BELIZE COUNTRY REPORT
SECOND NATIONAL COMMUNICATION
TO THE UNFCCC

GHG INVENTORY FOR THE
AGRICULTURE SECTOR

Submitted to:
National Meteorological Service,
Ministry of Natural Resources and the Environment

By

Anselmo Castañeda
Agriculture Sector Consultant

BELMOPAN CITY, BELIZE
June 2007

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1.0 BACKGROUND

Belize signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The purpose of the UNFCCC is to reduce and phase out anthropogenic sources of green house gases (GHG) that contribute to global warming and its consequential climatic changes and impacts on species, populations of plants and animals, ecosystems and global commons. As part of their obligations under the convention, contracting parties are required to conduct periodic GHG Inventories (GHGI) of emissions and sinks for reporting to the Conference of the Parties of the Convention. Belize completed its first GHG Inventory in 1998/1999 using 1994 as reference year. The results of that inventory formed a part of the First National Communication that was submitted in 2002. Although the Conference of the Parties decided that the Second National Inventories would be done for the 2000 reference year, Belize has made efforts to estimate and report on emissions (and sinks) of greenhouse gases in 1997.

The GHGI requires that information be accessed from several sectors. This particular document reports on the emissions of the Agriculture sector, and included emissions from enteric fermentation from livestock, methane from flooded rice, CO2 and trace gases from agricultural soils, savannah burning and agricultural residues burning. In 1994 the Agriculture Sector accounted for approximately 2% of total national GHG emissions, equivalent to 58.807 Gg of Carbon Dioxide.

2.0 INTRODUCTION

The Ministry of Natural Resources and the Environment (MNRE) established a Project Execution Group (PEG), and a Project Management Office (PMO) during the latter half of 2006 to oversee the preparation of the Second National Communication on the UNFCCC. The project to prepare Belize's Second National Communication operates out of a rented office space at the Caribbean Community Climate Change Centre, Lawrence Nicholas Building, in Belmopan City.

The National Meteorological Service, (focal point for the UNFCCC), supervises all activities with respect to the preparation of Belize's Second National Communication, through technical and administrative support of the PMU, headed by a Project Coordinator.

3.0 OBJECTIVES OF CONSULTANCY

The main objectives of the Consultancy as outlined in Service Contract No. 004/2006 of November 2006 are:

(i) To conduct a green house gas inventory of emissions within the agricultural sector for the reference years 1997 and 2000.

(ii) Recalculate the emissions within the agricultural sector that were reported for the 1994 reference year.

4.0 METHODOLOGY

The second national GHG inventory will assist Belize to examine trends in the emission of GHGs since the reporting period of the first inventory. Non-Annex 1 countries are not required to conduct and submit reports on annual GHG inventories, but instead would conduct these inventories for reference years decided by the Conference of the Parties. For the Second National Communication, Belize has decided to survey the GHG emissions of 1997 in addition to 2000.

Subsequent to the completion of the first inventory and submission of the First National Communication, some of the original default values have been revised, based on continuing research into the science of climate change. Some default values have been changed, while some country-specific values have been developed in a few cases. While the 2006 IPCC Revised Guidelines have been introduced, these have not yet been adopted for general application. The 1996 Revised Guidelines was again utilized as the basis for the Second National Communication, although the exercise has been facilitated by the application of the UNFCCC improved versions of the software. The Belizean consultants applied version 1.3.2.

For the two reporting years (1997 and 2000) the data used in the calculations were actually averages of three-year periods, namely 1996/1997/1998 and 1999/2000/2001 respectively.

Data collection was conducted during the first two months of the consultancy and even with some difficulties encountered it was possible to meet the deadlines for deliverables. When the official repositories of data did not have the required data sets, the Consultant was able to revert to the original producers of the production data, such as the fertilizer companies and poultry or livestock associations.

Three technical sessions were held with the Project Manager and National Focal Point, during the process of resolving the issues around data collection, in order to assist with the resolution of issues and to work on reduction of uncertainties prior to the production of the first draft report. The sessions served to achieve some degree of Quality Control as consultants shared experiences, lessons, and sources of data. A first draft report was produced and submitted to the members of the Project Execution Group for technical evaluation. Subsequently, a final national validation workshop was convened in April 2007 to present the results of the inventory and to obtain additional inputs from the participating stakeholders. These concerns were then incorporated into this final document.

5. PROBLEMS ENCOUNTERED DURING PREPARATION OF GHG INVENTORY

a. *Data Source*

Data was collected directed from the importers/producers/distributors of fertilizers and soil amendments; their data was more accurate compared to those at the government's Central Statistical Office (CSO) (now known as the Statistical Institute of Belize), and the Ministry of Natural Resources' Land Information Centre (LIC) data sources. Associations such as the Belize Livestock Producers' Association (BLPA) and the Belize National Poultry Association (BNPA) were very helpful in supplying data that was used to compare and corroborate data with the

sources of official statistics such as the Ministry of Agriculture and Fisheries. In cases where data was not available from the Policy Unit of the Ministry of Agriculture, the Consultant made direct contact with rice growers or buffalo owners.

b. *Timing of gathering information*

While the private sector was cooperative in agreeing to supply data on flooded rice, fertilizer imports and production, and soil amendments, due to the nature of their business it was necessary to keep reminding them for the need for the information. Especially for all mixed formulae containing N, the consolidation of this data presented a challenge to the fertilizer companies as they requested for more time for delivery of such information. It should be noted that this exercise was very helpful in getting a clear and more realistic picture of N-fertilizer usage in Belize as compared with 1994 GHGI whose estimate was based on the importation of only the big four suppliers of N, namely ammonium nitrate, ammonium sulphate, di-ammonium phosphate and urea.

c. *Quality of the information*

Importation of N fertilizers as reported by the Customs Department to the CSO are in consolidated amounts and does not permit its use where the N-contents or percentages cannot be segregated from those amounts.

The Agricultural Statistics from the Ministry of Agriculture presented several limitations for its use in this inventory preparation. The limitations include:

a) lack of production statistics for certain years for certain crops and livestock;
b) certain pulses were under the fruit trees grouping. Again, the large acreage of Vigna exported to the Caribbean by the Mennonite communities was named as Cowpea;
c) the Ministry of Agriculture should begin to report its statistics in metric units;
d) under rice cultivation, the inventory process requires that flooded rice be reported with greater detail and more accuracy, with actual yields and area, number of aerations, depth of water regime, including the management of the crop residue; and
e) in the livestock statistics, data is missing for certain animals and certain years, it is not consistent. In addition, for future inventories, Belize will be required especially for dairy and non-dairy categories, the growth stage and weight of the animals. (There will be the need to have a workshop with the staff of the Statistical Unit to agree on this format for future inventories.)

d. *Use and applicability of the conversion and default factors of the UNFCC and the IPCC*

Even though when the improved software provided by the UNFCCC, the Revised 1996 IPCC Guidelines with conversion and default factors were most applicable. It was noted that the UNFCCC modules had slight changes in the various columns of the worksheets; for example, the IPCC software initiated the calculations at the beginning of the worksheets while the UNFCCC did it on the last column of the worksheets.

In conclusion, it is once again noted that in order for results to be more reliable, the quality of the statistics recorded in Belize needs to be improved. It is therefore recommended that the Second National Communication Project take a lead role in organizing workshops with GOB data managers and the stakeholders of the private sector to help them understand the need for these improvements for all sectors reported in the GHG inventory.

6. RESULTS SUMMARY OF GHG EMISSIONS FROM THE BELIZE AGRICULTURAL SECTOR

The following graphs in Figure 1 present the contributions of the four GHGs emitted within the Agriculture sector which contribute to Belize's overall emissions. While the total methane emissions (from enteric fermentation and cultivation of flooded rice) reported in 1998-1999 using 1994 as the base year was relatively high for Belize, when the recalculation was conducted the total value was reduced to less than 3Gg. While the burning of savannah and the field-burning of crop residues are the main contributors of CO emissions, these two activities are the also large contributors to the non-CO_2 trace gases. The slightly higher CO emission in 1997 was due mainly to a higher tonnage of processed sugar for the export market. It is also worthwhile to note that the emissions of CO over the three periods are practically constant once the local conversion factors (from a BSI study in December 2006) for sugarcane residue burning were used.

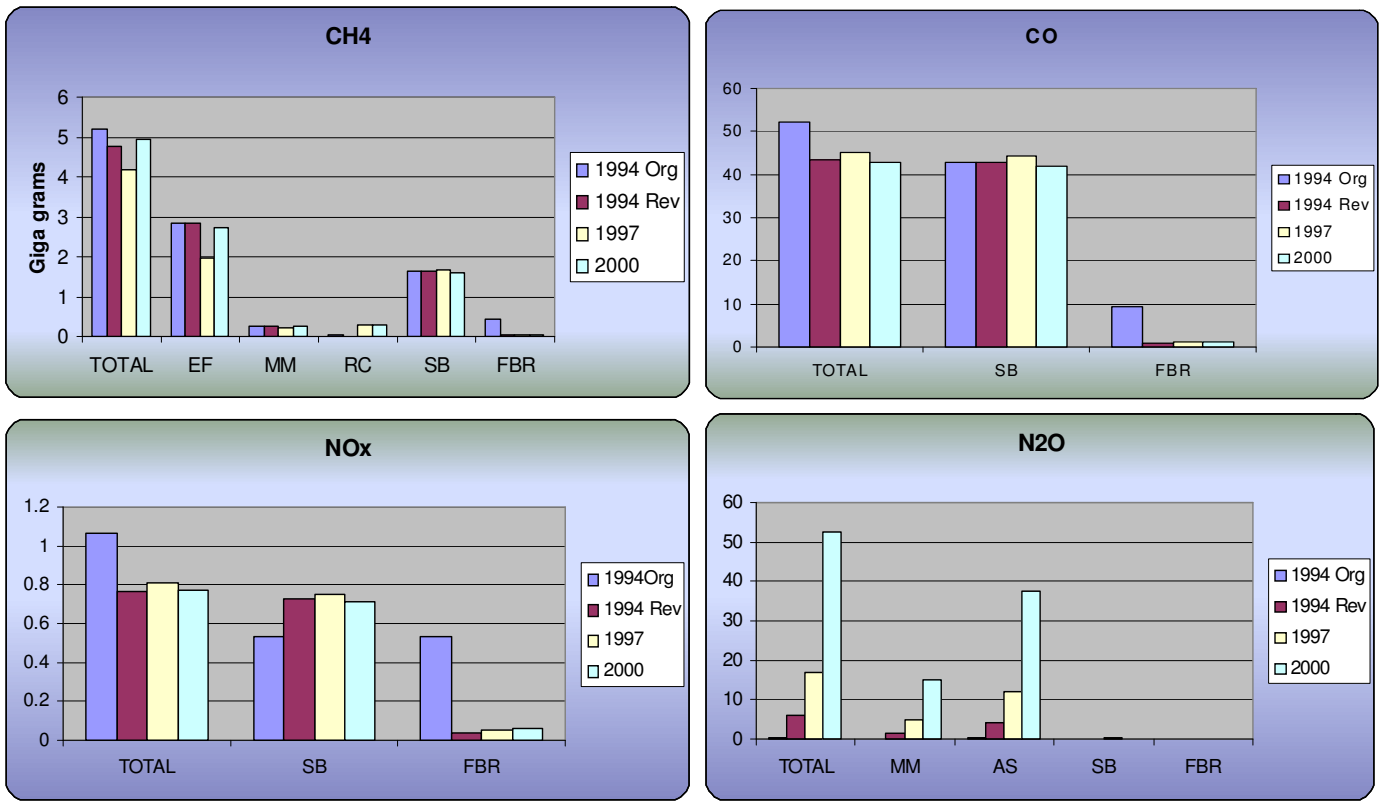

Figure 1 Emissions by Gas Type and by Source for the period 1994 to 2000

Table 1. Summary of GHG Emissions by Activity and by Year from the Belize's Agricultural Sector for the Period 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.

The 1994 submitted data shows that total methane emissions from domestic livestock was well above the average figure for developing countries at a reported 2.837 Gg. However, when the data was recalculated, the estimated methane emission was almost equal to the reported value. The Net Total Emissions for the period ranged 54.88Gg in Revised 1994, 66.97Gg for 1997 and 100.44Gg for 2000.

Figures 2, Net Total Emissions and 3 Total Emissions with CO_2 Equivalent show the stable trends for the reporting periods.

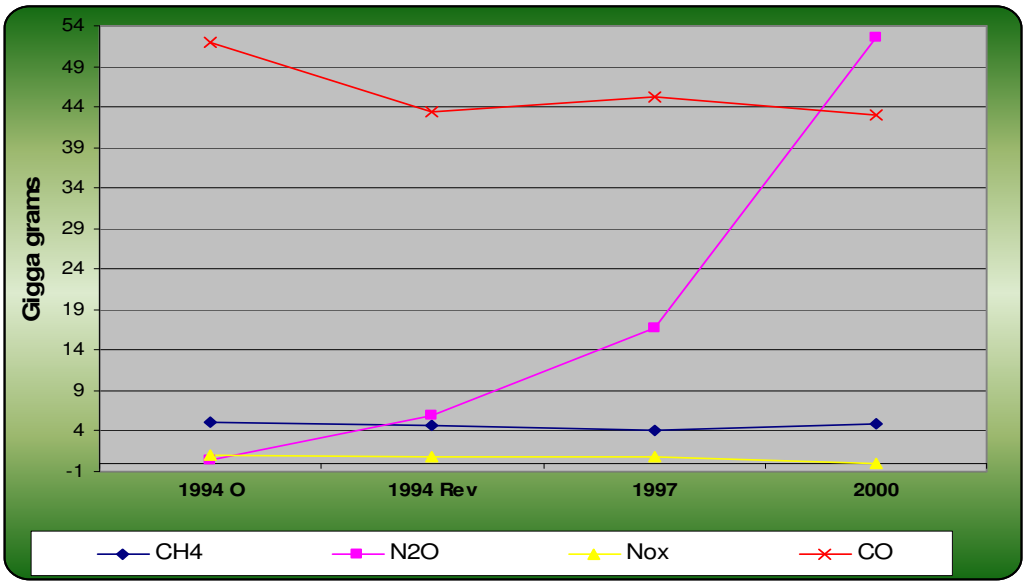

Figure 2. Trend (Gg) of net emissions for the period 1994 to 2000.

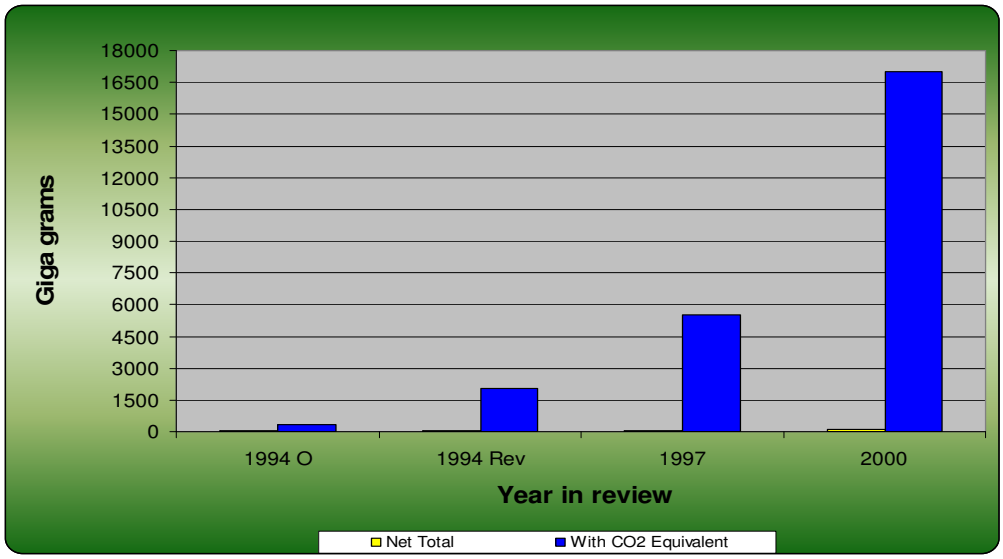

Figure 3. Trend of net emissions vs. emissions with CO_2 equivalent (Global Warming Potential) for the period 1994 to 2000.

Looking at the revised 1994, 1997 and 2000 data, an increasing trend is observed.

Annex A.

EXPLANATORY NOTES FOR YEARS 1994, 1997 and 2000 AGRICULTURE SECTOR OF THE GREEN HOUSE GAS INVENTORY FOR BELIZE'S SECOND NATIONAL COMMUNICATION

Prepared by Mr. Anselmo Castañeda

Data was gathered from the following sources: Statistics Unit in the Ministry of Agriculture and Fisheries in Belmopan City, Belize Livestock and Poultry Producers Associations, Central Statistical Office (now known as the Statistical Institute of Belize), two major fertilizer importers, formulators and distributors, wetland rice producers, buffalo farm ex-managers, ground white lime and dolomite producers and personal communication with specialists in the various sub-sectors.

Emission of gases for Year 1994 was recalculated utilizing the improved UNFCCC software. The recalculations for revised 1994 and 1997 and 2000 data are more realistic utilizing additional data and information.

1. In Worksheet 4-1 (Sheet 1 of 2 for 1994) the number of animals is reported in 1000s and the emissions factor for enteric fermentation (kg/head/yr) remains the same. The emissions factor for poultry was not calculated for any of the years as referred to in Table 4-2. The emissions factor for manure management (kg/head/yr) remains the same except for horses which is calculated as 2.18 and swine is 2.0 (Table 4-4). Total annual methane emission from domestic livestock for 1994 is 0.00284 Gg compared to the data in the first GHG Inventory report done in 1999 which was reported as 3.17 Gg. In the UNFCC 2006 GHG Inventory software, Columns "C & E" are divided by 1000 whereas in 1994 IPCC modules, it was not. As a point of reference, annual emission from enteric fermentation for developing countries is less than 0.001 Gg. The national population for buffalos was estimated by direct communication with Mr. Ralston Flowers (previous livestock officer at Caribeef Farms) and Mr. Melanio Pech of the Central Farm Livestock Section. The figures for sheep were estimated using a 10% increase per interval between 1994 and 1997 and 1997 to 2000. Figures for mules and asses were estimated as a 10% of the horses' population in the country. It should be noted that these draught animals are concentrated in the Toledo District and some in Cayo and Stann Creek Districts.

2. Worksheet 4-1 (Sheet 1 of 2 for 1997) has figures for buffalo, horses, goats and sheep as estimates at 10% increments based on 1994 figures. This data was not collected by the Ministry of Agriculture and Fisheries. However, the consultant used a conservative population rate figure of 10% over the three-year span between the three reference years under study.

3. Worksheet 4-1 (Sheet 1 of 2 for 2000) has figures for buffalo, horses, goats and sheep as estimates at 10% increments based on 1994 figures. Again, this data is not provided by the Agricultural Statistics report of the Ministry of Agriculture and Fisheries.

4. There are no anaerobic, solid and liquid manure management systems in Belize, hence, no estimations were done in worksheets 4-1 (Supplemental) except for pasture range and paddock systems (Worksheet 4-1 Supplemental Range and Paddock). This applies to the three reference years under study. In Worksheet 4-1 (Supplemental) for pasture range and paddock, the number of animals is reported in 1000s and nitrogen excretion remains the same (Table 4-6). Fraction of manure nitrogen per AWMS remains the same (Table 4-7). Turkeys are included under "others".

5. In Supplemental sheet 4-1s2 the emission factor is 0.02 from Table 4-8.

6. In worksheet 4-2s1, the harvested area is presented in square meter x 10. The correction factor for organic amendment is 1 as no organic amendment is applied to the soil. Seasonally integrated emission factor for continuously flooded rice without organic amendment is 20 (arithmetic mean used as default) as presented in Table 4-11. The total emissions (Column "E") are divided by 100, whereas in 1994 it was not.

7. For 1997, total rice harvested area was 14,217 acres (5,875 ha) of which irrigated rice accounted for 3,434 acres (1,419 ha); these irrigated rice areas are cultivated at Big Falls, Belize District and Blue Creek, Orange District. Of the remaining 10,783 acres (4,456 ha), it was assumed that 10% was flood prone (447 ha) and 90% drought prone (4,009 ha). According to the irrigated rice farmers, they only apply between 15 - 30 centimeters (cms.) of water depth; also there is only one crop harvested per annum. This information entered in worksheet 4-2s1 (Sheet 1 of 1.)

8. For 2000, total rice harvested area was 10,088.acres (4169 ha) of which an estimated 3,589 acres (1,483 ha) were irrigated. Of the remaining 6,499 acres (2686 ha), it was assumed that 10% was flood prone (269ha) and 90% drought prone (2,417 ha). According to the irrigated rice farmers, they only apply between 15-30 cms. of water dept; also there is only one crop harvested per annum. This information was entered in worksheet 4-2s1 (Sheet 1 of 1).

9. While it was clarified by the staff of both Forest and Agriculture Departments that "prescribed savannah burning" is not practiced in Belize, according to the definition of prescribed, an estimate of the activity in this particular ecosystem was derived through *Personal Communications* and *Expert Knowledge* with Forest Department staff and independent professionals. The sub-sector "Prescribed Burning of Savannahs" was also treated and estimated since there has always been a relatively high frequency and large acreages of this ecosystem that burns yearly and can be attributed to anthropogenic causes. This activity/source of emission is estimated both for the CO_2 and the non-CO_2 trace gases. In 1994, the LIC reported that there are 259,000ha of savannas, grassland and open and closed pine forests; the consultants differentiated two types of grassland based on rainfall: humid grassland (>700mm), and arid grassland (<700mm). For 1997 and 2000, only the humid category is used. The acreage burnt for 1997 and 2000 was estimated using satellite imagery and it is assumed, based on expert technical knowledge, that 50% of the area burns yearly. The exception is that the closed pine forests in the Coastal Southern Plains and Mountain Pine Ridge Forest Reserve burn at an annual rate of 30% due to fire management measures that are in place. Much larger areas in the South Costal Plains and the lowland

areas f the Belize and Orange Walk Districts burn annually since there is far less control effort and capacity. For 1994, in Worksheet 4-3 (prescribed burning of savannas), the area burned is presented in kilohectares. The Biomass density of savanna is 8.4 (6.6 + 1.8) as presented in Table 4-12. The default fraction actually burned is assumed as 0.80 as presented in Table 4-12. Default figure for fraction of living biomass burned is 0.45 as presented in Table 4-13.

10. In worksheet 4-3 (page 3-3) the default nitrogen-carbon Ratio is 0.006 as presented in Table 4-14. The emissions ratios are the same as presented in Table 4-14.

11. In worksheet 4- 4 (1-3) annual production is entered as kilotonnes or Gg crop residues. Residue to crop ratio were obtained from Table 4-15 and are basically the same except for Peanuts that has a value of 1 (0.11 as default value in 1994 inventory). The residue to crop ratio for Sugar Cane for 1994 was assumed as 1.4 similar to Sorghum. Dry matter fraction for some crops is estimated at 0.4 from Table 4-15 except for Rice which is 0.83. Fraction burned in fields value is 0.4 for 1997 and 2000 (0.25 was used in 1994) as normal practice for developing countries like Belize (In Chapter 4 Work Book 2, Section 4.5, page 8 of 20). The default fraction oxidized is 0.9 as presented in IPCC manual. Sugarcane production, being the largest acreage crop in Belize whose residues are burnt in the field, is basically stable (1.1 million metric tones of sugarcane). It is important to note that Belize has now developed its own conversion factors and have been applied to the revised 1994, 1997 and 2000 data. In Column F of Worksheet 4-4s1, the fraction of burned crop residue for crops other than sugar cane was raised from .25 (used in '94) to .40 in 1997 and 2000. Refer to Reference Manual page 4.81. The consultant was able to get nationally-derived factors from the Belize Sugar Industries Research Center (Personal Communication with Mr. Eduardo Zetina- Data developed in 2006 by a Booker/Tate Consultant Mr. David Eastwood) as follows:

    "**Sugar cane crop residue contribution to nitrous oxides."**

    The sugar cane figures are as follows:
    a. 75% goes to the mill (production in the MAF statistics) and 25% is moist or crop residue;
    b. Of the 25% that is crop residue only 75% burns (the pieces of cane that stay on the tops does not burn as only the leaves burn to the ground; and
    c. Of the 25% that is crop residue, 30% is dry matter or biomass and 75% is moisture. For example: from a 20 tones total above-ground biomass, 15 go to the factory and 5 stays in the field as crop residue. Of the 5 tones, 3.75 tones burn. Of these 3.75 tones, 1.125 tones is dry biomass. The residue to crop ratio is estimated at 0.25 (inserted in Column B), the dry matter fraction for sugar cane 0.0562 (inserted in Column D) and fraction burnt in the field is 0.1875 (inserted in Column F).

12. In Worksheet 4-4 (2-3) the carbon fraction of residue is presented as 0.4709 except for rice which is reported as 0.4144 (Table 4-15). The nitrogen-carbon ratio is 0.02 except for rice 0.014 (Table 4-15).

13. In worksheet 4-4 (3-3) the emission ratios are derived from Table 4-16.

14. Manure or animal waste Nitrogen in open range/paddock systems is used as fertilizer in Belize.

15. In worksheet 4-5s1, five N-fixing crops (FBN) and crop residue now include Vigna/Cowpea for 1997 and 2000 as compared to the list used in 1994.

16. In Worksheet 4-5 (4 of 5), total synthetic fertilizer N applied to the soil (N_{FERT} in kg N/year) was estimated from the production figures for Nitrogen based fertilizers. A three year average was used on Urea (46% N), Ammonium Nitrate (33% N) and Ammonium sulfate (21% N) plus all other mixed formulae containing N for Years 1997 and 2000. The figures were provided in metric tons (1 metric tonne equivalent to 1000 kgs.) by the two major importers and producers of synthetic fertilizers.

17. In Worksheet 4-5s1, in the calculation of Nitrous Oxide from non-N-fixing crops, and based on Note 27 in Page 4.82 of Chapter 4, Ref 6 in PDF format, it states that “one can use the dry matter content values in Table 4-15 to convert from total crop residue to dry matter. The Crop Residue Conversion Factors (Table 4-15) are: Corn=0.4, rice= 0.83, sorghum= 0.83 and sugar cane = 0.83. Residue remaining in the field may not always total 55% of total crop biomass.” The consultant considered a more conservative figure of 50% and this was used in this Worksheet. In the same Chapter 4 referred to above, Page 4.93, it is stated “crop production data for pulses, soybeans and non-N-fixing crops are listed in the FAO crop data base of 1990. Referring to the kg N/yr from crop residues on non-N-fixing crops, the default conversion factor is 0.015 kg N/year of dry biomass. For the revised 1994 calculations, since only statistics for 1994 and 1995 were available, the consultant used the Gg reported for that base year in Worksheet 4-4, sheet 1 of 3. For 1997 and 2000, the original statistical data for the three years were averaged and converted to kg N/yr of dry biomass.

Annex B. Module 4 for 2000

Annex C. Module 4 for 1997

Annex D. Module 4 for 1994