission scenarios (Brandt and Farrell, 2007). As such, the IPCC has contended that even if the concentration of all greenhouse gases and aerosols was to be kept constant at year 2000 levels, a further warming of about 0.1 degrees centigrade per decade is expected (IPCC, 2007).

Concomitantly, the projections anticipate that changing climatic conditions will lead to rising sea-levels and an increase in global sea water temperature; weather patterns will become more erratic, with more frequent extreme events, such as droughts, floods, and hurricanes. In fact, more recent evidence

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[42] A developing country is for the purposes of this strategy and action plan will be defined as a country which has an undeveloped or developing industrial base, and an inconsistent varying human development index (HDI) score and per capita income, but is in a phase of economic development. Conversely, the term developed country will be used to categorize countries with developed economies in which the tertiary and quaternary sectors of industry dominate.

[43] As of April 2007 the GEF had reserve allocations and pledges totaling approximately US$200 Mn, while the Adaptation Fund under the Kyoto Protocol of the UNFCCC is estimated to total between US$100 and US$500 Mn by 2012.

suggests that the economic impacts can be debilitating on a global scale with damages ranging between 5% and 7% of gross domestic product (GDP) (Stern, 2006; Garnaut, 2008).

4.2 National Context of Climate Change

Against this global context one can conclude that climate change poses challenges for all sectors of the Guyanese economy, but particularly those dependent on natural resources, such as agriculture. According to the IPCC Fourth Assessment Report (AR4) (2007) many social, biological and geophysical systems are at risk from climate change. These risks are even more profound given that they are occurring within an evolving socio-economic baseline (IPCC, 2007).

In Guyana, there is a bi-modal pattern of rainfall annually, the intervening periods are dry. In order to maximize the land resources for crops and livestock production, then a source of water must be in place to supplement the variable rainfall in sufficient quantities. Hence, water resources are stored for use in reservoirs or extracted from flowing rivers, to support agriculture. The projected scenarios and modeled data (INC 2002) indicate that there will be increased intensity of storms, leading to higher runoff resulting in flooding, leaching of soils which do not have good cover or may have been cleared for planting, leading to increase of sedimentation of waterways. Almost all drainage and irrigation depend on gravity flow; as such, any changes in elevation or bed profile of streams will result in inefficiency in operation or create additional costs due to the need to pump water for drainage and/or irrigation (*see Appendix 2*).

But at the same time, climate change also presents some short term opportunities for Guyana, and the agricultural and forestry sectors more specifically, if the country continues to seek efforts and investments to position itself strategically in an increasingly food insecure world in the face of escalating commodity prices (Trostle, 2008), and to take advantage of its standing forests (World Bank, 2006). Furthermore, under the Guyana Bagasse Cogeneration Project nearly 890,000 $_{-e}$ over a 14-year period will be mitigated and the project will receive Certified Emission Reductions (CERs), often referred as carbon credits. In the context of the Clean Development Mechanism (CDM), these carbon credits are based on the difference in greenhouse gas (GHG) emissions between the most likely future practices (known as the baseline scenario) and proposed practice due to project activities (known as the project scenario). This difference is defined as "additionality". By displacing fossil fuel use in energy generation, the Project will contribute to a reduction in the impact on climate change and is therefore eligible to receive carbon credits.

This National Agricultural Sector Adaptation Strategy to Address Climate Change (2009-2018), commissioned by the MACC project out of the CCCCC, is based on a plan by the GoG to develop a coordinated framework for climate change policy in agriculture. This framework will contribute to the development of a competitive, diversified, sustainable, and technologically advanced agricultural sector leading into the future. Further, it will provide the GoG, mainly through the Ministry of Agriculture (MoA), research and development (R&D) organizations and academic institutions with practical tools to develop effective and efficient contextually relevant policies to overcome the challenges posed by climate change and take advantage of the opportunities presented. The objectives, strategies and proposed interventions presented in this document builds on the issues and needs identified through previous and on-going processes and documents that include:

- The establishment and re-organization of the National Climate Committee (NCC) (1995);
- The establishment of the Natural Resources & Environment Advisory Committee (NREAC) (1995);
- National Biodiversity Action Plan (1999);

- Integrated Coastal Zone Management Action Plan (2000);
- National Environmental Action Plan 2000 – 2004 (2000);
- Guyana Climate Change Action Plan (2001);
- Mangrove Management Plan (2001)
- Guyana Initial National Communication in Response to its Commitment to the UNFCCC (2001);
- The preparation of Guyana Climate Change Adaptation Policy and Implementation Strategy for Coastal and Low-lying Areas (2002);
- Draft National Disaster Preparedness Plan (1985);
- The completion of Guyana's National Vulnerability Assessment to Sea Level Rise (GNVASLR) (2002);
- The completion of the National Capacity Self Assessment (NCSA) Project in response to its commitment to the UNFCCC (2006);
- Establishment of the National Climate Unit (2008);
- Commencement of Guyana's National Communication (2008);
- Conducting a pilot Vulnerability and Capacity Assessment (VCA) for the agricultural sector (2008); and
- The Conservancy Adaptation Strategy.

The Strategy provides an overview of the priority strategies and proposed actions requiring national cooperation to adapt to climate change. It includes recommendations on capacity building measures, policy and legislation and communication and awareness building gleaned from the sector assessments conducted. It identifies sources of possible assistance to support the implementation of the proposed actions.

5. Climate Change Impacts Nationally

There is evidence suggesting significant changes in global climate have occurred over the past century and that this phenomenon will continue throughout the century due to anthropogenic activities as well as natural cycles. The risk of extreme events and abrupt changes in climatic patterns is also increasing. It is likely that Guyana will face some degree of climate change over the next 30 to 50 years irrespective of global efforts to reduce greenhouse emissions with some of the projected impacts shown in Table 1 below (*see Appendix 2*)

Table 1: Global and local climate scenarios with some recommended adaptations

Global Climate Scenarios Assessment Report of the IPCC, models and data.	National Climate Scenarios, data analysis	Adaptation responses of the agricultural and allied sectors.
Warming of South American Continent inclusive of low latitudes of 0.2 to 1.0 from1970 and-2004. Models have indicated best estimate of 3.4 , with a likely range of 2.0 to 5.4 at 2090 to 2099. (A2)	i) An increase of the maximum temperature by 0.8 , from ii) Minimum temperature has shown an increase of 1.2 . A mean annual increase of 1.0 over the same period. (INC 2002).	a) Develop heat resistant varieties, diversify crops. b) Use shade & greenhouse to control heat exposure. b) Improved infrastructure to ensure irrigation in dry season. c) Better designs of animal pens, to allow for more airflow.
Global sea level is expected to rise by 0.23m to 0.51m by 2090, even with mitigation measures of reduction of GHG emissions. This does not take into account melting of ice caps.	Current sea level rise is at least several times the global average, in Guyana it is 10.2 mm/year. (Guyana's National Vulnerability Assessment to Sea Level Rise 2002)	a) Salt tolerant varieties. b) Increased water management to prevent saline intrusion. c) Improved sea and river defences protection. d) Land use change e) Increased public awareness about climate change, the role of mangroves and efficient waste management techniques
Impacts on Rainfall: By mid-century, annual average river runoff are projected to increase by 10-40% at high latitudes during wet seasons. Fresh water resources are projected to be less including a reduction of groundwater recharge. Other impacts are intense storms and regular ENSO events	Increasing rainfall intensities will contribute to higher runoff and increase flooding. The data supports the former; the latter is supported by the frequency of occurrences in floods currently, such as in 2005 and 2006 along the coast, but also in segments of Region 9.	a) To improve drainage capacity. b) To accommodate more storage in conservancies. c) Acquisition and deployment of more pumps. d) Recirculation of water. e) Better maintenance of drainage outfalls

Sources: IPCC Assessment report, GNVSLR 2002, INC 2002, Survey information of Agriculture Sector Agencies

5.1 Sea Level Rise

Guyana's coastal plain that lies below mean high tide level extends for about 430 km east to west and varying in width from 26 km to 77 km. This flat plain is protected from the sea by a mixture of natural defenses, sand banks, earthen embankments within mangrove stands, and a combination of concrete walls and rip-rap structures known collectively as sea defences. The rip rap structures are a strategic response to the threat of rising sea levels associated with climate change, as the crest level can be raised relatively easily to accommodate future rises in sea level.

The coastal plain, representing about 7% of the total land area, occupied by about 90% of the population and where most of the economic activity in the form of agriculture and commerce takes place, remains vulnerable to the impacts of climate change and its associated sea level rise. These impacts include flooding, storm surges, saline intrusion into freshwater aquifers and coastal rivers, and

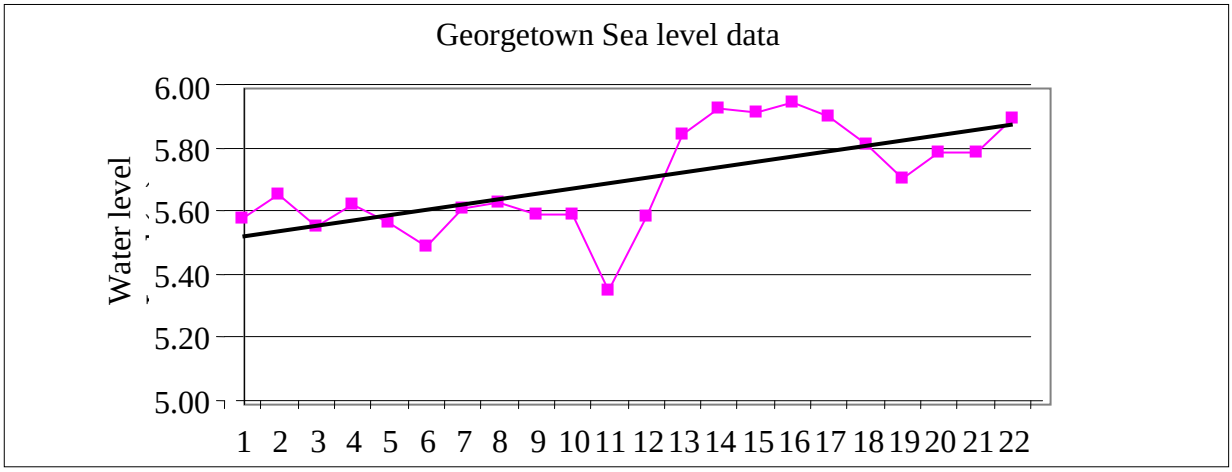
rising water tables. In the intermediate savannahs and hinterland areas there is projected to be increases in temperature, for a doubling of carbon dioxide () of 1. by 2040 and a projection of a 4. increase for a tripling of for the century (INC, 2002). Additionally, rainfall is projected to decrease for a doubling and a tripling of . (INC, 2002). However, some crops are expected to benefit from these increased temperatures, e.g., maize in some studies (Hatfield, 2008; Smith and Martino, 2007) particularly in the Intermediate Savannah areas, but without any irrigation system in place crops can only be grown during the rainy season, which can produce highly variable yields.[44] The success of subsistence and commercial farming in these areas will have to be based on plant breeding and sound agronomic practices to withstand high temperatures.[45] Heat and drought tolerance will be the key mitigating factors.

Further, the Caribbean Agricultural Research and Development Institute (CARDI) found that UF 717 *Brachiariha humidicola* was suitable for growth to support livestock in the savannah region which may provide some opportunities under Guyana's diversification plan and grow more food campaign.

Coastal land loss due to a combination of inundation and coastal erosion is projected to have widespread adverse consequences in the low-lying coastal plain of Guyana (see *Appendix 2*). Land loss from sea level rise especially in coastal locations is likely to be of a magnitude that can disrupt virtually all economic activity and impact the social sectors in the country. For example, recent estimates indicate that with a 1m sea level rise, up to of land could be lost, solely on account of inundation. (GNVASLR, 2002) This figure would increase more than threefold to 37 (14%) with storm surge superimposed on a 1m sea level rise scenario. Similarly, based on the Brunn rule, a retreat of up to 100m is projected with a 1m elevation of sea level (GNVASLR, 2002).

A plot of available sea level data 1960 to 1981 from the Transport & Harbours Department (T&HD) showed an increase of sea level of the magnitude that is about 5 times that of global average (Figure 3), which could be attributed to the probability of land subsidence (Bassier 1976).

Figure 3: Plot of sea level data from Georgetown



Source: Transport and Harbours Department, Plot of annual data, departures from the mean red line, and a trend line, black, showing rate of rise of sea level over two decades, in the Port of Georgetown (T&HD and Hydromet2002).

The Initial National Communication Report (2002) based on available tide gauge data for the period 1951 to 1979 for Port Georgetown, found mean relative sea level rise, using a linear extrapolation as

[44] While there has been some discussion on installing drip irrigation in areas such as the Intermediate Savannahs of Guyana, this remains an expensive undertaking that may then make agricultural products from such areas price uncompetitive.

[45] It will also be necessary to improve nutrient use, tillage, and residue management to ensure that agricultural practices do not contribute to the GHG problem facing the world.

10.2 mm yr^{-1}. This rate of relative sea level rise is about 5 times the global average and close to that observed in Trinidad, albeit for a later time period. This is therefore suggestive of some mechanism other than eustatic sea level rise, such as subsidence due to water extraction, ocean floor sediment loading or plate tectonics. Plate tectonics, however, does not appear to be contributing to this problem (INC, 2002).

Subsidence and sediment loading may both be contributing to the high rises noted in Guyana. The high rises observed in Trinidad and in Guyana may suggest a generalized increase of sea level in the region, supported by the Working Group (WG)1 AR4 to the IPCC in 2007, which states that sea level rise will not be uniform globally. In Narayan's (2002) biophysical impacts on saline intrusion up the three coastal rivers, it was calculated that saline intrusion from the sea level rise scenarios of 0.2m, 0.5m, and 0.9m up the Demerara, Essequibo and Mahaica Rivers is projected to be as in Table 2. From the projected impacts, this would increase the salinity content of between a tenth to a third of the soils on the coastal plain, reducing productivity and output, increasing cost of production, make Guyana's agricultural exports less price competitive and increase the vulnerability of a number of rural households that are already living on the margin of poverty (see *Appendix 1*). This will have impacts on the withdrawal of water in these areas for agricultural purposes as well as the likelihood of salinisation of the soil whenever the rivers flood their banks. The water table which is also projected to rise will create water-logging of soils onshore within the areas of influence of the river.

Table 2: Calculated saline intrusion for three future scenarios of sea level rise

River	Sea level rise (m)	Salt water intrusion (river mouth km)	Extent (km)
Mahaica River	0.2	2.2	23
	0.5	2.5	25
	0.9	2.8	28
Demerara River	0.2	4.4	55
	0.5	5	58
	0.9	5.6	64
Essequibo River	0.2	6.6	65
	0.5	7.5	72
	0.9	8.5	80

Source: Narayan's Biophysical Impacts in Guyana's National Vulnerability Assessment to Sea Level Rise 2002

From an adaptation standpoint, the Guyana sea defenses are currently designed to accommodate sea level rise of 6 mm y^{-1}, and the Sea and River Defence Department (SRDD) is using the rip-rap design, which can facilitate raising of the crest level easily, as protection of the coast is seen as a viable option. Agricultural losses could be as high as 20% of GDP in low lying coastal states (IPCC, 2007). Furthermore, given agriculture's contribution to the Guyanese economy the effects may be even more severe (see *Appendix 1*).

Under the European Union (EU) funded Shorezone Management System Project (EDF) the SRDD is collecting data on water levels, coastal morphology, waves, wind and current and undertaking mangrove restoration studies. The data collected will be used in the next phase under the EDF to undertake rehabilitation of the sea defences, adding to previous efforts undertaken by the Environmental Protection Agency (EPA) under the Integrated Coastal Zone Management Plan (ICZM) (2000). Another component is the development of a strategy and Master Plan for the continued maintenance of the sea defences. This phase has been completed and will restart under the EDF (Dalrymple per comm., 2008).

5.2 Tidal Impacts

The coastal plain is particularly vulnerable at high tides since the elevation of the surface of the sea is usually above the land level, thus the need to maintain the sea defences and other protection, such as mangroves, for the continued occupation of the coastal areas. In the event of high tides accompanied by high winds there could be storm surges that could overtop the walls, and cause flooding, similar to what which occurred during 2008 between the Montrose to Better Hope area in Region # 4 (Guyana Chronicle March 23, 2008), and at several other places such as on the Island of Leguan in Region # 3 and Crane on the West Coast of Demerara in Region #4. In her paper on the vulnerability of the coastal areas, Dalyrmple examined two areas, at Hope and Vreed-en-hoop and concluded that it is necessary to incorporate sea level rise and coastal topography into the design of sea defences. In addition in an earlier study it was also recommended that it was necessary to institute better sea defence management, involve local communities in the programmes, and minimize the destruction of mangroves[46] as possible solutions to alleviate flooding due to tidal impacts and sea level rise on coastal areas.

5.3 Drainage

Drainage structures were designed to accommodate 38.1mm of rainfall over a 24 hour period. In the past and in normal conditions these structures were functioning adequately in the drainage and irrigation (D&I) areas. However, annual rainfall intensities have increased (see *Appendix 2*). Thus in the recent past the existing designs of drainage structures have been unable to cope with the resulting demand causing more frequent flash and prolonged flooding and losses, estimated to be in excess of US$453 million and US$160 million in 2005 and 2006 respectively (ECLAC 2005 & 2006). These significant impacts were partly responsible for real GDP declining by 2.5% and 1.6% over the 2004 figure (ECLAC, 2005; Ministry of Finance, 2007).

The rate of sea level rise has consequences for drainage in Guyana that is currently mainly done via gravity flow. This flow is accommodated by the difference in elevation of the water levels in the upstream canals to the sea and river levels. Since the coastal area is below mean high tide level, ranging from 0.5m to 1.0m, then the sea or river has to be lower in elevation for drainage to take place. Higher intensity rainfall will require efficient drainage either through sluices or pumps, with the latter still being largely driven by fossils in Guyana. Hence there are two areas of concern; energy consumption in an atmosphere of increasing fuel costs[47] of energy and the increase in GHG emissions. In the case of the former, the NDIA has begun to modify the design of the drainage system to increase discharge capacity as one of their adaptive mechanisms. For example, where resources are available, they have sought to widen the sluice doors and have a shallower depth of the drainage canals to take care of the same or greater volume of water being drained as if there was a deeper channel (Wordsworth, per comm. 2008). However, this system is still largely dependent on the fall of the tide to be effective.

5.4 Rainfall

This segment of the Strategy utilizes recent Atmosphere – Ocean Global Circulating Models (A-O GCMs) that adequately couple the atmospheric and oceanic circulations and in some cases emission scenarios of future greenhouse gases, and tropospheric aerosols, and assumptions on population and economic growth, and energy availability and fuel mix (*see Appendix 2*). The climate simulations derived

[46] Bynoe, Paulette and Bynoe, Mark. (2000): *Final Report on a Socio- Economic Assessment of the Vulnerability of Guyana's Coast'*, Georgetown.

[47] Guyana remains a net importer of fossils.

from these A-O GCMs have been extensively used in the development of scenarios of regional climate change for impact assessments.

In this case, we used the results generated by the most recent A-O GCM of the Canadian Climate Centre (CGCM 1) run in transient mode with increasing by the observed values to the present and then by 1% per year into the future, to create regional climate change scenarios for the region in and around Guyana. This information is cross-referenced with other modeling analysis using the Hadley Climate Model (HAD CM). For each of the grid cells, Climatological data for 3 time slices: 1975 – 1995 (past), 2020 – 2040 (2 x) and 2080 – 2100 (3 x) are selected. For each of these time periods, changes in near-surface rainfall, temperature, evaporation, and water deficit, as simulated by CGCM 1 are extracted in monthly groupings corresponding to the First Dry Season (FDS: February to April), the First Wet Season (FWS : May to July), the Second Dry Season (SDS : August to October) and the Second Wet Season (SWS : November to January) of Guyana.

The rainfall deficits in the model for the doubling of concentrations going into the 2040's will be more pronounced in Southern regions of Guyana and the lower part of Region 6, while Regions 4, 5 and part of 6 will have the largest deficit in the SWS. This is also borne out using the data generated by the HADCM for rainfall data plotted over the various periods (see *Appendix 2*). Similarly, for a tripling of concentrations going into the century Regions 4, 5 and part of 6 will also have the largest deficit of rainfall. This will have serious implications for continued coastal agriculture.

Water resources availability therefore is projected to be adversely affected due to the impacts of climate change. The models, A-O GCM and HAD CM have predicted that there will be higher temperatures, increased evaporation and more intense storm events. The need to provide irrigation, coupled with the highly variable occurrence of rainfall has led to the creation of Conservancies. There are, from the west, the Tapakuma, Boeraserie, East Demerara and the Mahaica Mahaicony Abary /Agriculture Development Authority (MMA/ADA). In the projections of future climate scenarios, resulting water deficits due to changes in precipitation and higher temperature leading to increasing evaporation, it implies that these Conservancies would have to be maintained efficiently. It will therefore be necessary to maintain/increase storage, if possible, reduce losses, and be able to supplement supply when needed. All these Conservancies serve dual purposes, flood control and storage of irrigation water for their respective areas based on the agricultural sector's water needs.

5.5 Temperature Increase

Guyana's climatic pattern can be tracked using meteorological readings in the Botanical Gardens, Georgetown, where temperature data reaches back to 1909, and rainfall records go up to 1884. Recent research using linear extrapolation, has found that the maximum temperature has increased by 0.8°C, while the minimum temperature increased by 1.2°C with a mean annual increase of 1°C since records were made. Further, researchers noted that a greater increase in night-time temperatures has been contributing to the observed global warming elsewhere in the Caribbean. This observed trend also corresponds to a decrease in the diurnal temperature range of about 0.5°C, which is taken by researcher to be indicative of global warming (EPA, 2002). A plot of the modeled minimum temperature data over the period 2011-2030 for Wales and Leguan combined show that there will be an increasing rise of the minimum temperature. The same period of minimum data for MARDS and also the 2031-2050 period indicates that a similar trend of increase is projected (see *Appendix 2*).

5.6 El Nino Southern Oscillation (ENSO)

Guyana suffers acute droughts during the El Nino phase and oppositely, heavy rainfall accompanied by flooding during La Niña phase. Recently, the El Niño phase has been relatively more frequent or persistent than La Niña. This phenomenon (ENSO) is the primary mode of climate variability on the 2 -5 year time scale. Currently it is difficult to prove that there will be any significant change to the amplitude or frequency of ENSO in the future. Thus, the current large inter-annual variability in the rainfall associated with ENSO is likely to dominate over any effects attributable to global warming.

In his paper Khan (2002) noted that in terms of cyclones, Guyana has not experienced much impact during the hurricane seasons that the Caribbean sees each year. However, recently turbulent wind conditions have been experienced in both coastal and inland areas. In light of this new trend it is likely that as climate change advances Guyana will experience changes in this direction, as well as increased effects of sea swells and tidal surges. It is also possible with any shifts in hurricane numbers, patterns and intensities in the North Atlantic and Caribbean Sea to the north of Guyana will occur. Recent studies indicate a possible increase of about 10% to 20% in intensity of tropical cyclones under enhanced conditions. Khan found in other studies that during ENSO events, tropical cyclones and hurricanes are likely to be more severe, but no significant change in hurricane frequency or geographical extent for the North Atlantic under a 2 x climate. His concern for Guyana was the possibility of hurricane spiral bands that pass to the north affecting Guyana with more frequency than in the past (Ibid).

Upon exploring the ENSO phenomenon, Khan found that particularly in regional climate events, the ENSO has been very pronounced in the 1990s. While from 1982-3 the El Nino had an impact on Guyana's rainfall, it was not intense enough to cause concerns for agriculture. However, during the 1990s it has become apparent that convective storms have become more intense but fewer. The result was high intensity rainstorms leading to short-period flooding. The clusters in the Inter Tropical Convergence Zone off the Guianas are smaller and fewer but more intense. The monthly rainfall is therefore being accounted for by fewer days and higher rainfall. In 1997/1998 El Niño events produced widespread drought with accompanying forest fires and a significant impact on the economy of the country. The La Niña of 1996 caused severe flooding to affect several parts of the country. In 1999, 2000, 2005 and 2006 La Niña brought on sporadic flooding especially of coastal regions (Ibid).

5.7 Potential Impacts on Agriculture

As far as agriculture in Guyana is concerned, the prediction is that there will be an increase in temperature, a decrease in total rainfall together with a decrease in the length of the rainy period. This therefore means that there will be more intense rainfall during the wet season. In coastal Guyana where much of the agricultural sector is concentrated the resilience is likely to be tested by several climate change events notably rising levels, flooding, high temperature, high relative humidity, more pests and diseases incidence, salt intrusion, high evaporation rates and greater plant stress.

It is projected that there will be higher rates of photosynthesis. Despite the increase in photosynthesis the changes in temperature may have a far greater detrimental effect, resulting in a general trend of reduction in productivity for even small increases (1-) in temperature. This is because there will be an increase in plant transpiration rates and evaporation, leading most likely to deficits in soil moisture supply.

Climate change and sea-level rise are expected to result in greater risk of coastal erosion. Our mangroves may be negatively affected by sea-level rise, and thus threaten fertile agricultural lands behind these defences.

5.7.1 Aquculture

The species used are tilapia (*Oreochromis niloticus*), hassar (*Hoplosternum littorale*), freshwater pacu (*Colossome macropomum*), and swamp shrimp (*Mesopenaeus tropicales*). One effect of climate change, saltwater intrusion, can have a debilitating impact on aquaculture production since the hassar and pacu will not be expected to survive under saline conditions. Tilapia has been known to withstand salinity levels of up to 28 parts per thousand (ppt)(sea water); however, there is need for freshwater for reproduction and survival of the fries. High salinity is also expected to affect predator fishes e.g. houri (*Hoplias malabaricas).*

Changing rainfall patterns may also impact the spawning activity of hassar. In Guyana it is expected that the intensity of rainfall will increase, leading to a sharp change in conductivity of the water, and thus probably, an increased rate of spawning.

High temperature and increased rainfall should dilute the brackish water where swamp shrimp are reared, resulting in faster rates of growth. A rise of up to one foot of water in the pond will not have any detrimental effects on the crop.

A major problem for the expansion of aquaculture is that suitable lands (class I) are in direct competition with crop production. This is because the pH of the land is crucial. Only pacu can be reared on lands unsuitable for many crops. Class II and III lands also need much infrastructure and inputs. Farmers should therefore be encouraged to adopt fish/rice culture of production to offset detrimental changes on the soil.

5.7.2 Response to Flooding

GuySuCo has developed and installed extensive drainage and irrigation system throughout its cultivation. GuySuCo works very closely with the National Drainage and Irrigation Authority (NDIA) to ensure that there is adequate drainage for many of the lands contiguous to its cultivation.

However, with climate change there will be the need for additional drainage structures to offset the anticipated increase in surface runoff. This water may reach its cultivation whether directly from rainfall or via overflows from rivers and the EDWC and Boerasirie Conservancy.

5.7.3 Response to Flooding

Salinity has not been a major problem for GuySuCo or NARI, but has affected the rice and vegetable industries. With climate change it is projected that there will be sea-level rise and further saltwater intrusion that will affect the sector adversely. The rice and livestock sectors likely to be hardest hit as soils become more saturated with salt and pasture establishment and production may be a problem because none of the recommended pasture grasses (tanner, antelope or para) are very tolerant to high salinity.

5.7.4 Livestock Improvement

Imported semen is used for improvement of the cattle industry. The Holstein off-springs are not performing well under high temperature and high relative humidity conditions, thus semen from the Jersey and Brown Swiss breeds are now used for better adaptation.

There are three anticipated problems that may arise as a result of climate change:

- nutrition - reduced food (forage) and lower quality of forage especially for beef
- diseases – respiratory and digestive diseases may increase especially for Holstein off-springs.
- Availability of food for human consumption – there is likely to be increased incidence of mastitis which will lead to lower levels of milk production.

5.7.5 Crop Improvement

NARI is responsible for the development of all crops with the exception of rice and sugar cane, which are the responsibility of the Guyana Rice Development Board (GRDB) and GuySuCo respectively.

At NARI lines/strains are introduced and evaluated extensively for suitability to Guyana's growing conditions, response to pests and diseases, general growth, development and yields. GuySuCo is engaged in developing its own cultivars for at least one of three characteristics i.e. sugar, fibre and alcohol content. High fibre content is known to be closely linked with increased resistance to borers. This is essential since there has been a new borer (*Elasmopalpus lignocella*) emerging. The response of this insect pest to changing climatic conditions is still to be ascertained.

An emerging disease is ratoon stunting disease. In its breeding programme there is selection for resistance to smut and leaf scald. With this new disease becoming more prevalent, then the objective of the breeding programme may very well have to be adjusted to include an evaluation for resistance to this new disease.

Burma Rice Research Station is involved in the development of new rice lines. To offset climate change effects the plant materials intended to be the precursors of new rice varieties are being evaluated for salt tolerance and to tolerate increasing levels of water especially during vegetative growth.

A consideration of climate change is that the rice plant may physiologically be unable to have higher yields. This is because of the impact of growing degree days. With higher predicted temperatures the crop cycle will most probably be shortened, hence there may not be enough sink available to maintain current yields.

5.7.6 Plant Responses to Carbon Dioxide

Plants grow and develop in response to a range of stimuli but especially to the availability of carbon dioxide, water and mineral nutrients and to the quality and quantity of light. Most of these stimuli will be affected directly or indirectly by climate change, except that light quality and the natural rhythm of variation in day length will remain unaltered.

Current carbon dioxide concentrations limit plant photosynthesis. If other factors remain favourable, increased carbon dioxide concentrations will lead to greater rates of photosynthesis in plants.

Carbon dioxide is important because carbon atoms form the structural skeleton of the plant. A doubling of carbon dioxide levels may increase plant growth by 40-50% though continuous high levels saturate the plant's ability to use carbon dioxide and the benefits decrease with time. Higher carbon dioxide levels also allow the plant to use water more efficiently and may make the plant sturdier, more fruitful and more resistant (or less appetising) to pests.

Stomatal opening decreases in response to increased carbon dioxide concentrations, leading to an increased resistance to water loss from leaves. Thus, as carbon dioxide concentration increases, the water use efficiency (carbon dioxide gained in relation to water lost) also increases.

5.7.7 Temperature and Growth and Development

Since rates of plant development increase linearly with temperatures above a threshold, events such as germination, leaf appearance and flowering often occur after a fixed accumulation of heat above a base temperature (called day degree).

With an estimated increase in temperature by 1.2 for Guyana then there will be accumulation in the growing degree day. For instance a 105-110 day maturing rice variety will now mature in 100-105 days. The crop cycle will be shorter for all our crops and they will have a shorter time in which to accumulate their storage products. Hence, overall uptake rate will have to increase; if water deficit becomes a problem then there is likely to be drastic reduction in yields.

5.7.8 Plant Responses to Water

Water availability to the plant depends on the relative rates at which water is taken up from the soil by the roots and lost from the leaves. If water is in short supply in the soil, or water loss from the leaves is too high because of increasing temperatures and increasing light levels, the plant will suffer water stress. It will react by closing its stomata (leaf pores) to conserve water and will therefore shut off its carbon dioxide supply. Growth will suffer. Prolonged stress will cause loss of leaves and hardening of the plant. Extreme stress will kill it.

5.7.9 Responses of Pest, Disease and Weed to Climate Change

Effects on pest, diseases and weeds are among the most difficult to extrapolate from climate change scenarios because of the complexity of interactions, particularly in relation to specialised feeding relationships of pests.

Temperature is probably the single most important environmental factor influencing insect behavior, distribution, development, survival, and reproduction. An increase in the mean annual temperature of 1.2°C (Guyana by the 2040s) will mean that many insects will be active for a longer period of time. The range and distribution may also shift since the regions which have cooler nights (Hilly Sand and Clay region) may now experience more of these insects as a result of a rise in the minimum temperature.

Higher average temperatures will mean shorter intervals between generations of pests. Thus, just one more generation over a growing season can have a profound effect on population numbers. This effect will be exacerbated in the case of many sucking pests, as higher temperatures will be accompanied by increased water stress, leading to increased uptake of increasingly concentrated plant sap.

Thrips, aphids and mites are likely to be most responsive to the effects of climate change as they produce many generations in a single season. One of the most important natural controls of aphid populations is rainfall, as the impact of raindrops dislodges the aphids or damages their feeding parts.

On the other hand, reduced water supplies will lead to increases in cell sap concentration. Sucking insects and mites will have a more concentrated food supply and may increase more rapidly.

The general impact of climate change on diseases can be summarised as follows:

- wetter and warmer seasons will favour diseases such as *Phytophthora* that need water to spread;
- drier seasons will favour disease such as powdery mildew that can spread in dry conditions;

Pests and diseases are likely to be more troublesome as a result of climate change, because higher temperatures will allow increased survival and activity. Some pests (mites, aphids) and diseases (powdery mildews, rusts) will be favoured by hot, dry seasons. Leaf eating pests may be slightly disadvantaged by the higher carbohydrate status (and therefore reduced protein content) of host plants growing in the higher concentrations of carbon dioxide, and higher light levels associated with climate change.

Higher growth rates of leaves and stems observed for plants grown under high concentrations may result in denser canopies with higher humidity that favour pathogens. Pathogen growth can be affected by higher concentrations resulting in greater fungal spore production. Increased carbon dioxide levels will favour growth of competitive annual weeds more than it will favour plants in general. Higher temperatures and increased water availability, where the latter does not result in water-logging, will allow growth of many annuals. Perennial weeds will grow more quickly and most will flower earlier, if not controlled. Chemical weed control, with glyphosate in particular, will be less effective in hot, dry conditions

Most likely there will be an overall increase in the number of outbreaks of a wider variety of insects and pathogens. For farmers in the riverain areas and coastal Guyana:

- The possible increased use of fungicides and insecticides resulting from an increase in pest outbreaks will likely have negative environmental, health and economic impacts for agriculture;
- Increased temperatures will likely mean higher populations of pathogens; and
- More frequent and more intense rainfall events will tend to favour some types of pathogens over other.

Farmers would incur increased costs as a result of increased frequency of insecticide treatment and the accompanying negative environmental impacts would mount. Resistant varieties are the most effective method for control. Farmers' profitability could thus be impacted by the varieties they grow to combat a disease.

6. Challenges to the Agricultural Sector

6.1 Economic Challenges

Global climate change presents serious challenges to the agricultural sector in Guyana as the sector seeks to become more competitive, diversified and technologically adept to handle the vagaries of the international market place and climate variability (see *Appendix 1*).

While agricultural production nationally has improved since plummeting to an all time low in the early 1990s, the sector is still faced with a number of internal and external supply and demand side challenges that affect its economic viability, reduced farm incomes, increased social and economic vulnerability of poor rural and hinterland households, possible industrial downsizing, and reduced economic growth. Some of these challenges are likely to be magnified by climate change. For example, internally, the agricultural production base is still fairly narrow, making it particularly vulnerable to climate change impacts, external risks, natural disasters, and fluctuations in world market prices. At the same time, immediate challenges to the crops sub-sector (including sugarcane and rice) include: (i) difficulty in accessing fields during the rainy season due to the deplorable state of some farm to market roads, (ii) pests infestations such as '*blast*' and the paddy bug that affect paddy crops, (iii) the high cost of agricultural inputs such as agro-chemicals and fuel, (iv) insufficient production at the farm level, particularly for non-traditional crops; (v) relatively limited knowledge amongst non-traditional farmers about access to markets and to market information even though the NGMC is now seeking to address this issue; (vi) relatively high transportation costs from fields to markets, and (vii) limited access to financial resources for adaptation measures, such as building shade houses or greenhouses, (viii) under-developed agro-processing capacity, and weak research and technology systems.

Coupled with these internal challenges are external constraints, with that of immediacy being the phasing out of the preferential access to the EU market, with the EU beginning to implement their phased price reduction for sugar that should reach the EU (intervention) price of €329 /ton (- 37%) by 2009 (see *Appendix 1*). Such price cuts are projected to reduce revenue from this sector by an estimated 4.5% of the GDP (US$35 Mn).[48] Additionally, high oil prices[49] that, fluctuating commodity prices, and the erection of a number of non-trade barriers in some of Guyana's most important external agricultural market places.

Furthermore, while the government has relentlessly pursued debt-reduction and debt sustainability measures, with a total indebtedness that exceeds 100% of Guyana's Gross National Income (GNI), the country still remains heavily indebted.[50] This forces the government to divert critical resources away from programmes to improve the resilience of the economic fabric of the sector, such as improved rural infrastructure, while pursuing the commitments it signed on to under the Millennium Development Goals (MDGs).

Guyana's agricultural sector is also being undermined by increasing importation of goods into the CARICOM market that exceeds US$3 billion,[51] with often less than effective administration of the Common External Tariff (CET). This reduces the ability of Guyana's agricultural products to compete

[48] Economist Intelligence Unit: Guyana. Country Profile 2004, p.20

[49] A necessary ingredient to assist with pump excess water off the land in some areas, and other cases to lift irrigation water, with climate change, the cost of these activities will increase, making agriculture less competitive.

[50] Sahay R, (2005). Stabilization, Debt and Fiscal Policy in the Caribbean. IMF Working Paper WP/05/26

[51] Bynoe, M (2007) Draft Food Security Strategy for the CARICOM Region.

on a favouable basis with many of these products that often receive substantial subsidies from their home countries.

Guyana has been seeking to deal with some of these challenges via various programmes. For example, it has developed a Guyana National Action Plan (GNAP) for sugar, mainly to respond to the challenges posed by phasing out of preferences. Among the measures to be adopted are:

1) Market oriented expansion of the sales, profitability of production and structural diversification of the sugarcane industry in Guyana – investment budget € 499 million, the main components of which are:
   a) Construction of a new raw sugar factory and establishment of new cane cultivation at Skeldon estate;
   b) Establishment of a cogeneration plant at Skeldon;
   c) Construction of refinery at Skeldon;
   d) Expansion of cane production/upgrading of factories and establishment of cogeneration at Albion, Enmore and Blairmont estates;
   e) Installation of a packaging plant for raw sugar at Enmore;
   f) Construction of a deep water berth at Berbice; and
   g) Ethanol production from cane.
2) Promoting the growth and development of specific non-traditional agriculture sub-sectors; and
3) Providing infrastructural and human resource development support to achieve the above.

Furthermore, under the European Commission's (EC) Multi-Annual Indicative Programme for Sugar (MIP), Guyana is receiving technical assistance to facilitate implementation of some aspects of the Guyana National Action Plan (GNAP) on Accompanying Measures for Sugar Protocol Countries affected by the Reform of the European Union (EU) Sugar Regime.

Also, under an IADB-funded Agricultural Export Diversification Programme (AEDP) many of these constraints are being addressed. At the same time, under various other initiatives, such as the Competitiveness Programme (CP) and the Guyana Trade and Investment Support (GTIS) Programme some targeted interventions will, and have been pursued respectively to aid with the advancement of the sub-sector.

Nonetheless, critical areas for support still remain. As such, adaptation strategies that seek to improve crop efficiency, diversify the production base, and maintain the competitiveness of the sector must include:

- Increased investment in rural infrastructure to reduce the vulnerability, particularly of coastal agriculture, to droughts, rainfall-related floods, and saltwater intrusions and over-topping that can negatively affect agricultural productivity and output.
- Explore the development of a new pricing strategy for drainage and irrigation schemes, to ensure the full-cost of the resource is factored in and the systems are treated as public good.
- Conduct a flood risk assessment (FRA) outlining the main flood risks to Guyana in general, and the sector in particular, presenting recommendations for mitigating such risks.
- Implement economic risk management to combat climate change and reduce crop losses.
- Strengthen the integration and enforcement of environmental and social safeguards in land use planning in Guyana to reduce land-use conflicts and improve output in the face of global climatic changes.

- Improve information gathering and market intelligence to ensure that farmers have the best information available for planning purposes, and

Pursuing these programmes will be necessary if the national agricultural sector is to respond and adapt to the new, and increases in the magnitude of the existing challenges posed by climate change.

6.2 Technical Challenges

The same circumstances that deepen the country's economic, social and environmental vulnerability also impede its ability to acquire and use appropriate technologies to stimulate its agricultural development and to support adaptation to climate change.[52] Much of the technology is developed in the developed world but marketed globally. Guyana's agricultural sector therefore find's itself in a position of having to adapt these technologies to local conditions. Furthermore, while under the UNFCCC funding is available to all developing countries to undertake technology needs assessments (TNAs) and to develop projects to provide these technologies[53], there has often been insufficient attention paid to the development of indigenous technologies and tapping into indigenous knowledge. For example, it is the belief that the Amerindians have been living with climate variability and may have developed adaptive agricultural activities that can be utilized at a commercial level.

The current technologies are likely to be further tested by climate change as: (i) some supply chains are characterized by low productivity and lack of quality standards and processes, (ii) limited research and transfer of technology services, many of which are not linked with specialized networks to facilitate screening and adaptation of new varieties and fingerlings for these agri-business chains; (iii) scarce supply of technical and research-based services; (iv) low awareness on the impacts of agro-chemicals, moreso in an atmosphere of reduced rainfall, coupled with limited monitoring and enforcement capabilities; and (v) weak technological awareness and business practices to meet Good Manufacturing Practices (GMP) and Good Agricultural Practices (GAP) in the livestock chain.

Currently, farmers are engaged in a multiplicity of adaptation techniques, inclusive of the following (see *Appendix 2*):

- The cultivation of flood tolerant high yielding varieties,
- Rehabilitation of nine (9) D&I Schemes under the Agricultural Services Support Programme (ASSP),
- Construction of new water outlet structures on the coast to reduce the incidence of flooding,
- Rehabilitating sectors of the sea defences along the coast, using a flexible rip-rap design,
- Following more mixed farming methods,
- Establishing of adequate infield drainage systems,
- Excavating external drainage systems,
- Diversification of income generating activities,
- Increasing the size of holdings so as to benefit from the economies of scale, particularly in the rice industry, and
- Merging farms into Co-ops so as to share administrative expenses.

[52] Draft CARICOM Adaptation Strategy (2008).

[53] Additionally, under the Clean Development Mechanism (CDM) of the Kyoto Protocol of the UNFCCC countries are able to apply technologies to reduce their emissions of greenhouse gases and such emission reductions are tradable under the global carbon markets as in the case of the Guyana Begasse Cogeneration Project.

To further the approaches to adapt to climate change the country must utilize adaptive techniques that are informed by the requisite information to determine, not only what is physically possible, but also what is economically feasible and socially acceptable. In this regard, therefore, it is necessary to improve data collection on coastal and interior morphology, sea level, wind and current and water quality, surface and groundwater. Rainfall and runoff data in the watersheds of the major river basins and the Conservancies are vital to capture and retain to allow for informed decisions to be made about these freshwater bodies. Also, every effort must be made to move towards a low carbon sector, through seeking more energy efficient ways of operating.

Additionally measures include:

- Conduct investigations on the most notable and important pests and diseases affecting the sector, inclusive of weeds such as the Antelope grass, to climatic changes. A proper understanding can help combat these scourges that impact farm budgets and ultimately, farm households' income.
- Engage the main stakeholders on the implications of climate change, encouraging them to pursue best farm management practices, inclusive of water use efficiency, plant breeding, agrochemicals and fertilizer application.
- Showcase best management practices through the establishment of public funded demonstration farms to research and demonstrate cutting edge technologies, in areas such as plant breeding, plant breeding, agrochemicals and fertilizer application, plant husbandry, and water conservation and management.
- Explore the genetic diversity within crop types that may be better adapted to climatic changes.
- Undertake a comprehensive freshwater management programme that will determine peaks and troughs of water demand and supply in the sector and recommend measures to best deal with these scenarios.
- Explore the feasibility of instituting crop insurance,
- Better communication strategies and a more timely and targeted diffusion of results from the researchers to the stakeholders and to the general public is necessary to adapt to climate change.
- Education and awareness of potential climate change impacts and adaptation strategies for stakeholders, researchers and decision makers are felt to be lacking.
- Accurate pricing strategies are necessary to be put in place to account for the real cost of adaptation.

The Bali Accord negotiated in December 2007 highlights the importance of developing and transferring new technologies to adapt to and mitigate adverse effects of climate change. Such technologies will require considerable new and additional financial resources to be devoted to research and development. However, the country must be prepared to seek to mainstream its research programmes into areas that are strategic and advantageous to Guyana. Furthermore, it will be important for Guyana to propose and negotiate for the best terms and conditions in a new climate change regime and seek from now to enhance its institutional mechanism to access those resources when they become available in 2012.

6.3 Institutional Challenges

Many institutions that support agricultural development in Guyana operate from a *limited human resource base*, especially at the professional level, even though staff members from more than 50% of agencies examined had received either academic or technical training in climate change or were in the process of

receiving training in areas related to climate change. However, limited human resources, made more acute by emigration[54], may constrain the effective implementation of the Adaptation Strategy.

At the same time, the informational needs to allow for effective climate change modeling analysis are now being addressed. As such, the ability to monitoring and map the effects of climate change on the agriculture sector is lacking. Furthermore, the information necessary to influence the policy framework for adaptation planning is often incomplete.

The lack of such data can lead to inappropriate interventions or actions being taken, resulting is destruction of crops, loss of income, loss of tax payers' money and excessive cost over-runs. Thus, the data and information needed for climate change adaptation measures in the agricultural sector itself needs to be researched in relation to the operational needs of those concerned. In conducting such an assessment, the following questions are pertinent: (i) What data is needed, both now and in the future? (ii) What are the benefits of having these data? (iii) To what extent are these data already available? (iv) How can the data be collected? and (v) In what form should the data be stored and presented? Collecting this information can assist in:

- Improved analytical techniques requiring more accurate or different data.
- Assessing climatic change leading to more extreme hydraulic loading conditions.
- Improved accuracy of predictions as a result of using a longer time series of data.
- Meeting the needs of the insurance industry for more accurate assessments of risk.
- An increased demand for real-time data for use in flood forecasting and warning stakeholders.

It is very important that organisations involved in climate change have an approach to data acquisition which is targeted and cost-effective. Consequently, the following questions need to be addressed.

While some effort has been made via the establishment of the National Climate Committee (NCC) to enhance inter-agency collaboration, modalities for the sharing of information, relevant for the agricultural sector and its response to climate change outside this framework, still needs to be worked out. This will allow for there to be greater cohesiveness of efforts and mainstreaming of the Adaptation Strategy and go some where towards ensuring the success of the activities planned.

Additionally, through the establishment of the Agricultural Sector Development Unit (ASDU) within the Ministry of Agriculture to act as the executing arm of the Ministry's programmes, some effort is being made to better streamline the Ministry's human resources and respond to the limited pool of these resources. Despite this and other initiatives, the Government must continue to aggressively pursue all available opportunities via the UNFCCC and other mechanisms, to seek to enhance the human, informational and technical capacity within the agencies in the agricultural sector and those responsible for managing climate change information and impacts (*see Appendix 4*). Furthermore, the recently established National Climate Unit (NCU) should be a legislative body, equipped with the resources to carry out its functions.

Lastly, public awareness and education have unanimous support as a technique for changing attitudes and building support for improved farming practices. The role of public education in farm management to adapt to climate change should be to promote awareness, understanding, and new attitudes regarding the role of innovation and technology against pests, diseases, floods and droughts; values in following efficient water management regimes and appropriate uses of the natural resources available to the sector. The audience for this message is diverse in its education levels and socio-economic status, as

[54] International Monetary Fund (2006). Mishra, Prachi. Emigration and Brain Drain: Evidence from the Caribbean. January 2006. http://www.imf.org/external/pubs/ft/wp/2006/wp0625.pdf

well as in the part individuals and groups play--consciously or unconsciously-in determining present and future adaptation measures. Thus, a broad-based approach to education is required, since people must make decisions at many levels in order for new or strengthened adaptation policies to take effect. At the national level, the policy-makers seem to be fairly well engaged. However, at the local and grassroots level, there is need for a concerted effort in disseminating the message. As such, demonstration plots, talks by technical experts, and specific interventions in key decisions-can raise consciousness and prepare farmers to give serious consideration to management proposals.

6.4 Policy and Legislative Challenges

The policy edicts within agencies to address climate change issues are often tangential and are either vague or have no provisions in the Agencies' mandates that relate directly to climate change adaptation. However, semi-autonomous agencies do have some flexibility to incorporate climate change into their mandate. An analysis of agencies' mandates reveals that at least 50% of (semi-autonomous) agencies have scope within their mandate to address climate change adaptation. This is associated with four (4) factors:

1. *The institution's mandate has an open-ended objective* for the agency to address other issues of importance to its sub-sector, such as in the case of the Guyana Rice Development Board (GRDB) and the Guyana Rice Producers Association (GRPA).
2. *The institution is a research-oriented or academic organization,* such as the Guyana School of Agriculture (GSA) or the National Agricultural Research Institute (NARI).
3. *The institution's mandate relates to the management of the country's natural resources and the maintenance of infrastructure,* such as the Mahaica Mahaicony Abary- Agriculture Development Authority (MMA-ADA), Sea and River Defence Division (SRDD), National Drainage and Irrigation Authority (NDIA) and the Guyana Forestry Commission (GFC).
4. *The institution's mandate relates to environmental/disaster management,* such as the Environmental Protection Agency (EPA) and Civil Defence Commission (CDC).

At the sectoral (and national) level current policies and laws governing the agriculture sector do not directly address climate change (see *Appendix 3*). In fact, even where these do in a tangential manner, in many instances the laws are not enforced due to limited man-power and technical resources, or the penalties are so insignificant that they do not act a deterrent to perpetrators. It is therefore contingent upon policymakers to modify existing laws to mainstream climate change issues within existing agricultural and other sectoral policies. Furthermore, there is the need to resuscitate the ICZM Committee.

6.5 Energy Challenges

Guyana, like the rest of the world, is confronted with an escalating fuel bill as a net importer of this product that rose to US$147 per barrel in 2008, though it has fallen back to less than US$50 per barrel in recent months but is projected to rise again.[55] This high cost of oil has been occasioned by rapid industrial growth in China, India, Brazil and South Africa propelling demand. This increase in demand has been contributed to by an expanding global population who require food, shelter and transportation. At the same time, most projections indicate decline fuel reserves, those that cannot be tapped or carried out on a feasible scale with current levels of technology, and those that cannot be

[55] New York Mercantile Exchange (NYMEX), 10 March 2008. Oil prices briefly rose to a record $108.21 per barrel in afternoon trading on 10 March (settling to $107.90 by close of trading). The report suggested oil supplies are tightening even as demand remains strong. http://www.nymex.com/lsco_fut_cso.aspx

extracted without causing irreparable damage to some sensitive ecosystems.[56] The cumulative effect of these factors is to restrict supply in the face of an expanding demand, causing fuel prices to remain high. Fossils remain a vital input in Guyana's agricultural sector, particularly in the rice mills, sugar factories, and operating tractors, combine harvesters, and water pumps.

The energy challenge is exacerbated by the need to provide energy services in a context of Energy Security, Energy and Development, and Energy and Climate Change.[57] Although Guyana is responsible for a miniscule percentage of global GHG emissions there is an opportunity for the country to put its agricultural sector through energy sector reforms on a much more sustainable footing through investments in supply and demand side management and renewable energy possibly with support from the Clean Development Mechanism (CDM).

[56] Greenspan, A (2007) *The Age of Crisis*, Blackwell, New York.
[57] World Bank, 2005. Seminar, "Global Energy Challenges," 13 January 2005, Eigtveds Pakhus, Denmark http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/WBEUROPEEXTN/DENMARKEXTN/0,„contentMDK:20779525~menuPK:394044~pagePK:64027988~piPK:64027986~theSitePK:394038,00.html

7. Opportunities

As noted above, Guyana has a competitive advantage in land and freshwater, and with the appropriate infrastructure and management, the agricultural sector can exploit these advantages in the face of climate change. For example, it is projected that greater concentrations of will result in higher photosynthesis rates and may also reduce water losses from some plants. Photosynthesis is enhanced when additional carbon is available for assimilation and so crop yields generally rise. The actual response to increased differs among crops. Most commercial crops in Guyana, including rice, sugar cane, and most vegetable crops, tend to respond favorably to increased , with a doubling of atmospheric concentration leading to yield increases in the range of anywhere between 5-20% (Reilly et al, 2007). This projection is based on the assumptions of fertilization effect and that there will be sufficient nutrients and water available to support these increases. If one is to assume that food prices are to maintain their 2007 levels, this would result in an increase in export earnings from agriculture in the vicinity of US$11.7 to US$46.8 million annually (see *Appendix 1*). However, this carbon fertilization effect may be counteracted by reduced water availability and soil fertility.

From the above projections/scenario, it is unlikely that climate change will imperil the ability of Guyana to feed its population and to export agricultural products. Results from the technical assessment suggest that, at the national level, productivity of many major crops will likely increase under the climate scenarios used in these crop models. Crops showing generally positive results include corn for grain, soybeans, and citrus fruits, while with the construction of shade houses, the yield for some crops such as tomatoes are projected to increase under some conditions and decrease under others. However, for these projections to be realized, the fertilization effect would have to be substantial. In the crop yield models, a limited set of on-farm adaptation options are considered, including changes in planting dates and changes in varieties. These contribute substantial gains in yields of irrigated crops, indicating the need for better freshwater management locally.

The economic assessment considered adaptations in response to changing productivity, prices, and resource use, as well as changes in crops and the location of cropping, irrigation, use of fertilizer and pesticides, and a variety of other farm management options. The assessment indicated that economically, both consumers and producers benefit, the former through increased commodities, wider choices and even seasonal lowering in the price of some products, while producers' profits increase due to seasonal scarcities, increasing demand and relatively high international commodity prices (see *Appendix 1*).

Additionally, climate change is likely to affect the food supply in some regions of the world, with many in the poorer countries likely to slip further into food insecurity. However, demand drivers such as, the rate of population growth, the size of disposable income in fast growing economies like China, India, Brazil, Argentina and South Africa, taste, cultural issues, government policies and natural conditions such as floods and droughts associated with climate change, are all expected to both keep food prices buoyant and provide a boon to the Guyanese agricultural sector. At the same time, the quality of the products and ease with which they can be obtained will remain important considerations in the demand for agricultural products

Another area which Guyana stands to benefit from in the face of climate change is in the area of carbon credits acquired through pursuing more renewable energy sources, such as bagasse energy in the sugar sector, paddy and wood husk in the rice sector, and windmills to pump water. Furthermore, with an expansive standing forest, the opportunities to be exploited here are immense, with Guyana being used as a major source for the development of mitigation technology. This remains an expanding area

of research and private sector expansion and an area that Guyana needs to explore the option of becoming involved in immediately.

8. The National Adaptation Strategy and Action Plan

8.1 Rationale for the Strategy

Guyanese farmers and natural resource managers face a number of challenges in maintaining a profitable, competitive, diversified and sustainable agricultural sector. These challenges have or are being addressed through various policy initiatives in the form of the National Development Strategy (NDS) 2001 – 2010, the Poverty Reduction Strategy Paper (PRSP): 2000 – 2005, the Competitiveness Strategy (CS) of 2006, and the Jagdeo Initiative (JI), the last initiative being a CARICOM proposal to reposition the region's agricultural sector. However, as indicated in the INC Report (2002), climate change is considered the most serious long-term threat to agriculture. Responding to climate change, through adaptation strategies will create new challenges, but also bring opportunities for rural enterprises and the national economy with further strategic positioning of the country's investment resources. Understanding a changing climate, recognizing Guyana's social, economic and environmental vulnerabilities, identifying potential risks and seeking opportunities to respond proactively to minimize those risks is a collective challenge for the GoG, research and development institutions (nationally and regionally), industry, rural communities and natural resource managers.

Underpinning the critical role for the government are the development policies and frameworks that mitigate vulnerabilities, support risk management and sustainable practices by farmers and promote a culture of innovation and responsiveness to change to deal with factors affecting agricultural businesses in the future.

Forward-looking policy can reduce the effects of climate change by anticipating the future regime of SLR and weather, in order to capitalize on opportunities and minimize harm. Conventionally, this means identifying the planning horizons for key impact areas and industries, developing plans and planning capability, selecting the best options, and implementing them well. It also entails contingency planning to deal with impacts, and responding effectively to climatic disasters. A fundamental new dimension is emerging: the need to integrate adaptation policies with policies for sustainable economic development and disaster management, to achieve a "triple dividend" from scarce resources.

Furthermore, effective adaptation implies making vulnerable people resilient, and able to return to normal status quickly, even after a major jolt. This means dealing with other causes of vulnerability like low incomes, no title to assets, lack of education, resource depletion, governance, economic instability, disease, demographic factors and poor risk management. For the agricultural sector, the critical factors are adequate infrastructure and communications, public services, scale, and access to finance.

Similarly, to deal with disasters, the policy makers will need to ensure that the basics of food, water and shelter are available. However, the normal post-event response of disaster relief is unpredictable, often slow, and does not tackle the underlying factors that make communities and businesses vulnerable. The key economic strategies are economic diversification, technical training like soil and water conservation, secure communications and infrastructure and hazard reduction.

The solution, therefore, would appear to be one that builds local capacity and resilience in a way that links sustainable development, risk management, and adaptation for a win-win-win situation. This yields a "triple dividend" in the payback for the scarce resources that are available to invest. Each dollar takes care of climate impacts, disaster recovery and economic growth. In addition, there may be opportunities to incorporate emissions reduction measures.

The Strategy, while it is unable to deal with the myriad issues surrounding the agricultural sector and the rural poor, provides a framework for mainstreaming climate change imperatives in the agricultural sector. It is a cost-effective approach that seeks to mainstream many of the proposed actions through existing programmes or initiatives. It achieves this through a combination of strategies and actions under each focus area to manage multiple risks to sustainable agriculture in an environment of climate change. The strategies and actions have been drawn from an assessment of the available technical, economic, institutional and policy information on climate change and how climate change will impact the Guyanese agricultural sector. The Strategy recognizes the role of farmers in primary production and resource stewardship, and seeks synergies and cost-efficiencies to streamline climate change considerations in natural resource policy.

8.2 Goal of the Strategy

The goal of this Strategy is to more effectively reduce the risks posed by climate change and position the agricultural sector to adapt through technical innovation and diversification to increase its competitiveness and sustainability by 2018.

8.3 Objectives of the Strategy

The Strategic objectives are:

- To enhance the capacity within the agricultural sector to adapt to climate change and position this Strategy to foster a nationally consistent policy framework.
- To build resilience and adaptive capacity within the sector.
- To assist the GoG in providing primary producers with a policy framework that embraces research and development and promotes climate change adaptation techniques in agriculture.
- To build greater awareness about adaptive techniques.

8.4 Key Enablers of the Strategy

Supporting the effective formulation and implementation of measures in this Strategy necessitate some focus on the following key overarching enablers:

1. ***Mainstreaming Adaptation:*** The Strategy recognizes that climate change is a cross-cutting issue and, therefore, seeks to build partnerships, complement existing programmes, and harmonize development assistance being provided to the sector.
2. ***Research and Development:*** It is crucial that policy decisions and actions of stakeholders are informed by analytical/technical assessments, given the highly complex nature of climate change.
3. ***Awareness and Communication:*** The group likely to be most severely affected by climate change is the poor and vulnerable in rural coastal and hinterland areas. It is therefore essential that not only the threats are identified and communicated widely, but also the opportunities and adaptive techniques, and research findings.
4. ***Policy Coordination:*** To ensure ongoing sustainable agricultural policy development and implementation requires policy leadership to both monitor and coordinate the development of an adaptation policy and to ensure that the goals of this Strategy are adhered to, the interventions and actions are implemented according to a strict timetable, the results are

monitored, actions are altered in light of changing realities, and new actions are taken as necessary.

5. ***Public-Private Partnership:*** Strategic collaboration between the private sector and the Government is crucial to uncovering where the most significant obstacles to competitiveness lie, determining what type of interventions are most likely to remove them, and engaging public and private sector stakeholders in the implementation of activities that strengthen the competitiveness of the economy.

8.5 Guiding Principles of the National Agricultural Adaptation Strategy

The Strategy has identified a number of principles and parameters that should be followed in pursuit of the above stated objectives. These are:

- The strategies and actions need to build capacity for priority setting in key areas of vulnerability within the agricultural sector.
- The strategies and actions need to build resilience and adaptive capacity in the agricultural sector.
- The strategic objectives must aim to support profitable and sustainable agriculture.
- The strategic objectives should seek to enhance research and development capabilities for the agricultural sector to adapt to climate change.
- The strategic actions should be tailored to addressing specific issues in the agricultural sector.
- That the policies are coordinated and cohesive, thus increasing the possibility of resulting in beneficial outcomes through establishing synergies and complementarities with other policy initiatives.
- The strategies and actions should enhance communication of climate change implications for the agricultural sector.

These principles led to the development of strategies and actions under five (5) focus areas:

- Capacity Enhancement (both technical and institutional),
- Infrastructure Management,
- Policy and Legislation,
- Research and Development, and
- Awareness and communication.

The Strategy presented focuses on on-going activities, as well as immediate, short-, medium- and long term actions. It provides a framework for mainstreaming climate change concerns within the agricultural sector and is proposed as a cost-effective approach. It is set to achieve its objectives through a combination of strategies and actions under each focus area to manage and adapt to the challenges posed by climate change to sustainable agriculture in Guyana. The strategies and actions have been drawn from the national stakeholders workshop, economic review, and assessments of the technical, institutional and policy needs to address the more pertinent issues presented by climate change and mainstream these within existing development programmes and strategies.

8.6. Strategies and Actions

As demonstrated in Sub-section 5.7 and Section 6, some level of climatic changes is inevitable. This is projected to result in: (i) more intense rainfall leading to increased flooding, particularly along the low coastal plain, (ii) droughts and more ENSO related weather patterns leading to possible saltwater intrusion and increases in the pest population, (iii) sea level rise leading to move over-topping at high-tides and putting both the man-made and natural sea defences under severe strain, and (iv) changes in the national climatic conditions, such as temperature, wind speed, and evaporation rates. The agricultural sector remains severely vulnerable to these threats.

To reduce the agriculture sector's vulnerability to these threats, it will be necessary to adapt a coordinated, cohesive and pro-active approach for the sector. This will involve mainstreaming the concerns of the sector within existing development plans and programmes to ensure they are given due attention. The following focus areas seek to capture on-going efforts and identify gaps for action.

8.6.1 Capacity Enhancement

While not a net emitter of greenhouse gases, Guyana's agricultural sector must adapt to confront the likely changes associated with climate variability through enhancing its capacity if it is to remain viable in regional and global markets. In responding to climate change, efforts at enhancing the sector's capacity must focus on improving the technical, institutional, and informational dimensions with which stakeholders operate. Climate change, therefore, may be providing an opportunity for the sector to adjust farm management practices that may not have otherwise occurred, in supporting the sustainability of agriculture. Such adjustments could better prepare Guyana's agricultural sector to cope with climate change by enhancing its capacity and, hence, the resilience of human and natural systems.

Bringing climate change into focus as an additional element in strategic planning for the sector requires among other things, the development of science, knowledge and management tools for application in practical solutions across a range of decision scales and for different levels of stakeholders, inclusive of resource managers, extension officers and farmers. Capacity enhancement is seen as critical to supporting longer term strategic adaptation interventions in the sector, including tools for flexible management and disseminating innovations to contain costs. Farmers, in particular, need to be convinced that the one sharing information with them is qualified to do so. Additionally, they seek practical options and tools to cope with climate change at the farm level.

Adequate capacity, in terms of institutions, technical skills, human and financial resources, is essential if the principles and theory of a sustainable agricultural sector management are to be translated into practice and result in successful programmes to adapt to climatic changes. The complexity of climate change issues and how it impacts the agricultural sector means that those involved must have an understanding of both the ecological and socio-economic characteristics of the areas in which agriculture is practiced in Guyana, so that they appreciate the interdisciplinary nature of the management intervention, and the dynamic and inter-linked characteristics of the diverse environments.

At the same time, the informational needs to allow for effective climate change modeling analysis are now being addressed. As such, the ability to monitor and map the effects of climate change on the agriculture sector is lacking. Furthermore, the information necessary to influence the policy framework for adaptation planning is often incomplete.

The planning, design and implementation of effective adaptation strategy is dependent on the availability of accurate, relevant and current data and information. Understanding hydrological, climatological, and coastal processes, which underpins government policies for the agricultural sector is

compromised unless an adequate surveillance, monitoring and evaluation mechanism is created and continue to collect the necessary data.

8.6.2 Policy and Legislation

The policies governing the agricultural sector in terms of the National Development Policy (NDS) and the Poverty Reduction Strategy (PRS) while identifying the need for rehabilitating Guyana's rural infrastructure to*, inter alia*, place the agricultural sector on a more sustainable foundation are silent on climate change implications for the sector. However, some sectoral policies, such as the Sea and River Defence Act and the National Drainage and Irrigation Act identify the threat posed by climate change and the need to protect, for example, the mangrove forests and maintain an efficient D&I system.

At the same time, existing laws governing the agricultural sector generally encapsulate statutory powers in existing legislation to respond to the potential or likely effects of climate change. However, there are some gaps and weaknesses that need to be addressed in order to make them more responsive and position the sector to respond appropriately. Undoubtedly, an adequate policy environment is necessary to mainstream climate change concerns. Additionally, instituting the relevant laws will allow the responsible agencies to enforce the necessary stipulations to maintain the integrity of natural resources that support the agricultural sector which may come under threat from climatological changes.

Currently, some of the laws are too outdated to offer any significant influence and require amending. This is reflected vividly in the inadequacy of fines and penalties legislation. Furthermore, there is a lack of coordination among agencies, inadequate institutional arrangements, the absence of modern day principles such as the precautionary principle and reliance upon alternative enforcement and compliance methods. More importantly, the legislative process has not kept pace by passing the required implementing legislation. In the isolated circumstances where regulations were made, they have become rigid and inflexible and their application to the issues presented by sea level rise and climate change is generally inadequate.

8.6.3 Research and Development

Climate change and increased climate variability will present a number of challenges and opportunities for the agricultural sector in Guyana. As such, farmers and natural resource managers will need to make decisions that allow the sector to adapt by increasing resilience and seeking opportunities, where possible, to move towards a low carbon sector. This will necessitate research and development (R&D) that promotes innovation in science, and tools for adaptation and policy development. Furthermore, R&D must seek to address climate change as an important component of future business and risks facing agriculture, and recognise adaptation measures undertaken in response to past climate variability by, for example, indigenous peoples. This will require a comprehensive approach to problem solving.

Guyana has taken some steps toward understanding climate variability in R&D via the NARI and the GRDB Research Station. However, there are still substantial areas for R&D, more so, on a spatial basis. It is therefore critical that there be continued investment in this area. This is important to enable farmers and natural resource managers to be resilient in the face of climatological changes. To achieve this objective would require enhanced participatory involvement of stakeholders, especially collaboration between the research-based institutions like NARI, Institution of Applied Science and Technology (IAST) and the University of Guyana (UG).

There is also the need to have downscaled scenarios at the regional level and meteorological data collected at a micro-level to allow for better modeling analyses and germplasm trials to be undertaken. Such modeling and trial plots are crucial for decision making by farmers, resource managers and the

GoG. But this is only likely to occur if research institutions, industry, farmers and other stakeholders collaborate to develop a systems approach to understanding climate change effects, drawn from diverse models of the physical climate system, agricultural systems, ecosystems, social processes and economic systems, validated with representative data. This Action Plan articulates the role R&D will play in equipping farmers and natural resource managers to face the challenges of climate change.

8.6.4 Awareness Building and Communication

Guyana's climate is changing as part of a global trend, with potentially substantial implications for agriculture. Therefore, farmers and natural resource managers need to understand these trends and implications for their businesses and implement strategies to adapt to these changes.

In responding to climate change, the GoG has a significant, ongoing role in supporting the efficient allocation of resources, managing distribution of costs and benefits proportionally amongst those potentially affected and facilitating efficient decision-making by providing information, institutional support and policy advice.

In a setting where the cumulative impact of past changes and future climate trends may expose farming systems to conditions not experienced before, the scale and significance of climate risk and appropriate response strategies may vary significantly across industries and individuals. Industries and individuals are therefore best placed to make relevant investment decisions, enterprise choice and similar business decisions within the context in which they operate. To be able to meet these challenges effectively, farmers and other decision-makers need to be kept informed of on-going developments, including opportunities for innovation and investment. This Action Plan aims to enhance communication to climate change implications for the agricultural sector by:

- Fostering an increased understanding and integration of scientific knowledge into farm management decisions
- Incorporate issues of climate change into education and training packages directed at agricultural industries.

8.7 Recommended Actions

FOCUS AREA AND STRATEGY	ACTIONS		TIMEFRAME	FUNDING		COLLABORATING AGENCIES
				Amount (US$)	Possible Source(s)	
1a. Capacity Enhancement (Technical)						
1.1 Integrate climate management considerations into programmes for developing farm management systems.	1.1.1	Engage the main stakeholders on the implications of climate change, encouraging them to pursue best farm management practices, inclusive of water use efficiency, plant breeding, agrochemicals and fertilizer application, and integrated pest management (IPM).	Long term	T.B.D.	FAO/UNDP/GEF	MoA, NARI, WUAs, Farmers Associations
	1.1.2	Conduct hazard and vulnerability mapping nationally to identify and prioritize agricultural regions/areas that are most vulnerable to the impacts of climate change, and integrate these considerations into planning and investment programmes for the sector.	Immediate	1,000,000	WB/IDB/GEF	MoA & GLSC
	1.1.3	Explore the genetic diversity within crop types that may be better adapted to climatic changes.	Immediate and Ongoing	T.B.D	FAO/UNDP/IDB	NARI, GSA, UG & GRDB
	1.1.4	Develop dynamic farm/agricultural management tools that integrate climate change risks into existing and emerging management systems to facilitate adaptation.	Short to Medium-term	200,000	FAO/UNDP/IDB	NARI, GSA, UG & GRDB
	1.1.5	Identify and build on successful strategies and indigenous knowledge of adaptation by the agricultural sector to climate change already being implemented.	Immediate and Ongoing	100,000	FAO/CCCCC	MoA, NARI, NDIA & GWI
	1.1.6	Develop, where possible, environmental management systems for agriculture.	Short-term	30,000	UNEP/UNDP/GEF	MoA &EPA
	1.1.7	Conduct assessment on ground water availability.	Medium term	T.B.D	WB/IDB	MoA, GWI & NDIA
	1.1.8	Provide economic incentives to reduce wasteful freshwater practices in the sector.	Short term	Minimal	N/A	MoA & MoF
	1.1.9	Conduct feasibility study of instituting crop insurance.	Immediate	100,000	IDB	MoA & PSC
1.2 Integrate the pest, weed and disease implications of climate change into strategies to minimise their impact on agricultural and natural resource systems.	1.2.1	Conduct investigations on the impacts of climate change on the most notable and important pests and diseases affecting the sector.	Short- to Medium-term	500,000	FAO/IDB	NARI, GRDB, GSA & UG
	1.2.2	Showcase best management practices through the establishment of public funded demonstration farms to research and demonstrate cutting edge technologies, in areas such as plant breeding, agrochemicals and fertilizer application, plant husbandry, and water conservation and management.	Medium-term	200,000	FAO	NARI, GRDB & MoA
1.3 To improve the capacity of models to predict climate impacts	1.3.1	Strengthen the Hydrometeorological Department (HD), inclusive of installing early warning systems and providing	Immediate and Ongoing	T.B.D	IDB/EU/WB	MoA & HD

FOCUS AREA AND STRATEGY	ACTIONS		TIMEFRAME	FUNDING		COLLABORATING AGENCIES
				Amount (US$)	Possible Source(s)	
on agriculture at scales relevant to farmers and agricultural managers.		technical expertise, to improve its weather forecasting ability so that farmers can better plan field activities.				
	1.3.2	Establish routine monitoring and data collection and storage procedure for the conservancies/reservoirs.	Immediate and Ongoing	T.B.D	IDB/EU	HD & NDIA
	1.3.3	Establish and improve calibration of hydrological model to synthesize conservancy flows.	Short-term	100,000	IDB/EU	NDIA, MMA-ADA, EDWC & RDCs
	1.3.4	Use reservoir model and simulated historic flows to determine appropriate operation rules for the conservancies/reservoirs.	Short-term	100,000	IDB/EU	NDIA, EDWC & MMA-ADA
	1.3.5	Maintain tidal gauges to monitor sea level rise and other parameters.	Ongoing	T.B.D	IDB/EU/WB	SRDD & HD
1b. Capacity Enhancement (Institutional)						
1.4 Develop the necessary capacity within the MoA, natural resource agencies and farmers' associations to respond to climate change.	1.4.1	Conduct a comprehensive review on human resource policies within the agricultural sector to include provisions for skills development through training on climate change and climate risk reduction to staff who are at the forefront of the supply chain, job recruitment and the compensation packages for key positions that remain vacant.	Immediate	200,000	UNEP/GEF/GoG	MoA, GFC, GLSC, SRDD & Farmers' Associations
	1.4.2	Prioritize endogenous capacity constraints within the agricultural sector in terms of urgent and immediate needs for adaptation.	Immediate and ongoing	20,000	UNEP/GEF/GoG	MoA
	1.4.3	Conduct regular and appropriate adaptation training exercise for local engineers, i.e., in coastal hydrology and geotechnical analysis, extension officers, farmers' associations, and natural resource managers.	Short- to Medium-Term	T.B.D	GoG/CCCCC/FAO	MoA, GFC & Farmers' Associations
	1.4.4	Develop and maintain a regular information management system on human resource capacities of the various community groups and institutions.	Short- to Long-term	T.B.D	GoG	MoA
	1.4.5	The MoA and related institutions should establish a memorandum of understanding with the University of Guyana for UG to provide technical support, in terms of its course offerings and research agenda.	Immediate	Minimal	N/A	MoA & UG
	1.4.6	Resuscitate the ICZM Committee and upgrade and implement the Action Plan	Immediate	T.B.D	EU/IDB/IDB	EPA, OP & SRDD
	1.4.7	Assist farmers to establish proper information management systems.	Immediate and ongoing	100,000	FAO/UNEP	MoA, GRDB, & Farmers' Associations
	1.4.8	Collect climate data at a variety of scales (spatial and temporal) and downscaled to better inform policy and management decisions.	Ongoing	T.B.D	CCCCC/EU	HD, UG & CCCCC

FOCUS AREA AND STRATEGY	ACTIONS	TIMEFRAME	FUNDING		COLLABORATING AGENCIES
			Amount (US$)	Possible Source(s)	
2. Infrastructure Management					
2.1 Build resilience and adaptive capacity to climate change in the agricultural sector	2.1.1 Develop a Public Investment Plan that will provide a single guide and reference to rural infrastructure investment in Guyana over the next 10 years, and building on the ASSP, AEDP and Sea Defence Rehabilitation. This will make public investment in the sector more stable and sustainable.	Immediate	100,000	EU/WB	MoF, MoA & MPW&C
	2.1.2 Survey command areas of all outlet structures and establish demand patterns, and scope for improved water use efficiency and recycling of drainage water.	Immediate and ongoing	T.B.D	IDB/EU/WB	NDIA
	2.1.3 Reconstruct and retrofit approximately forty (40) km of the most critical sea and river defences in coastal regions.	Immediate and ongoing	10,000,000 (Under EDF 9)	EU	SRDD
	2.1.4 Conduct a study to determine the feasibility of completing Phases II and III of the MMA/ADA Scheme.	Short-term	200,000	CDB/EU/WB/IDB	MoA & MMA-ADA
	2.1.5 Establish a year based routine maintenance plan for major rural physical infrastructure.	Immediate	T.B.D	GoG	MoA, MPW&C & RDCs
	2.1.6 Explore the possibility of declaring all D&I areas public goods and moving towards a full cost pricing for the services provided by these areas.	Short – to Medium-term	T.B.D	GoG	MoA & NDIA
3. Policy and Legislation					
Policy					
3.1 Ensure that climate change issues are integrated, where relevant, in policies pertinent to the agricultural sector	3.1.1 Develop a National Agriculture Strategy and mainstream adaptation mechanisms regarding climate change.	Short-term	30,000	GoG/IDB	MoA & related agencies
	3.1.2 Revise various Acts pertinent to the agricultural sector, such as the Water Commission Act and the Sea Defence Act to take into account climate change considerations.	Short-term	30,000	GoG/CCCCC/GEF	MoA & related agencies
	3.1.3 Link the national Climate Change Policy with the national Water Policy.	Short-term	Minimal	GoG	MoA & GWI
	3.1.4 Implement the National Climate Change and Adaptation Policy.	Immediate and ongoing	T.B.D	GoG/CCCCC/GEF	MoA, NCU & NCC
Legislation					
3.2 Ensure that climate change issues are integrated, where relevant, in the laws pertinent to the agricultural sector to better manage and protect the natural resources on which the sector depends.	3.2.1 Develop and implement a national land use plan	Medium-term	500,000	GoG/IDB/DFID	GLSC
	3.2.2 Reduce impacts from sea-level rise through land-use restriction in coastal areas, control of building in low-lying areas, industry transformation assistance, wetland protection, flood protection, and sand dune protection.	Medium-term	T.B.D	IDB/DFID/WWF	GLSC, MH&W & EPA
	3.2.3 Develop national disaster management legislation.	Short-term	50,000	CDB/DFID/EU	CDC & MLA
	3.2.4 Update and implement the draft Disaster Management Plan.	Immediate	20,000	GoG/UNEP/GEF	CDC
Research and Development					
4.1 Develop approaches, tools and	4.1.1 Build on existing R&D capability present in the NARI,	Long-term	T.B.D	FAO/DFID	MoA, NARI, IAST &

FOCUS AREA AND STRATEGY	ACTIONS		TIMEFRAME	FUNDING		COLLABORATING AGENCIES
				Amount (US$)	Possible Source(s)	
improved participatory engagements that enhance the research and development capabilities to adapt to climate change.		IAST and UG to improve tools to manage climate risks while at the same time drawing on indigenous knowledge and expertise in managing climate variability.				UG
	4.1.2	Undertake specific research on how carbon dioxide will affect the growth, productivity and yields of specific crops, fisheries, and livestock.	Medium- to Long-Term	T.B.D	FAO	NARI, GRDB & UG
	4.1.3	Conduct research to determine various genetic strains in the livestock industry, and crops that may be best suited to specific areas in Guyana.	Medium-Term	T.B.D	FAO/DFID/EU	NARI, GSA & NDDP
	4.1.4	Conduct research on the risk of changing disease and pest patterns.	Medium-Term	T.B.D	FAO	NARI, GRDB, & UG
	4.1.5	Conduct pilot research on growing specific high value crops in shade houses and greenhouses.	Immediate and ongoing	200,000 (FAO Funded)	FAO/IDB	NARI, GSA & UG
	4.1.6	Pursue the opportunities provided by biotechnology for introducing salt tolerant, pest resistant species.	Medium- to Long-term	T.B.D	IDB/WB/OAS	IAST, NARI, UG & GSA
	4.1.7	Introduce fiscal measures to promote the use of climate risk reduction technologies and practices in the agricultural sector.	Long-term	T.B.D	FAO/GEF/IDB	MoA & MoF
Awareness Building and Communication						
5.1 Enhance communication and awareness of climate change implications for the agricultural sector and adaptive techniques available.	5.1.1	Assess the level of understanding of climate change issues in the agricultural sector and identify barriers to communication.	Immediate and ongoing	T.B.D	GoG/CCCCC/GEF	MoA, EPA, NCU
	5.1.2	Develop a comprehensive public awareness programme, that links with the national education strategy, to educate the public and private sector particularly with regard to its role in preventing or mitigating the impacts of climate change e.g. land-clearing, erosion, emissions as a means to promoting compliance with the legislative regime for climate change.	Short-term	T.B.D	GoG/CCCCC	MoA, NCU, EPA & MoE
	5.1.3	Identify priority messages to increase climate change awareness amongst stakeholders.	Immediate and ongoing	T.B.D	GoG/GEF	MoA, NCU & NCC
	5.1.4	Train farmers to access information via the internet.	Ongoing	T.B.D	GoG/GEF/IFAD	MoA
	5.1.5	Provide framework to encourage partnerships between the scientific research and agricultural extension officers.	Ongoing	T.B.D	GoG/CCCCC	MoA, UG,GSA & IAST
	5.1.6	Enhance the capacity of extension officers to be trainers and dissemination agents.	Short-term	T.B.D	GoG/FAO/IFAD	MoA
	5.1.7	Develop a communication strategy for timely and targeted diffusion of results from the researchers to the stakeholders and to the general public is necessary to adapt to climate change.	Short-term	T.B.D	GoG/IFAD/GEF	MoA & NCU

FOCUS AREA AND STRATEGY	ACTIONS	TIMEFRAME	FUNDING		COLLABORATING AGENCIES
			Amount (US$)	Possible Source(s)	
	5.1.8 Establish mechanism for information sharing amongst the MoA and related agencies.	Short-term	T.B.D	GoG	MoA
	5.1.9 Develop an information clearinghouse facility in the HD and make basic weather, agro-meteorological and hydrological data easily available and accessible.	Short-term	T.B.D	GoG/CCCCC	HD & MoA

Legend On-going Immediate Short-term = 1 – 3 years Medium-term = 3 – 5 years Long-term = > 5 years

Acronyms

CCCCC	Caribbean Community Climate Change Centre
CDC	Civil Defence Commission
DFID	Department For International Development
EDWC	East Demerara Water Conservancy
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agricultural Organization
GEF	Global Environment Fund
GFC	Guyana Forestry Commission
GLSC	Guyana Lands and Surveys Commission
GoG	Government of Guyana
GRDB	Guyana Rice Development Board
GSA	Guyana School of Agriculture
GWI	Guyana Water Incorporated
HD	Hydrometeorological Department
IAST	Institute of Applied Science and Technology
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development
MLA	Ministry of Legal Affairs
MMA-ADA	Mahaica, Mahaicony, Abary – Agricultural Development Authority
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoF	Ministry of Finance
MPW&C	Ministry of Public Works and Communications
N/A	Not Applicable
NARI	National Agricultural Research Institute
NCC	National Climate Committee
NDIA	National Drainage and Irrigation Authority
OAS	Organization of American States
OP	Office of the President
RDC	Regional Democratic Council
SRDD	Sea and River Defence Department
TBD	To be determined
UG	University of Guyana
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WB	World Bank
WUAs	Water Users Associations
WWF	World Wildlife Fund

9. Implementation and Delivery of the Strategy

This Strategy presents a set of strategies and actions to address climate change issues across the agricultural sector in Guyana in a coordinated way. The Strategy complements a number of other initiatives being undertaken to address climate change, such as the resuscitation of the National Climate Committee (NCC), the establishment of the National Climate Unit (NCU) and the implementation of the Second National Communication (SNC) Project. Collectively, these efforts cover a substantial area of the Guyanese landscape where Guyana's natural resource capital is being managed for sustainable use and production of benefit for all Guyanese.

Implementation of the strategic direction and actions to manage climate change across the Guyanese agricultural sector are the responsibility of the Government of Guyana, farmers and their associations, and the private sector.

The Strategy provides a framework to coordinate activities to manage the impacts of climate change within the institutional, legislative and budgetary frameworks that exist in the country. The Ministry of Agriculture is expected to oversee the implementation of this Strategy. The strategy is envisaged as embracing a ten (10) year time frame. Furthermore, the MoA in collaboration with national stakeholders will develop a detailed implementation plan including timelines for implementation of the different components and a budget for implementation. In further developing its implementation plan the focus will need to be on the following steps:

Actions	Date
Review existing activities against the Strategy	April 2009
Commend the Strategy to Cabinet as an action to address climate change issues in the agricultural sector	June 2009
Identify any gaps in coordination required to achieve the Strategy and determine resource implications for addressing those gaps	October 2009
Recommend to the Ministry of Agriculture the specific actions to address identified gaps	November 2009
Review effectiveness of the Strategy in generating specific actions that are addressing the challenges to climate change.	April 2011

Genuine partnership will be an essential part of identifying measures to adapt to climate change. Strategic collaboration between the farmers and the Government is the best way to uncover where the most significant obstacles to adaptation lie and what type of interventions are needed to remove these obstacles. But the foremost payoff of partnership is that reforms become actualized, adaptation becomes real, and public, private and other stakeholders become mutually engaged in the implementation of activities that strengthen the resilience of the sector.

9.1 Roles of Stakeholders in the Agricultural Sector

The agricultural sector of Guyana accounts for the largest component of GDP, employment, and export earnings of all the natural resources in the country. It underpins the economy at all levels, is a source of livelihood, and supports a number of other life forms. Every Guyanese is a stakeholder in guarding against the agricultural sector being ravaged by impacts associated with climate change either

because they depend on the sector in a variety of ways, it shapes or affects their lives in some way or the other, or their livelihood is impacted upon by the sector. This is true irrespective of whether that person is a farmer, fisherman, or other member of society. The involvement of each individual, corporation, government organisation, or group in taking action and responsibility would therefore contribute in significant ways towards maintaining, safeguarding and adapting to the vagaries of climate change. By extension of this responsibility, each stakeholder will have a role to play in supporting the implementation of this Strategy, and his/her own contribution towards the achievement of the objectives of national policy relating to climate change adaptation measures.

9.1.1 Public Agencies

Public agencies have a responsibility to promote and facilitate the development of policies, programmes and plans relating to the sustainable development of the sector and to build resilience therein. These agencies are expected to take legislative and administrative steps to ensure that a technologically advanced, diversified and competitive agricultural sector is achieved by 2018, and to facilitate the creation of an enabling environment for other partners to play their part. Public institutions also play an important role in the area of monitoring and enforcement, and the maintenance of public infrastructure.

9.1.2 The Private Sector

The private sector has been singled out for mention in the UNFCCC which calls for the encouraging of partnerships between governments and the private sector. Since the sector, apart from sugar, is dominated by private interests, no strategy can adequately plan for adaptation without including this main player. In meetings held with private farmers and their associations in the compilation of this Strategy, there were clear signs of interest from these individuals in the Strategy that would allow them to participate and to benefit from its implementation. These include financing, institutional and human resources capacity building, research, information and monitoring, and incentive measures.

9.1.3 Regional Bodies

As part of the integration objectives of the Strategy, Regional Bodies will be responsible for integrating climate change issues into their regional plans. These authorities can play a very important role in the effort to bring about higher awareness, adaptation and mitigation efforts, and responsible use at the fundamental levels of the sector.

9.1.4 The General Public

Arising from the participatory principle, each citizen would have a role and responsibility to contribute to decisions taken to increase the sector's adaptive capacity. The public is the largest stakeholder group and has a powerful voice which can be very effective in achieving the goal of a sustainable and flexible agricultural sector.

10 Financing the Implementation of the Strategy

Many of the actions recommended by this Strategy do not represent an additional burden on existing budgets as many of the activities can be mainstreamed, even though there will be need for some additional funding, particularly for infrastructure management and research and development.

The Strategy presupposes/expects that much of the capacity building programmes can be accommodated within existing efforts by the Ministry to enhance its capacity as well as via a number of donor-funded projects. It is also the expectation that risk reduction initiatives and risk management more generally in the agricultural sector will be treated as a development priority within the budgeting process and that the MoA will seek to impart upon farmers and other stakeholders the need to incorporate risk reduction measures in designing their projects.

The government has also taken the initiative to diversify the agricultural based and is receiving funding in excess of US$15 million for this effort. Similarly, under the ASSP, it is receiving over US$21 million to assist with the rehabilitation of drainage and irrigation schemes in nine (9) agriculturally based areas. At the same time, the country continues to receive support from the European Union to rehabilitate its sea and river defences to the tune of Euro 100 million. All of these efforts are aimed at making the agricultural sector more resilient to climate change impacts and will serve this Strategy well.

At the regional level, various initiatives, inclusive of a technical assistance project to pursue protective agriculture, another US$3 million project to aid in technology transfer, and assistance from the Chinese government on adaptive greenhouse technologies are all expected to complement the Strategy. Also, the World Bank is assisting the region in risk management and mitigation and efforts are being pursued on the possible establishment of crop insurance. Lastly, whatever funds or assistance become available for the Jagdeo Initiative, may also be able to benefit the Guyanese agricultural sector directly. Clearly, all of these initiatives are important to actualizing the actions proposed in the Strategy. However, sustainability of these initiatives and the benefits that can accrue will necessitate a better rates collection system and one that is economically efficient.

The implementation of the strategy will require that financial resources be made available to support the actions and the responsibilities of implementing organizations. The estimated cost of implementation over ten years is still needs to be tabulated. It can be financed from assorted sources including:

- **Innovative Financing Mechanisms** – This will include e.g. REDD, CDM,
- **Existing funds** – This will include regional and international (Multilateral and bilateral and philanthropic) funds such as the Special Climate Change Fund, the Adaptation Fund, the GEF resources and others.
- **Private and public sector financing** (marketing best practices)

Annex S1: Register of Participants

National Adaptation Strategy for the Agricultural Sector to Respond to Climate Change

Stakeholders Workshop – October 7, 2008

Guyana Forestry Commission Boardroom

No.	Name	Organization
1	Peggy Mc Lennan	Ministry of Foreign Affairs
2	H.Dewnath	NCC
3	Jagnarine Singh	GRDB
4	P. Pitamba	MOA
5	Brian Sears	Ministry of Agriculture
6	Pradeepa Bholanath	Guyana Forestry Commission
7	Samuel La Fleur	East Demerara Conservancy
8	Kester Craig	Civil Defence Commission
9	Shyam Nokta	OP
10	Pratima Doodnauth	
11	Jagdesh Singh	Guyana Forestry Commission
12	Annalise Bayney	Iwokrama
13	Mr. Andrew Bishop	Guyana Lands and Surveys Commission
14	Oudho Homenauth	National Agriculture Research Institute
15	S.Razack	Environmental Protection Agency
16	Dominique Saheed	Environmental Protection Agency
17	Elizabeth Ramlall	Ministry of Agriculture
18	Fredrick Flatts	Ministry of Agriculture
19	Denise Simmons	SEES,UG
20	N. Hasan	New-Guyana Marketing Corp.
21	Lennox Wilson	Ministry of Agriculture
22	Eustace Alexander	Conservational International, Guyana
23	Gavin Agard	Guyana Forestry Commission
24	Quacy Bremner	Guyana Forestry Commission
25	Paulette Bynoe	SEES,UG
26	Anton Dey	Guyana Sugar Corp.
27	Harold Davis	Guyana Sugar Corp.
28	Ashley Adams	Guyana Sugar Corp.
29	Bhaleka Seelall	Hydromet
30	Lionel Wordsworth	National Drainage & Irrigation Authority
31	Zainool Rahaman	Hydromet
32	Theodosius Velloza	UG
33	Bernard Carter	Consultant

Annex S2: Register of Participants

National Adaptation Strategy for the Agricultural Sector to Respond to Climate Change

Stakeholders Workshop – December 4, 2008

Regency Suites/Hotel

No.	Name	Organization
1.	Rishi Persaud	Institute of Applied Science and Technology (I.A.S.T)
2.	Ashley Adams	Guyana Sugar Corporation (GuySuCo)
3.	Samuel La Fleur	East Demerara Water Conservancy-MoA
4.	Walter Persaud	Guyana Sugar Corporation (GuySuCo)
5.	Theodosius Velloza	University of Guyana (UG)
6.	Dr. Mark Bynoe	Development Policy and Management Consultants (DPMC)
7.	Andrea Mahammad	Guyana Lands and Surveys Commission (GL&SC)
8.	Bernard Carter	Consultant (Independent)
9.	Dr. Dindyal Permaul	Ministry of Agriculture
10.	Narine Singh	Guyana Rice Development Board (GRDB)
11.	Gitanjali Chandrapaul	National Climate Unit (NCU)
12.	Joseph McGann	CCCCC / MACC
13.	Annie Pitamber	Ministry of Agriculture / NCU
14.	Viviane Baharally	Guyana Rice Development Board (GRDB)
15.	Antonio Peters	Hydromet Department – MoA
16.	Thaeshwari Pooran	Hydromet Department – MoA
17.	Ramnarine Singh	Ministry of Local Government
18.	Latoya Jones	Guyana Red Cross
19.	Dominique Saheed	Environmental Protection Agency (EPA)
20.	Cleavon Cameron	Environmental Protection Agency (EPA)
21.	Bruno Lopes	Delegation of the European Commission
22.	David Fredricks	National Agriculture Research Institute
23.	Maxim Ali	Ministry of Agriculture – Project Cycle Unit
24.	Dr. Dane Hartley	Ministry of Agriculture
25.	James Singh	Guyana Forestry Commission
26.	Andrea Thom	Guyana National Bureau of Standards
27.	Bissessar Persaud	Guyana Rice Development Board (GRDB)
28.	Ravendra Singh	Guyana Rice Development Board (GRDB)
29.	Zainool Rahaman	Hydromet Department – MoA
30.	Brian Sears	Ministry of Agriculture
31.	Jason Fields	Ministry of Foreign Affairs
32.	Giampiero Muci	Delegation of the European Commission
33.	Lucina Singh	Pesticides and Toxic Chemical Control Board
34.	Brian Dey	Ministry of Agriculture
35.	Eva Bachtsetzi	Ministry of Agriculture
36.	S.Jacobs	Guyana Public Service Union
37.	Mahendra Sharma	Guyana Energy Agency

No.	Name	Organization
38.	Vishnu Panday	Guyana Sugar Corporation (GuySuCo)
39.	Jacqueline Nero	Ministry of Agriculture – Statistical Unit
40.	Janice Bollers	World Wildlife Fund
41.	Narda Mohamed	Guyana Agricultural and General Workers Union
42.	Marlon Daniels	Guyana Water Inc.
43.	Chandrawattie Persaud	Guyana Public Service Union
44.	Lynette Cunha	Guyana School of Agriculture
45.	Krishna Sewlall	Ministry of Agriculture
46.	Justin Hecton	United States Agency for International Development (USAID)
47.	Read Porter	Environmental Law Institute
48.	Dharamkumar Seeraj	Rice Producers Association
49.	Dr. Ashok Sookdeo	Ministry of Health
50.	Richard Blair	Inter-American Institute for Co-operation on Agriculture (IICA)
51.	George Jervis	Guyana Rice Development Board (GRDB)
52.	Agnes Dalrymple	Ministry of Public Works & Communication
53.	Dr. Dwight Waldron	National Dairy Development Programme (NDDP)
54.	Nizam Hassan	New-Guyana Marketing Cooperation
55.	Ignatius Jean	Inter-American Institute for Co-operation on Agriculture (IICA)
56.	Marciano Glasgow	Development Policy and Management Consultants (DPMC)
57.	Dianna Da Silva	Development Policy and Management Consultants (DPMC)