TECHNICAL NEEDS ASSESSMENT OF THE AGRICULTURE SECTOR IN BELIZE

SECOND NATIONAL COMMUNICATION TO THE UNFCCC

CLIMATE CHANGE PROJECT

Submitted to
The Ministry of Natural Resources and the Environment

Prepared by Anselmo Castañeda

June, 2007

TABLE OF CONTENTS

Executive Summary

As a follow-up activity to the preparation of the GHG Inventory for the Agriculture Sector earlier this year, the Technical Needs Assessment exercise was commissioned in order to identify possible practical technologies that would contribute to the mitigation of the emissions within the sector.

The agriculture sector has six sub-sectors that are sources of emissions as identified by the IPCC and the UNFCCC. These sectors are: enteric fermentation that produces methane; manure management that produces methane; flooded rice cultivation that produces methane; agricultural soils with organic or mineral fertilizer applications that produce N_2O (nitrous oxide); prescribed burning of savannahs that produce methane, nitrous oxides, carbon monoxide, NOx's etc. and agricultural residue burning that produce the four gases mentioned above. The recently completed GHG inventory shows that enteric fermentation, savannah burning, and field burning of agricultural residues were the main contributors to methane and CO during the reporting period. Savannah burning and field burning of agricultural residues were the main contributors to NO_x while manure management and agricultural soils management were the main contributors to N_2O.

Based on the procedures outlined in the NCSP handbook " Conducting Technology Needs Assessment for Climate Change Handbook ", this study was conducted using existing literature on the topics in the sector and also by interviewing technical stakeholders directly involved (working) in the six different sub-sectors. National documents were referenced in order to document the required policy, legislative and institutional frameworks of the agriculture sector.

Eight technologies were identified that would mitigate the GHG emissions of the agriculture sector. They are: a) delivery of un-burnt sugarcane production to the factory; b) ample use of minimum or no-till land preparation for grain crops; c) introduce the use of windbreaks or use silvo-pastoral systems in livestock production; d) biogas digesters for farm use; e) aeration (dry out period) done 1-2 times during rice crop cycle; f) application of methodology and maintenance of databases to monitor acreage and location of fires; g) methodology to assess carbon stock/acre of savannah lands and in the soils and h) national public awareness programme to reduce savannah burning. These were prioritized and ranked using the three major criteria groups of development benefits, market potential and contribution to climate change; each of these three major groups had sub-categories of criteria. The ranking for applicability of the technologies was low potential (1), medium (2) and high (3). Wind-breaks and use of sylvo-pastoral systems and national public awareness program to reduce savannah burning rated the highest with 42 points out of a possible total of 48.

In view of the fact that Belize does not have a technology transfer policy, it becomes necessary that the Second National Communication Project begins the process to develop it since the impacts of climate change will be limiting Belize's sustainable development in the near to long term future.

1. BACKGROUND

Belize signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The purpose of the UNFCCC is to reduce anthropogenic sources of green house gases (GHG) that contribute to global warming and its consequential climatic changes. As part of its obligations under the convention, contracting parties are required to conduct periodic GHG Inventories for submission to the Secretariat. The first GHG Inventory was conducted in 1998 using 1994 as the reference year, while the Second Inventory utilizes 1997 and 2000 as the reference years.

The GHGI estimated emissions in a number of sectors, including the agriculture sector. The GHG inventory in the agriculture sector estimated emissions derived from:

- enteric fermentation that produces methane
- manure management that produces methane
- flooded rice cultivation that produces methane
- agricultural soils with organic or mineral fertilizer applications that produce N_2O (nitrous oxide)
- prescribed burning of savannahs that produce methane, nitrous oxides, carbon monoxide, NOx's etc
- agricultural residue burning that produce the four gases mentioned above.

Of the six sources mentioned above, the Ministry of Agriculture manages data of five except savannah burning.

As part of the reporting process in the Second National Communications, country parties are required to determine and report on their technology requirements for the improved and continued implementation of the Convention. An additional assignment of Technology Needs Assessment was given to the consultants conducting the Greenhouse Gases Inventory in order to capitalize on the lessons learnt and experiences gained during the earlier exercise. This TNA report

describes Belize's technical needs in the agriculture sector for the mitigation of green house gas emissions.

2. INTRODUCTION

While Belize has ratified the UNFCCC in 1992 and the Kyoto Protocol in 2006, the country's main constraint to respond to climate change vulnerabilities is the inadequacy of the resources available for adaptation and mitigation measures. This technical needs assessment exercise aims at identifying some technologies applicable in the agriculture sector to that would complement other mitigation measures for reduction of the GHG emissions by the sector.

The Second National Inventory of greenhouse gases showed that emissions from the agriculture sector continued to be released from the same sources as those for the first inventory. In 1994 the total GHG emission amounted to 54.8876 Gg. This has increased to **66.9793** and **100.44** Gg in the years 1997 and 2000 respectively. The inventory results show that agricultural soils and prescribed savannah burning were the two main sources of GHGs in the agriculture sector in Belize. The other four sub-sectors produced minimum quantities of GHGs. Table 1.1 gives the quantities of GHG emission for each sub-sector for the years, 1994, 1997, and 2000.

The agriculture sector is a net emitter of GHGs and accounts for ---% of the total. As the acreage of mechanized wetland rice cultivation increases, this sub-sector will increase its share of methane emissions. Most of this expansion is expected in the Orange Walk District in northern Belize. Methane from enteric fermentation has been somewhat stable, but the national herd of cattle and swine are not expected to increase drastically in the near future.

Table 1. ***Sources and quantities of GHGs from Agriculture Sector for the years 1994, 1997 and 2000.***

Emission Source	1994 Submitted (Gg)	1994 Revised (Gg)	1997 (Gg)	2000 (Gg)
Enteric Fermentation (CH_4)	2.837	2.84013	1.962647	2.73852
Manure Management (CH_4)	0.244	0.24464	0.20828	0.24882
Flooded Rice Cultivation (CH_4)	0.03285	0.00008	0.2838	0.2966
Agricultural Soils (N_2O)	0.491	4.31043	12.0145	37.51866
Prescribed Savanna Burning	CH_4- 1.626 N_2O- 0.015 N0x- 0.532 CO- 42.695	CH_4- 1.62646 N_2O- 0.02013 N0x- 0.72746 CO- 42.69464	CH_4- 1.68288 N_2O- 0.02083 N0x- 0.75270 CO- 44.17568	CH_4- 1.59280 N_2O- 0.01971 N0x- 0.71241 CO- 41.81092
Agricultural Residue Burning	CH_4- 0.445 N_2O- 0.015 N0x- 0.531 CO- 9.344	CH_4- 0.0373 N_2O- 0.00113 N0x- 0.04092 CO- 0.7833	CH_4- 0.04965 N_2O- 0.0149 N0x- 0.05384 CO- 1.04273	CH_4- 0.052 N_2O- 0.00158 N0x- 0.05725 CO- 1.09209
Net Total per Year	**58.807**	**54.8876**	**66.9793**	**100.4400**
Total w/GWP per Year	**346.83**	**2046.2417**	**5514.0847**	**16980.0184**

N.B: These figures are extracted from the summary sheets of the UNFCCC Modules.
GWP: CO_2 = 1; CH_4 =24.5 and Nitrous oxide = 320.

For the year 2005 the agriculture sector's contribution to GDP was 8.9%. The contribution to GDP by crops and horticulture was 6.4%, livestock farming was 1.9 and forestry/logging was 0.6%; there was no specific data on wetland rice production towards GDP. Total GDP for 2005 was BZ $2,221.8 million (www.cso.gov.bz).

3. REVIEW OF POLICY, LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

Policy

Belize does not have legislation specific for technology transfer. However technology transfer is one of the tools that small developing countries can use to become competitive in a global environment. This is especially true of appropriate technologies from countries of similar geographic and socio-economic standings. Use of technologies is integrated into various policies including:

Agriculture Policy

The agricultural development of Belize is guided by the Agricultural Policy developed by the Ministry of Agriculture and Fisheries for the period 2002 to 2020.

The vision statement as defined for the sector is that of "A FULLY TRANSFORMED/ MODERN SECTOR THAT IS FULLY COMPETITIVE, DIVERSIFIED AND SUSTAINABLE". Therefore, the policies (Agriculture, Fisheries & Cooperatives) will be guided by the major challenges/constraints (labour productivity, inadequate/inappropriate credit, opportunity for improving food security, inadequate infrastructure, maintaining plant/animal health status, increase agro-processing and linkage to the tourist industry, greater diversification) facing the sector. Cross-cutting policies will focus on research & development, human resource development, agro-processing, sustainable resource management, watershed management, extension, credit, trade/price, diversification and rural development designed to address factors that cross all three sub-sectors.

Belize's development strategy aims at achieving sustainable development, ensuring that all segments of the population benefit as the country implements sound and comprehensive socio-economic strategies to achieve broad-based

economic growth. Poverty reduction forms the centrepiece of the Government's economic development strategy, which is seeking to bring vulnerable groups into the mainstream of economic activity.

In this context, the policy agenda of the Government includes five main elements and objectives:

- Enhancing and sustaining economic growth
- Improving access to quality social services:
- Modernising the State and improving governance
- Ensuring safety and security in Belize
- Implementing policies and measures for environmentally sustainable development: through improving natural resources management (land, water and forestry), expansion of sustainable tourism and improving natural disaster prevention and management.

This last element of the development strategy encompasses the agricultural sector's relationship to issues of climate change though not explicit to issues of mitigation measures.

Food and Nutrition Policy

The "FOOD AND NUTRITION SECURITY POLICY FOR BELIZE was developed in 2001 and its vision statement is: "*to guarantee that all individuals, families and the general population have access in terms of quality and quantity to the food that they need for adequate intake and biological utilization to ensure a healthy and socially productive life"*

This Food and Nutrition Policy has the following six programs: facilitation of education of the public; the increase in food production; food safety; the generation of income; school feeding; nutrition of the elderly and nutrition of other indigent groups. Most importantly, the policy outlines a strategy for coordination of actions. The issue of food and nutrition security is complex and care must be

taken to ensure proper management and coordination in order to achieve success.

National Poverty Elimination Strategy (2007-2011)

The Second National Poverty Elimination Strategy and Action Plan of Belize are based on the proposed achievements that are structured around the following five mutually sustaining policy pillars. These pillars are:

1. Economic Policies for Sustained Growth and Poverty Reduction;
2. Good Governance for Sustainable Development;
3. Investment in Human Capital and Services;
4. Infrastructure to Support Poverty Reduction; and
5. Strategic and Comprehensive Interventions in Special Attention Areas.

The interaction between these policy pillars is the key to NPEAP implementation and to the effectiveness of the package of measures proposed for reducing poverty. Furthermore, the pillars incorporate both the objectives of the national Millennium Development Goals (MDGs). While these policy pillars do not directly or explicitly contain climate change as a major national issue that may have serious consequences on Belize's sustainable development, the Action Plan for this planning period addresses environmental issues.

National Environmental Policy and Strategy

In 2006 the Department of the Environment of the Ministry of Natural Resources and the Environment prepared its update of Belize National Environmental Policy and Strategy. While the document has not been endorsed or approved by Cabinet, it outlines policy statements on Belize's environmental management. Specifically, the document recognizes the serious implications of climate change to every-day living or the impact on the livelihoods of people considered as poor.

Under the six guiding principles following in the preparation of this document, four of them have direct relevance to climate change, namely:

Principle 1- Acknowledging the need for a change in environmental culture and attitude.

Principle 3- Localizing environmental management.

Principle 5- Environmental economic tools and technology and

Principle 6- Promoting regional and global environmental cooperation with special attention to the needs of Belize.

Finally the revised Environmental Vision for the people of Belize is “Mindful of the importance of our environment to the well being of present and future generations, recognizing that the sustainable use of our environment is the only way to secure its availability to future generations, and being conscious that the prudent use and proper management of the environment shall constitute an integral part of the development process and can not be considered in isolation of it, we accept our responsibility as citizens of Belize and the world to protect and conserve our environment, to be stewards of our patrimony and engage in the sustainable use of the natural and built environment”.

Legislative Framework

GOB recognizes its environmental responsibilities both nationally and internationally and has enacted major legislation to address current and emerging challenges. A signatory to the UNFCCC and Kyoto Protocol, national legislation for land administration and for environmental conservation and protection is farsighted and robust: Provisions include the National Lands Act (1992), the Environmental Protection Act (1992), the Housing and Town Planning Act (1990), the Forest Act (1990) the Wild Life Protection Act (1990), the National Parks Systems Act (1990). As a result of active management and a sound legislative framework, 44% of land in Belize is subject to various forms of biodiversity protection including large expanses of coastline and unique barrier reef safeguarded under the Marine Protected Areas legislation and the establishment of magnificent marine parks. GOB has entered into a significant number of innovative co-management agreements with environmental NGOs and communities that increase participation in the regulation and decision-making about local natural resource use.

The Environmental Protection Act (chapter 328 of revised edition 2000)

The Belize Environmental Protection Act relates to the preservation, protection and improvement of the environment, the rational use of our natural resources, and the control of pollution.

Environmental Impact Assessment Regulations

This regulation was enacted in 1995. Its regulations govern the type and size of development that requires an EIA. This TNA project is subject to this regulation and requires the preparation of an EIA.

The Forest Fires Act

This Act allows for the preparation and implementation of a fire protection plan that may be necessary for the prevention of forest fires or bush fires or the extinguishing of such fires.

The Agriculture Fires Act

This Act applies to the setting of fire to any crop, vegetable or trash growing `or being in or upon land. Any person desirous of setting fire on land must make a written application to the Chief Agriculture Officer or any officer authorized by the Chief Agriculture Officer.

Institutional Framework

Department of the Environment

The Department of the Environment (DOE) was legally established by the enactment of the Environmental Protection Act, 1992 (EPA). It is a Department within the Ministry of Natural Resources and the Environment (MNRE). The DOE has a wide function in matters pertaining to environmental protection and the control of pollution. It is responsible for monitoring all activities that impact on the environment and health. The Environmental Protection Act mandates that the DOE require from industry the preparation of Environmental Impact Assessments and risk analyses, and to make suitable recommendations to mitigate the harmful effects of any proposed action on the environment. Its duties include: monitoring environmental health; advising the Government on the formulation of policies relating to the good management of natural resources and the environment; conducting studies and making recommendations on standards relating to the improvement of the environment and maintenance of a sound ecological system; through Inter-ministered Cooperation, and to foster the prudent use and proper management of the natural resources of Belize.

Several Statutory Instruments have been passed under the EPA. One such instrument is the Effluent Limitations Regulations, 1995, which, among other things, requires that Industry maintain a registry of pollutants and that industry meet certain standards for effluent discharges.

While the DOE laws and regulations do not specifically mention the management of green house gases, the Act provides for the enactment of regulations to control, prevent, and minimize the emission of GHGs.

Agriculture Department

The Agriculture Department of the Ministry of Agriculture, Fisheries and Cooperatives has as its main function that of a regulatory agency and offers technical assistance or extension service to farmers. It assists in marketing services and leads the crops and livestock diversification efforts in the country. At the Ministry level, there is a Policy Unit that prepares strategy and policy documents while at the same is responsible for the collection, analysis and storage of agricultural production statistics.

Commodity Producer Associations

There are various commodity associations that function in the country. These the Belize Livestock Producers' Association, the Grain Growers' Association, the Citrus Growers' Association, the Sugar Cane Farmers' Association, the Poultry Association, the Toledo Cacao Growers' Association, etc. These associations serve their membership with marketing and price negotiations, offer technical and inputs assistance and also keep industry production statistics.

The Private Sector

The private sector companies that participated with data for the preparation of the Second National GHG Inventory were the Belize Sugar Industries, the two Fertilizer Companies and the two producers of ground limestone/dolomite for agriculture use. These companies, while taking some more time to deliver requested data in the format required, were very cooperative by enabling access to relevant data and information during the greenhouse gas inventory preparation process.

4. ANALYSIS OF SUB-SECTORS FOR TECHNICAL NEEDS ASSESSMENT AND AVAILABLE NATIONAL TECHNOLOGIES

In the agriculture sector there are six identified sources of GHGs, namely:

- enteric fermentation that produced methane
- manure management that produced methane
- flooded rice cultivation that produced methane
- agricultural soils with organic or mineral fertilizer applications that produced N_2O (nitrous oxide)
- prescribed burning of savannahs that produced methane, nitrous oxides, carbon monoxide, NOx's etc. and
- agricultural residue burning that also emitted the four gases mentioned above.

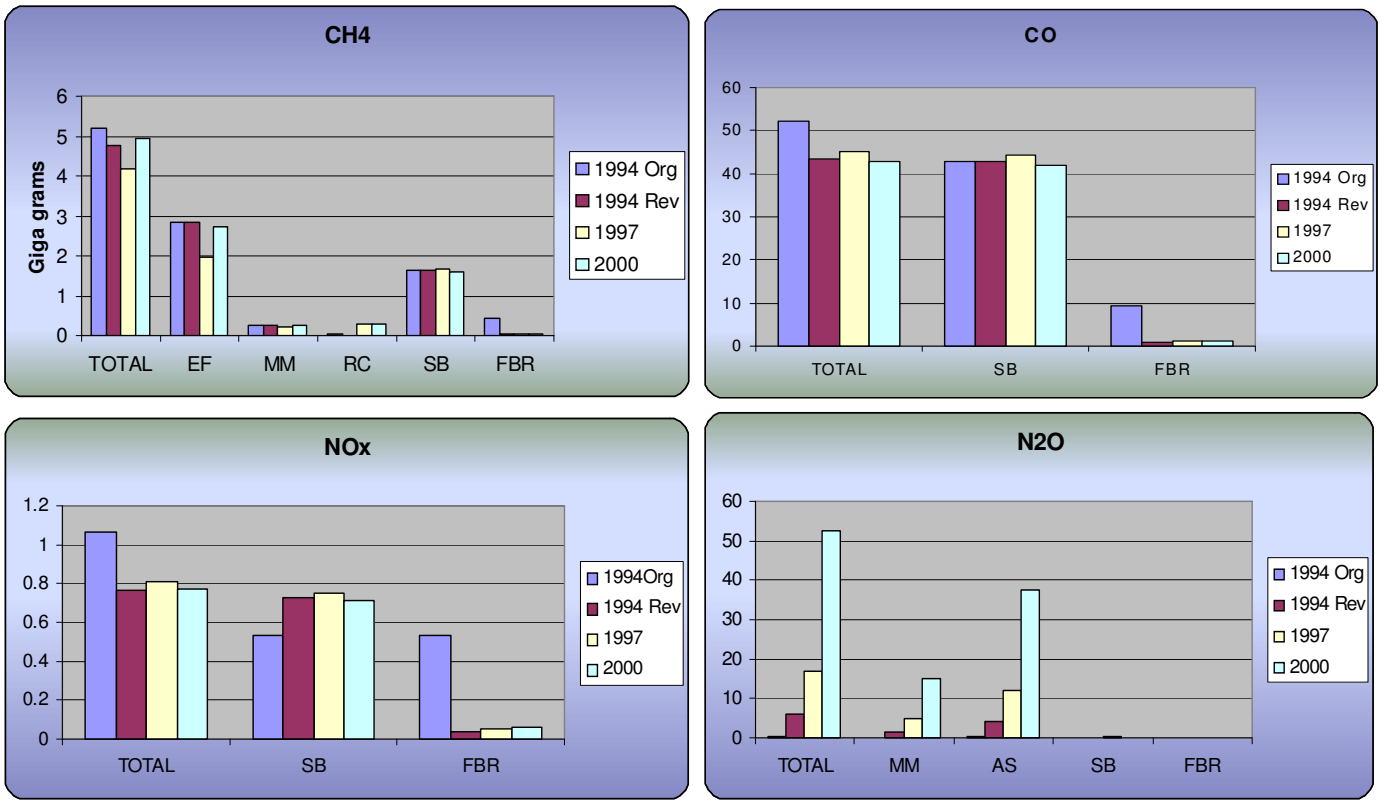

Figure 1 Emissions by Gas Type and by Source for the period 1994 to 2000

The graphs above present the levels of emissions which these sources contributed to the four GHGs in Belize for the 1994, 1997 and 2000 reporting years. Enteric fermentation, savannah burning, field burning of agricultural residues were the main contributors to methane and CO. Savannah burning and field burning of agricultural residues were the main contributors to NO_x while manure management and agricultural soils management were the main contributors to N_2O.

Sugarcane production is the largest acreage which is treated by field burning of agricultural residues. During the last ten years sugar production has averaged approximately 110,000 tons ranging from a low of 100,435 tons in 2005 to a high of 123,782 tons in 1997 (Policy Unit, Ministry of Agriculture). An increase in sugar production is not expected. The only mitigation measure to reduce the emissions is to adopt a management decision that farmers should deliver most of their production to the factory as un-burnt cane. All other grain crops are not burned but are left in the filed and plowed under at every crop cycle. The widespread use on no-tillage or minimum tillage for grain crops can contribute to reduction of emissions. Therefore technology needs are expected to be medium to high.

Very recently the Belize Sugar Industries procured a green sugarcane harvester valued at Bz. $600,000 with a capacity to harvest 40,000 tons per crop. Therefore, an estimated 16-20 such harvesters would be required industry-wide but the farmers need to be organized also into harvesting groups. With 70% of the sugarcane acreage in different levels of mechanization, the wide use of this equipment would be achieved in the next 10 years or so when the land will be well mechanized and the farmers organized. In the short term, the manual harvesting of cane is limited because of the shortage of labour; it requires two times the amount of workers.

As per enteric fermentation and manure management, the national herd in Belize has been stable with ups and downs depending on the local market demands.

Beef cattle are raised in open range and their manure is spread by the animals in the pastures. Dairy cattle and swine are somewhat confined and their manure can be collected and used for methane production using biogas digesters on the farms. Poultry manure can not be used in the digesters because of the high fiber content of the bedding material that is combined with the manure. It must be noted that in the early 1990s, there was a biogas project funded by a German Aid Project. During this project approximately 50 digesters (for swine farmers only), ranging from 5 to 50 cubic meters capacity, were built all over the country using local materials. Refrigerators, stoves and lamps were imported, modified for methane use and were later sold to the farmers at subsidized prices. Unfortunately when the project finished there was no long term follow-up plan by the Ministry of Agriculture to make this technology sustainable over the long term. Currently there are new types of digesters, available in Central America which cost 20 % (Pers. Comm. with Melanio Pech, Central Farm) of those that were built with cement, steel and iron. With the current prices of fossil fuels, this technology can be re-introduced by the two trained technicians who have expressed their interest in continuation of this technology. Leadership and guidance at the Ministry level would be necessary for the re-introduction but needs to be set as a priority in the Ministry's work plans.

The advantages of low-cost plastic bio-digesters to low-income rural communities include:

- a reduction of the physical workload, especially of women;
- a reduction of the pressure on natural resources such as fuel wood and charcoal;
- cheap energy production, resulting in cash savings;
- improving the farming system by recycling manure through bio-digesters to produce gas for cooking and effluent for fertilizer (once the manure has passed through a bio-digester it becomes an excellent organic fertilizer;
- use of waste which would otherwise cause pollution, especially in urban areas.

As per the management of agricultural soils with organic or mineral fertilizer applications that produce N_2O, so far only cacao in Toledo is produced organically and successfully enough to satisfy the export market to the United Kingdom. Since 2001 the citrus industry has began to ferment the pulp, but the process of using open trenches does not permit the pulp to decompose adequately due to the high acid and water content. Farmers are using this "compost". It has been difficult to get production volume and cost statistics since the Citrus Growers' Association is not in control of this process. The private company does not want to release the relevant data or even discuss the technology needs to make the process fully functional.

All the other export crops (sugar cane, citrus, banana, papayas, etc) and grain crops depend on mineral fertilizers which are 100% imported. In addition those crops that are grown in the acid soils in southern Belize require ground white marl and or dolomite that are produced locally. Again the acreage of these export crops are not expected to increase since the quota system of the preferential markets in the EU and USA does not allow for expansion but are rather promoting diversification to other activities or other crops. Technology needs to reduce emissions from the source is also limited.

The farming community in Belize generally does not use windbreaks or use silvo-pastoral systems in livestock production. These two technologies would enhance the sinks for GHGs and also have added benefits of fodder, firewood and timber production.

As per the cultivation of wetland or flooded rice that produces methane, the main producing area is in the Blue Creek Mennonite Community in the Orange Walk District and Big Falls, Belize District. Current area under production is approximately 1,500 hectares and is not expected to increase since the current cost of production, mainly due to petroleum and taxes, does not permit them to export to CARICOM or Central America. The yields have increased by

approximately 40% over the last five years to an average of 7,500lbs/acre (8,400 kg/hectare) due mainly to soil management (red earthworms, natural soil inhabitants and the prevention of compaction by reduced tillage) and the use of natural foliar fertilizers. The flooded fields are aerated one to two times for fungus control; each time the dry out period lasts for a week. Some conventional mineral fertilizer (urea and phosphates) is still used in this production system.

The “prescribed” burning of savannahs that produce methane, nitrous oxides, carbon monoxide, and NO_x's is addressed by the Forest Department of the Ministry of Natural Resources and the Environment. This department is responsible for managing the forests and regulates all forest laws of which the Forest Fires Act is one of them. In Belize the “prescribed” burning of savannahs per se is not a practice for agriculture and livestock grazing. The fires are accidental but because of the significant acreage that are burnt yearly in the Mountain Pineridge Area and the coastal plains, the emission of GHGs are significant and are measured when preparing the GHG Inventories. In discussions with staff of the Forest Department, they need:

- to improve technology as it pertains to the current of knowledge as to where and how much is burnt. This could be fulfilled with the improvement of our ability to monitor savannah fires through regional initiatives like SERVIR.
- a methodology to assess carbon stock per acre of savannah lands and in the soils.
- a database system with a related spatial database to keep track of fire impacts on savannah ecosystems need to be developed and managed by an appropriately staffed institution; additional staff would be required.
- an effective public awareness program that would result in a change of culture to prevent fires, including the savannahs.

5. PRELIMINARY SELECTION OF PRIORTY AREA(S) FOR NEEDS ASSESSMENT

Based on the analysis of the various sub-sectors above, it is determined that the many activities are required. The issue of the cost of adopting alternative technologies may be offset by the benefits in terms of lower operating costs and reduction in GHG emission.

Table 2. **Source of emissions and possible technologies to mitigate GHGs in the Agriculture Sector**

Emission Source	Technology to Mitigate	Comments on how
Agricultural residue burning producing the four gases	-delivery of sugarcane production to the factory as un-burnt cane - ample use of minimum or no-till land preparation for grain crops	-Management decision to convince farmers -acceptance of new technology and higher cost of the equipment
Enteric fermentation that produces methane	- biogas digesters for farm use - introduce the use of windbreaks or use silvo-pastoral systems in livestock production	-available polyethylene digesters at low cost -low to medium cost stoves, lamps and refrigerators - not a priority in the Ministry's work plans -available in-country know how -technology available in Central America
Manure management that produces methane	-close animals at night to collect manure and use biogas digesters	-acceptance of this management practice needs serious effort.
Flooded rice cultivation that produces methane	- aeration (dry out period) is done 1-2 times during crop cycle - reduced tillage to reduce soil compaction	- there is no addition of organic material adding more straw or manure or green cover crops
Agricultural soils with organic or mineral fertilizer applications that produce N_2O (nitrous oxide)	-citrus pulp composting available -conventional mineral fertilizers including dolomite and white marl are widely used for all crops	- technical data on technology very difficult to access but farmers beginning to use it -only export cacao is organically produced -export crop acreage not expected to increase
Prescribed burning of savannahs that produce methane, nitrous oxides, carbon monoxide, NOx's etc	-methodology and databases to monitor acreage and location of fires -methodology to assess carbon stock per acre of savannah lands and in the soils	- staffing at Forest Department is limited - need to network with regional programs (SERVIR) to have monitoring systems in place

5.1. Criteria for technology needs assessment

In order to assess the technology needs of the six emission sub-sectors of the agriculture sector three broad based criteria groupings are considered. These are development benefits, market potential and contribution to climate change. These groups were further divided into a number of indicators as shown below.

1. Development benefits

- Job creation
- Wealth creation for the poor
- Capacity building
- Social acceptance
- Use of local resources
- Lead to efficiency improvement in industry
- Public awareness creation

2. Market Potential

- Initial capital outlay
- Affordability
- Investment sustainability
- Low maintenance – durability
- Commercial availability and
- Replicability

3. Contribution to Climate Change

- No or low GHG emissions
- Minimal harm to the environment
- Low potential for leakage
- Enhance sinks and waste recovery

5.2 Preliminary Priority Setting

Selection Process

Eight areas were looked at where technology transfer may be appropriate. These are:

a. delivery of un-burnt sugarcane production to the factory

b. ample use of minimum or no-till land preparation for grain crops

c. introduce the use of windbreaks or use silvo-pastoral systems in livestock production

d. biogas digesters for farm use

e. aeration (dry out period) is done 1-2 times during rice crop cycle

f. methodology and databases to monitor acreage and location of fires

g. methodology to assess carbon stock/acre of savannah lands and in the soils

h. national public awareness program to reduce savannah burning

These technologies were ranked based on a grading system of 1 to 3. High chance for applicability received a score of 3 while low chances of use of technology received a score of 1.

Table 3. **Preliminary Ranking of Technologies**

SELECTION CRITERIA	Harvest un-burnt sugarcane	Minimum or no-till land preparation	Windbreaks or use silvo-pastoral systems	Biogas digesters	Aeration (dry out period) is done 1-2 times	Method. and databases to monitor area and location of fires	Method to assess carbon stock/acre of savannah lands & in soils	National PAP to reduce savannah burning
1. Development benefits								
Job creation	2	1	2	1	1	1	2	2
Wealth creation for the poor	1	1	2	1	1	1	1	1
Capacity building	1	2	3	2	1	3	3	3
Social acceptance	2	2	3	3	3	2	2	3
Use of local resources	3	2	3	1	1	1	1	3
Lead to efficiency improvement in industry	3	3	2	3	3	1	1	3
2. Market Potential								
Initial capital outlay	3	2	1	2	1	2	2	3
Affordability	3	3	2	3	3	2	2	2
Investment sustainability	3	3	3	3	3	3	3	3
Low maintenance – durability	2	2	3	3	3	3	3	3
Commercial availability	2	3	3	3	3	3	2	3
Replicability	3	3	3	3	3	3	3	3
3. Contribution to Climate Change								
No or low GHG emissions	3	2	3	2	3	3	3	3
Minimal harm to the environment	3	3	3	3	3	3	3	3
Low potential for leakage	2	2	3	2	3	3	3	3
Enhance sinks	1	1	3	1	1	1	1	1
TOTAL	37	35	42	36	36	35	35	42

NB: Total possible points per column is 48 (3 x 16)

5.3 Barriers to Technology transfer

The stakeholders identified the following as barriers common to all technology transfer programmes in the country:

i. High initial cost associated with the technologies
ii. Inadequate human and institutional capacities
iii. Access to technology information (e.g. cost, performance, vendors, etc.)
iv. Lack comprehensive technology transfer policy
v. Inadequate capacities in estimating and certifying potential greenhouse gas reductions associated with the technologies
vi. Resistance to change and adoption of new technologies
vii. Reduced knowledge of GHG issues

6. CONCLUSIONS AND RECOMENDATIONS

The agriculture sector provides some eight opportunities for technology transfer. While few may require come capital investment as is the case with minimum tillage equipment and biogas digesters, the majority require a change in attitude to accept the proposed alternatives.

The sugarcane industry in the northern part of the country has the largest acreage of a crop that currently burns the crop for easy harvest and also the burns the residue every year in order to control rodents and other pests such as the spittle bug. Currently the practice of harvesting green cane has limitations since it would require twice the amount of labour which is not available. What is already happening is that the Belize Sugar Industries has already purchased a green cane harvester which costs about Bz. $600K and can harvest between 250 to 400 tons per day depending on the quality of the sugarcane and how well mechanized is the land. But in the next 10 years, in order for the industry to be competitive, mechanized green cane harvesting is the only way to increase efficiency and competitiveness and industry leaders are already going in that direction.

The livestock industry can also benefit from mitigation measures if its managers and owners collaborate with the Ministry of Agriculture to promote and re-introduce, on a nationwide scale, the use of biogas digesters. Technology exists in the region and can easily be procured at reasonable prices. An added benefit of this technology is that farmers will have a cheap source of energy for cooking and lighting plus a high quality organic fertilizer to recycle in their crop production systems.

All cropping areas, grains, pastures and export fruit crops, can benefit from wind breaks and sylvo-pastoral systems (combine pasture fields with multi-purpose forest trees. These systems will have economic benefit, aesthetic value and become sinks for the GHGs emitted by the farming system.

In grain cropping the use of minimum or no-till land preparation practices reduces compaction and significant soil structure disturbance since the mechanization equipment would only till the narrow width of soil where the seeds are set. The net

effect is that this technology increases the soil Carbon levels contrary to the effects of conventional tillage.

The use of aerating or having a “dry-out period” of at least once at mid-growing season is a significant contributor to reducing methane emissions from wetland rice cultivation. While this is not a standard practice in the country, the Blue Creek Mennonite farmers do have a dry out period of about a week but this is done to control fungi.

The three technologies proposed to reduce emissions from Savannah burning are directed towards information management for decision making and creating awareness to the population at large on the reasons not to burn these areas either accidentally or intentionally. The three combined can have significant change in the attitude and culture towards this illegal activity.

REFERENCES

A Food And Nutrition Security Policy For Belize. February 2001. Ministry of Agriculture and Fisheries (GOB). 14p.

Assessing Technology Needs for Climate Change (Final Draft). August 2003. National Communications Support Unit Handbook, UNDP.

Belize National Assessment Report for the 10-year Review for the Implementation of the Barbados Programme of Action. 2003. Ministry of Natural Resources and the Environment, GOB. 50p.

Botero, R. & Preston, T.R. 1987. Low-cost bio-digester for production of fuel and fertilizer from manure, p. 1-20. Cali, Colombia, CIPAV. (unpublished manuscript, in Spanish)

Conducting Technology Needs Assessments for Climate Change. July 2004. National Communications Support Unit Handbook. UNDP. 25p.

Ghana's climate change technology needs and needs assessment report, under the United Nations Framework Convention on Climate Change, January 2003

McCalla, W. 1995. Compendium of Environmental Protection and Natural Resources Management Legislation. Department of the Environment. 233p.

Methods for Climate Change Technology Transfer Needs Assessments and Implementing Activities: Experiences of Developing and Transition Countries, Prepared by the Climate Technology Initiative, March 2002

National Environmental Policy and Strategy. 2006. Department of the Environment. 56p.

The National Food & Agriculture Policy (2002-2020): No farmer = No food**.** April2003. Ministry of Agriculture and Fisheries (GOB). 56p.