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PRELIMINARY OPTIONS FOR METHODOLOGIES TO APPLY ADJUSTMENTS UNDER ARTICLE 5.2 OF THE KYOTO PROTOCOL

Agriculture

Expert report

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Contents

This report was prepared by
Dong Hongmin Ph.D. Yue Li. Associate Professor, Agrometeorology Institute,
Chinese Academy of Agricultural Sciences, 30, Baishiqiao Road
Beijing 100081
P.R. of China

Tel: 86-10-68919979 (O) 86-10-68918369 (H) Fax: 86-10-68975409
Email: Donghm@ns.ami.ac.cn nd /or Donghm@mail.caas.net.cn

1 Introduction

The purpose of this section is to develop methodological option strategies to obtain technical revised estimates of GHG emissions from following activities:

- CH_4 emissions from enteric fermentation
- CH_4 emissions from manure management
- CH_4 emissions from rice production
- N_2O emissions from manure management systems
- CH_4 and N_2O emissions from savanna burning
- CH_4 and N_2O emissions from agricultural residues burning
- N_2O emissions from agricultural soils

For each source, five different methods will be discussed:

- Simple IPCC methods using available data
- Estimation based on Annex I averages and driving factor
- Extrapolation based on a driving factor
- Linkages of emissions between sources and gases
- Interpolation and extrapolation

2 CH_4 emissions from enteric fermentation

2.1 Tier 1 of the IPCC methods

2.1.1 Description of method

IPCC Tier 1, which relies on IPCC default emission factors and external available animal population data, could be used to recalculate the emissions. Emissions are calculated by applying an emission factor to the number of animals of each livestock type in a country to produce a total CH_4 emission for enteric fermentation.

Equation 2.1.1

$$\text{Total Emissions}CH_4\ (Gg/yr) = \sum_i EF_i \times (\text{Population}\ )_i(\text{head})/(10^6\ kg/Gg)$$

Where:

Total Emissions = total emissions from Livestock; (Gg CH_4/yr)

Index i = sums all livestock types;

EF_i = default emission factor for the i livetock type (kg/head/yr)

$(\text{Population})_i$ = the number of animals for the i livestock type (head)

2.1.2 Technical preconditions and data requirements

This approach could be used for the case of incomplete of a source but availability of the necessary activity data from national statistic data or UN data, or for the case of problem methodology. IPCC default emission factors and livestock characteristics data listed in the *Table 4-2 of Revised 1996 IPCC Guidelines on National Greenhouse Gas manual* are required to support Tier 1 emission estimate.

2.1.3 Availability of data

- Population and milk production statistics

The livestock population data and average annual milk production for dairy-cows from FAO database can be used if national data are unavailable or inappropriate. **Table 2.1.1** contains the information on population and productions of the various categories livestock of the Annex B countries according to the statistics from FAO database. There is no separately population number for dairy cattle and non-dairy cattle

- Default emission factor

Table 4-3 and Table 4- 4 of Revised 1996 IPCC Guideline on National Greenhouse Gas Inventories reference manual provide default emission factor values for various categories of the representative livestock type. For cattle, we use the average default emission factors of dairy cattle and non-dairy cattle to calculate the emissions from cattle. **See table 2.1.2**

2.1.4 Examples

Table 2.1.3 shows how the GHG emission from enteric fermentation in New Zealand can be calculated.

2.1.5 Assessment of reliability

The reliability of this method largely depends on the confidence level of IPCC default emission factor. The comparison of CH_4 emissions from enteric fermentation using IPCC tier1 and national methods/data in the New Zealand was presented in **Table2.1.3.** Table 2.1.3 shows that the IPCC default factor for sheep is 8.0, while the national emission factor is 15.1, which leads the difference of the factor by 88.7%. Therefore, the difference of CH_4 emission estimates between IPCC method and national method/data is 32.8% in New Zealand

2.1.6 Constraints and limitations

The Default emissions factors given in Tier1 are not based on country **-** specific data, they did not accurately represent a country's livestock characteristics, and may be highly uncertain as a result. There will be an added uncertainty associated with the livestock population from FAO data.

2.2 Estimation based on Annex I averages and driving factor

2.2.1 Description of method

Method1: Average Emissions Rate Per Head for Various Livestock Type.

Adjusted emissions could be determined based on average emissions rate per head for various livestock type over Annex B countries with similar circumstances and the external available animal population data.

Equation2.2.1

$$\textit{Total Emissions}CH_4\,(Gg/yr) = \sum_i AVEF_i \times (Population\ )_i(head)/(10^6\ kg/Gg)$$

Where:

Total Emissions = Total Emissions from Livestock; (Gg CH_4/yr)

Index i = sums all livestock types; and

$AVEF_i$ = Annex B average emissions rate for the i^{th} livetock type (kg/head/yr)

Method 2: Average Emissions Rate Per Livestock Unit (LU).

Adjusted emissions could be determined based on average emissions per **Livestock Unit** over Annex B countries with similar circumstances and the external available animal population data in livestock units. One cattle is set as one livestock unit, one swine would be 0.4 LU, sheep and goat 0.1 LU, poultry 0.01 LU.

Equation2.2.2

$$\textit{Total Emissions}CH_4\,(Gg/yr) = AVEF_{Lu} \times \textit{Population of Livestock Unit (head)}/(10^6\ kg/Gg)$$

Where:

Total Emissions = total emissions from Livestock; (Gg CH_4/yr)

$AVEF_{Lu}$ = Annex B average emissions rate for a standard Livetock Unit (kg/head/yr)

2.2.2 Technical preconditions and data requirements

If the emission factor is inappropriate, the adjusted estimate could be made by applying the average emission rate over Annex B countries with the similar circumstance and necessary activity data from national statistic data or UN data. Following data are required to support this indexing based on Annex B average approach.

Method 1: Average Emissions Rate Per Head for Various Livestock Type.

- The emission rates for the various livetock type of all the Annex B countries
- Livestock population of animal types listed in the *Table 4-2 of Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories manual* [1].

Method 2: Average Emissions Rate Per Livestock Unit (LU).

- The CH_4 emission from enteric fermentation sector of all Annex B countries.
- Livestock Unit population data.

2.2.3 Availability of data

Method 1 : Average Emissions Rate Per Head for Various Livestock Type.

- The emission rates for the various livetock type

The emission rates for the various livetock type of all Annex B countries are available from Table 4.A Sub-sectional report for the enteric fermentation of the first and second national communications. **Table 2.2.1** contains the average emissions rates for the various livetock type based on the data provided by New Zealand and Hungary.

- Livestock population data

There are livestock population data on FAO database. **Table 2.1.1** contains the information on population of the various category livestock according to the statistics from FAO database.

Method 2: Average Emissions Rate Per Livestock Unit (LU).

- CH_4 emission data from enteric fermentation sector

All CH_4 emission *data* from enteric fermentation sector of all the Annex B countries are available *from UNFCCC database.* **Table 2.2.2** contains CH_4 emission *data* from enteric fermentation sector of all the Annex B countries

- Livestock Unit population data

Livestock Unit population data can be calculated based on the population data from FAO database. **Table 2.2.3** provide the Livestock Unit data of the entire Annex B countries in 1994, one livestock unit express the emissions from a cattle.

Base on **table 2.2.2** and **table 2.2.3,** Average emission rate per LU are estimated and presented in **table 2.2.4** for all Annex B countries.

2.2.4 Examples

Method 1: Average Emissions Rate Per Head for Various Livestock Type over Annex B Countries.

Table 2.2.5 shows how the emission from enteric fermentation of New Zealand in 1994 is calculated according to the Indexing Based on Annex B approach.

Method 2: Average Emissions Rate Per Livestock Unit (LU) for All Annex B Countries.

Multiply the number of LU by average emission rates per LU over Annex B countries to get to give emissions in New Zealand in 1994. **See table 2.2.6**

2.2.5 Assessment of reliability

Method 1 : Average Emissions Rate Per Head For Various livestock Type over Annex B countries.

Comparison of CH_4 emissions from enteric fermentation between using average emission rate of Annex B method and national methods/data in the New Zealand presented **in Table 2.2.5.** The table suggests that use of the Annex B averages approach could give about 21% of different estimates compared to using national method/data.

Method 2: Average Emissions Rate Per Livestock Unit (LU) for All Annex B Countries.

Comparison of Ch_4 emissions from enteric fermentation between LU method and national methods/data for all Annex B countries in 1994 was presented **in Table 2.2.6.** The table suggests that the differences of CH_4 emissions between using the LU methods and using national method ranged from 6.0- **-** 13.7% for all Annex B countries.

2.2.6 Constraints and limitations

Method 1 on average emission rate over Annex B countries with different circumstances do not accurately represent a country's livestock characteristics for various categories, and may be highly uncertain as a result.

Method 2 on average emission rate of Livestock Unit can not represent the change of the emission factor with the improvement of livestock productivity. The recalculation of CH_4 emission from enteric fermentation after several years is necessary.

2.3 Extrapolation based on a driving factor

2.3.1 Description of method

CH_4 emissions could be estimated by indexing a Party's baseline emissions using an appropriate growth factor of animal population.

Equation 2.3.1

$$\textit{Total Emissions}CH_4\,(Gg/yr) = \sum_i \;(\textit{Base year emission})_i \times e^{R_i X}$$

Where :

Total Emissions = total emissions from livestock; (Gg CH_4/yr)

Base year emission = CH_4 emission from enteric fermentation in base year (1990 or other) for animal type i

Index i = sums all livestock types;

R_i = exponential growth rate of the animal population

X = the number of a specific year (For 1994, X will be 5 if the base year is 1990)

2.3.2 Technical preconditions and data requirements

If the base year emission and the growth factor of the animal population are available, this approach could work. Data requirements for this method are:

- Base year emission from enteric fermentation for various animal type;
- Exponential growth rate of the animal population for various animal type

2.3.3 Availability of data

- Base year emission:

The base year emissions of CH_4 from enteric fermentation of all Annex B countries can be obtained from *UNFCCC database.* **Table 2.2.2** contains the information on CH_4 emissions from the base year emissions in the first and second national communication

- population growth rate:

The FAO database contains the information about livestock population growth rate. **Table 2.3.1 presents** the growth factor information on population of the various categories animals from 1990-1998.

2.3.4 Examples

- **Table 2.3.2** shows how the emission from enteric fermentation in New Zealand in 1994 is calculated according to *the Extrapolation growth factor method.*

2.3.5 Assessment of reliability

Table 2.3.2 suggests that the difference of CH_4 emission estimated by using the national method and the growth factor method of New Zealand in 1994 was 0.66%.

2.3.6 Constraints and limitations

The base year emission with uncertainty may lead to relative large uncertainty. The estimation of the Exponential growth rate of the animal population has additional uncertainty.

2.4 Linkages of emissions between sources and gases

Livestock population is the basic data for CH_4 emission from both enteric fermentation and livestock manure . However, the main source of enteric fermentation is cattle, and the swine is the most important sources of the livestock manure. So it is very difficult to estimate CH_4 emissions from enteric fermentation based on the CH_4 emissions from manure management system.

The CH_4 emissions from enteric fermentation could not be estimated based on related sources and gases.

2.5 Interpolation and extrapolation

2.5.1 Description of method

Emissions could be estimated by indexing the party's emissions trend for several years.

Equation 2.5.1

Total EmissionsCH_4 (Gg/yr) = f(x)

Where :

Total Emissions = Total emissions from livestock; (Gg CH_4/yr)

f(x) = CH_4 emission function over year.

2.5.2 Technical preconditions and data requirements

The technical precondition for this method is availability of reliable CH_4 emissions for minimum two years .

2.5.3 Availability of data

- The CH_4 from enteric fermentation of all annex B countries can be obtained from *UNFCCC database.* **Table 2.2.2** contains the information on CH_4 Emissions from the 1990-1997.

2.5.4 Examples

Table 2.5.1 is an example for setting trend equation for Canada, New Zealand and USA .

2.5.5 Assessment of reliability

From the table 2.5.1, it seems that the interpolation and extrapolation does not produce large additional difference of estimations if there are enough year emission data. The reliability of this method depends on the confidence level of CH_4 emission data submitted by Parties. The differences between nation method and the extrapolation method are –1.43% - 3.43% for Canada, -1.45% -1.35% for New Zealand, and -2.08-1.92% for USA, respectively.

2.5.6 Constraints and limitations

The uncertainty will be relatively large if there are only 2 year 's reliable emission data, particularly for the economic transfer countries.

2.6 Comparison and ranking of methods

There are four methods with different reliability, which could be used to obtain the revised technical estimates of CH_4 emissions from enteric fermentation. The ranking criteria for adjustment methods are based on the reliability and data availability. The process for determining which adjustment method to use is shown in the decision tree (see Figure 2.6.1)

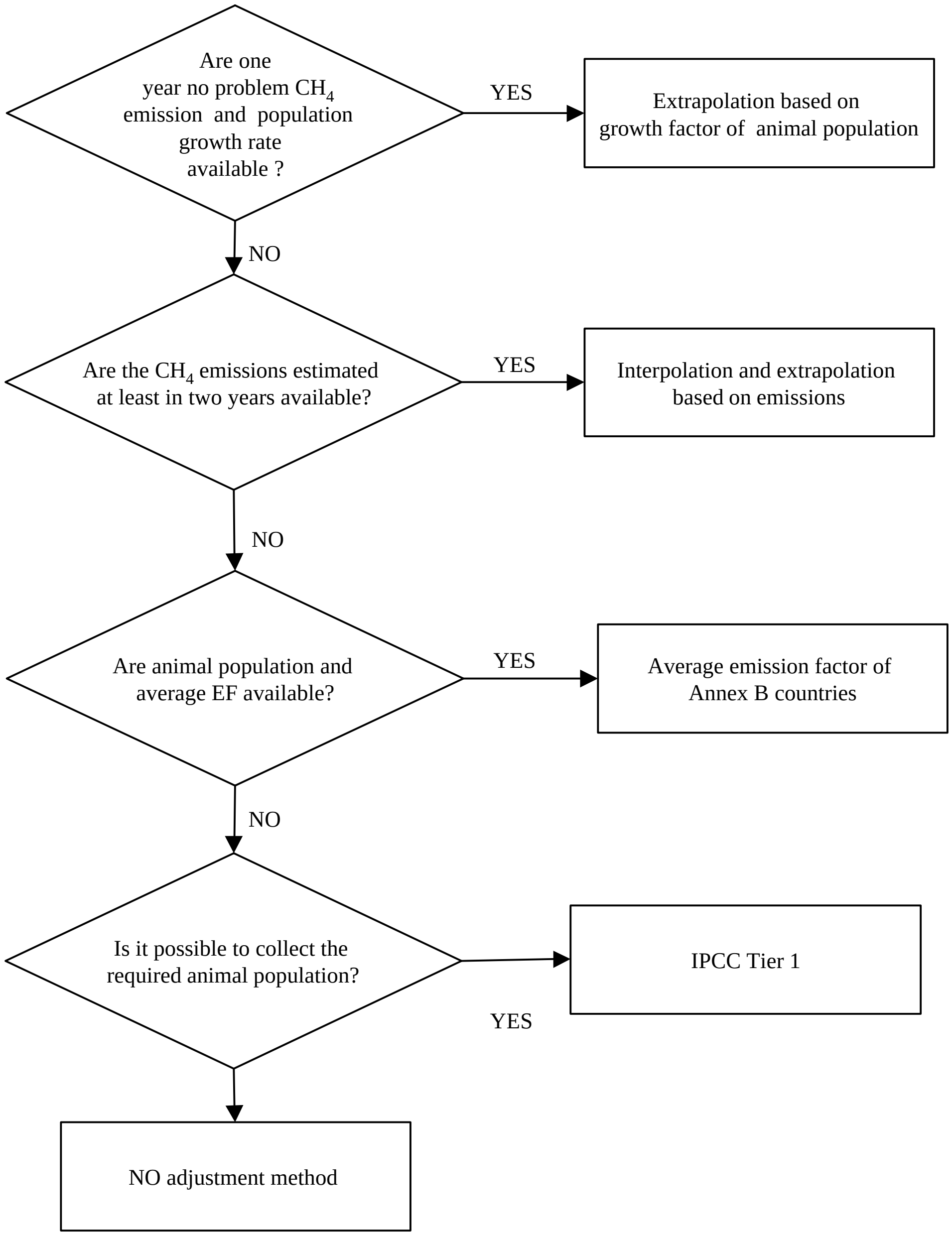
The Extrapolation based on population growth rate: Animal populations increase rates for all Annex B countries are available from FAO database. If one-year reliable estimates can be obtained, the adjusted CH_4 emission from enteric fermentation can be calculated using extrapolation method based on animal population increase rate. The difference between the estimates obtained using this method and the estimates reported by Parties are lowest in all methods, and the difference is smaller than 10%.

Interpolation and extrapolation: The adjusted estimation of CH_4 emission from enteric fermentation could be recalculated using interpolation and extrapolation method based on at least two-year reliable estimates. Additional animal production information is not needed for this method. The reliability of this method depends on the confidence level of CH_4 emission data submitted by Parties. The differences between the adjusted estimates and the estimates reported by Parties are relative lower than the following two methods.

Average emission rate method: Considering that some countries adopted IPCC Tier2 to estimate the emission factors of different animals, the country- specific emission factors will decrease the uncertainty of emission rate. If the average emission rate over countries with similar circumstance is used to estimate the adjusted emission, the uncertainty will be relatively lower than using IPCC Tier 1.

IPCC Tier I method: Even though default emissions factors values recommended by IPCC[1] did not accurately represent a country's livestock characteristics, If there are no any reliable estimates submitted to UNFCCC, CH_4 missions from enteric fermentation should be calculated using IPCC Tier I.

Figure 2.6.1 Decision tree for selecting adjustment method of CH_4 emission from enteric fermentation



3 CH_4 emissions from manure management systems

3.1 IPCC Tier I methods using available animal population data

3.1.1 Description of method

CH_4 emissions from animal waste management (AWM) could be calculated or recalculated based on IPCC Tier I method by using available animal population data from Party or FAO database and default emission factors recommended by IPCC 1996.

Equation 3.1.1

Total CH_4 emissions (Gg/yr) = $\sum EF_i \times Population_i$ (head)$\times(10^{-6})$

Where :

Total CH_4 emissions = CH_4 emission from manure management system

i = Animal type i

EF_i = Default emission factor for the animal type i (kg/head/yr)

$Population_i$ = Population of animal type i

3.1.2 Technical preconditions and data requirements

This approach could be used for the case of incomplete source but availability of the necessary activity data from national statistic data or UN data, or for the case of problem methodology. Following information may be needed when calculating CH_4 emission from manure management system:

- Animal population data
- Default emission factors of different manure management for each subgroup animals. .

3.1.3 Availability of data

- Default emission factors: *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook* [2] *Table 4-4 and Table 4-5* listed the default emission factors for most animal type.
- Animal population: Animal population data can be collected from FAO database. The **table 2.1.1** contains the information on population and productions of the various categories livestock of the Annex B countries according to the statistics from FAO database.

3.1.4 Examples

- **Table 3.1.2** shows how to calculate CH_4 emissions from animal manure management systems in New Zealand using IPCC Tier 1.

3.1.5 Assessment of reliability

The reliability of this method depends on the reliability of animal population data and the confidence levels of default emission factors recommended by IPCC 1996[1]. There were large differences between default emission factors in AWMs recommended by IPCC 1996 and emission factors produced based on country-specific information on livestock characteristics and manure management practices. For example, the difference of CH_4 emission from AWMs between using IPCC tier1 and national methods was high as 1037% in New Zealand **(table 3.1.2)** ; The emissions reported by Czech Republic[4] for dairy cattle, non-dairy cattle, sheep, goats, horse, swine, and poultry have –77% to 193% difference comparing with results estimated according to IPCC tier 1 **(Table 3.1.3). Table 3.1.1** contains the CH_4 emissions of Annex B countries.

3.1.6 Constraints and limitations

The default emission factors recommended by IPCC 1996 are not based on country - specific data, they did not accurately represent a country's livestock characteristics and manure management practices, and may be highly uncertain as a result.

3.2 Estimation based on Annex I averages and driving factor

3.2.1 Description of method

3.2.2 CH_4 emissions from AWMs could be recalculated based on the average emission factors reported by Annex B Parties and available animal population data (Party or FAO database).

Equation 3.2.1

$$\text{Total } CH_4 \text{ emission (Gg/yr)} = \sum AVEF_i \times Population_{ij} \text{ (head)} \times (10^{-6})$$

Where :

Total CH_4 emission $_i$ = CH_4 emission from manure management system in the year of j
$AVEF_i$ = Average emission factor of Annex B countries for animal type i (kg/head/yr)
$Population_{ij}$ = The animal population of animal type i in the year of j

3.2.3 Technical preconditions and data requirements

The technical preconditions for this method is the emission factors for animal type i from Annex B Parities can be obtained.

The data required for this method are :

- CH_4 emission factors of each categories animal from Annex I Parties
- Animal population .

3.2.4 Availability of data

- Emission factor: The CH_4 emission factors for AWMs from Annex B countries with similar circumstance can be obtained from the first and second national communications and supplemental documents.
- Animal population: Animal population can be obtained from national statistic year book or FAO database.

3.2.5 Examples

If country X has problem with the estimation of CH_4 from swine manure, the CH_4 emission from swine can be estimated as described in **table 3.2.1.**

3.2.6 Assessment of reliability

The reliability of this method depends on the reliability of animal population data and the confidence levels of emission factors used by other countries. The confidence levels of CH_4 emissions from animal waste reported by Parties to UNFCCC were ±20 - ±80 per cent in quantitative or M-L in qualitative terms *(Page 36-37, in FCCC/SBSTA/1998/7).*

3.2.7 Constraints and limitations

The average emission factor over Annex B countries with different circumstances did not represent a country's livestock characteristics and manure management system, and may be highly uncertain as a result.

3.3 Extrapolation based on a driving factor

3.3.1 Description of method

If country X has problem in estimating CH_4 emission from AWMs in some years, the methane emission from AWMs can be calculated or recalculated based on the changes of animal population, manure management systems.

Equation 3.3.1

$EFni = EFoi\times (\sum MSo_{ijk}\%\times MCF_{jk})/ (\sum MSn_{ijk}\%\times MCF_{jk})$.

Where :

EFn_I = new emission factor for animal type i

EFo_i = nmission factor in the year when CH_4 emission was estimated

i : Animal type

$MSo_{ijk}\%$ = fraction of animal manure handled using manure system j in climate region k in the estimated year.

$MSn_{ijk}\%$ = fraction of animal manure handled using manure system j in climate region k in the unestimated year.

MCF_{jk} = CH_4 conversion factors for each manure management system j by climate region k.

Equation 3.3.2

CH_4 $emission_i$ *(Gg/yr) =* $Efn_i \times population_i = EFo_i \times (\sum MSo_{ijk}\%\times MCF_{jk})/ (\sum MSn_{ijk}\%\times MCF_{jk}) \times population_i$ *= Base year* $emission_i$ *(1 + population increase or decrease rate %× (DYear) /100)* $\times (\sum MSo_{ijk}\%\times MCF_{jk}) / (\sum MSn_{ijk}\%\times MCF_{jk})$.

Where :

CH_4 $emission_i$ = CH_4 emissions from animal type i (Gg CH_4/yr)

population i= the population of animal type i in the unestimated year

ΔYear = number of specific year – base year number

3.3.2 Technical preconditions and data requirements

Following data are required to support this method :

- Methane emission for animal type i in the previous reports
- Animal population increase or decrease rate
- The changes of manure management systems usage. If the usage changes on manure management systems are not available, using EFo_{ijk} instead of EFn_{ijk}

3.3.3 Availability of data

- Base year emission can be obtained from UNFCCC.
- Animal population change rate can be obtained from FAO database.

3.3.4 Examples

Table 3.3.1 shows that how CH_4 emission from sheep manure management in New Zealand in 1994 is calculated based on base year CH_4 emission and sheep population decrease rate from 1990 to 1997 .

3.3.5 Assessment of reliability

The reliability depends on the confidence levels of base year estimates and the population data.

3.3.6 Constraints and limitations

The constraint of this method is that CH_4 emission from this source of AWMs could not be estimated using this method if some sources have never been estimated in some countries.

3.4 Linkages of emissions between sources and gases

1.4.1 Linkages of emissions between sources

The influencing factors controlling CH_4 emissions from enteric fermentation and from manure management systems are different. The main influencing factor for CH_4 emission from enteric fermentation is energy intake, milk production, feed quality, and CH_4 are mainly produced by ruminant animals. The main influencing factors

for CH_4 emissions from AWMs are manure management systems and climate. It is not suitable to work out CH_4 emission from animal manure management systems based on CH_4 emissions from enteric fermentation.
1.4.2 Linkage of emissions between gases
There are some linkages of CH_4 and N2O emissions from AWMs. But N2O emission factor can not be deduced from CH_4 emission factor, or CH_4 emission factor can not be deduced from N2O emission factor. It is not suitable to reckon CH_4 emission from AWMs through the results of N2O emission from AWMs.

3.5 Interpolation and extrapolation

3.5.1 Description of method

It is assumed that CH_4 emission would linearly increase or decrease with the time.
Equation 3.5.1:

CH_4 emissions $_{ij}$ (Gg/yr) = Base year emission$_{ib}$ + CH_4 emission increase or decrease rate per year ×(j-b)

Where :

CH_4 emissions $_{ij}$ = CH_4 emissions from animal type i in the year of j (Gg CH_4/yr)
Base year emission $_{ib}$ = CH_4 emission from animal type i in the base year (Gg CH_4/yr).
CH_4 emission increase or decrease rate per year = (Emission $_{ip}$-Emission $_{ib}$)/(p-b)
CH_4 emissions $_{ip}$ = CH_4 emissions from animal type i in the year of p (Gg CH_4/yr).

3.5.2 Technical preconditions and data requirements

The technical precondition for this method is availability of CH_4 emissions from manure management system for at least two years.

3.5.3 Availability of data

CH_4 emissions from particular animal manure can be obtained from UNFCCC.

3.5.4 Examples

Table 3.5.1 shows how to estimate CH_4 emission from animal manure management systems based on the linear relation between CH_4 emission provided by parties and year.

3.5.5 Assessment of reliability

Table 3.5.1 shows that the differences between the national reported result and the interoplated and extrapolated results are –1.5 % and 2.3% for 1993 and 1996 based on the emissions from 1990 and 1994 .
The reliability of this method depends on the national reported results and change trend of animal population. If the population increase or decrease linearly , and the previous estimated results were with higher reliability, this method has higher reliability. If there are enough data, it is recommend setting up the CH_4 emissions function over year and simulating CH_4 emission from a specific year.

3.5.6 Constraints and limitations

The constraint of this method is that the reliable CH_4 emission from animal type must be available for at least two years.

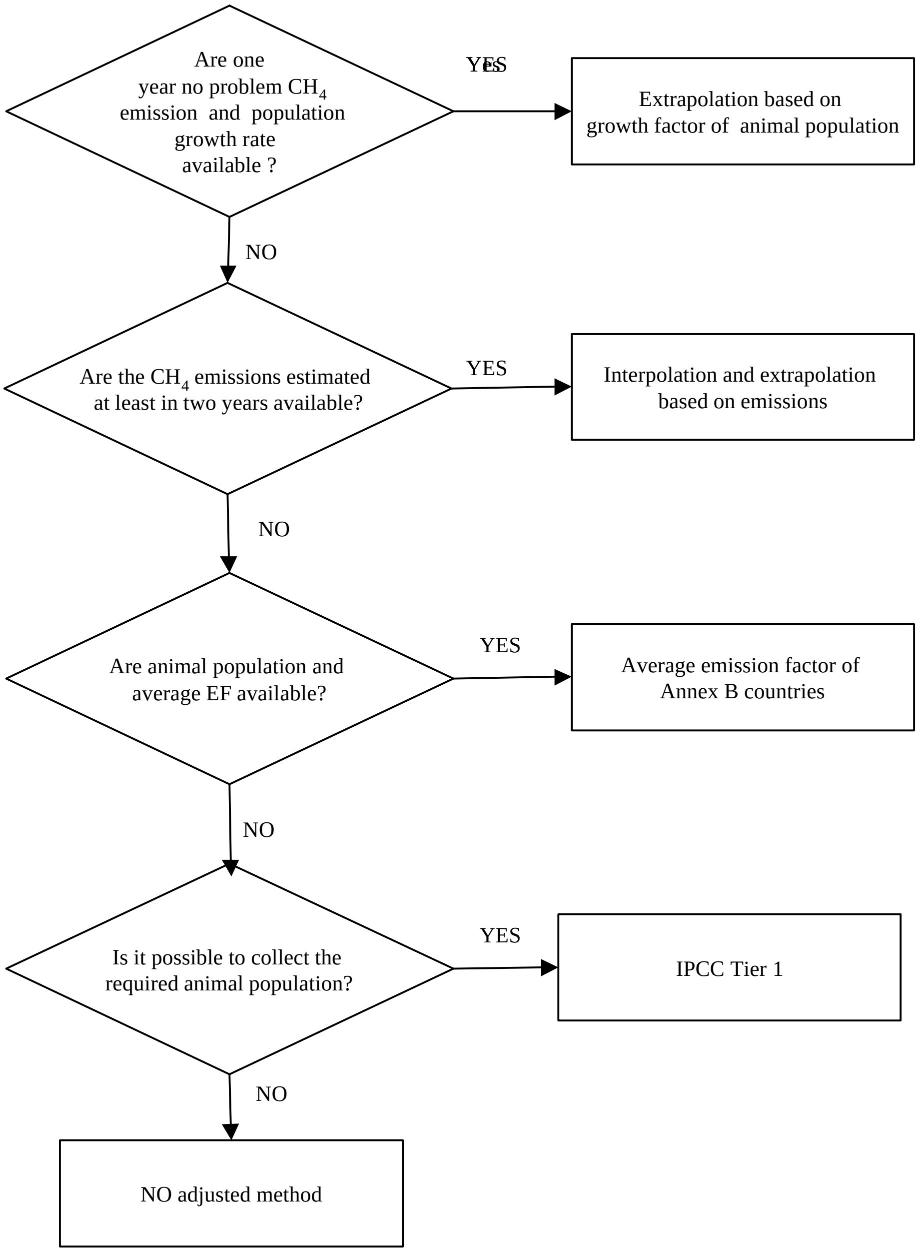
3.6 Comparison and ranking of methods

In conclusion, there are four methods with different reliability that could be used to obtain the revised technical estimates of CH_4 emissions from manure management system. The ranking criteria for adjustment methods are based on the reliability and data availability. The process for determining which adjustment method to use is shown in the decision tree (**see Figure 3.6.1)**
The Extrapolation based on population growth rate: The CH_4 emissions could be estimated just based on one year CH_4 emission and animal population increase rate by growth rate method. The differences between the CH_4 estimates obtained using this method and the estimates reported by New Zealand were -2.8% in 1994 and –1.45% in 1995, respectively. Because animal population increase rates for all annex B countries are available from FAO database. If the one-year reliable estimates can be obtained, this method is most preferable.
Interpolation and extrapolation: If there are two-year reliable CH_4 emission of Parties, adjusted CH_4 estimates from AWMS could be obtained by interpolation and extrapolation method without additional animal production information requirement. The differences between the adjusted estimates and the estimates reported by Parties are lowest in four methods.

Average emission rate method: Considering some countries adopted IPCC Tier2 to estimate the emission factors of different animals, it minimized the uncertainty of IPCC default emission rate, the confidence levels of CH_4 emissions from animal waste reported by Parties to UNFCCC was $\pm$20 **-** $\pm$80 percent in quantitative terms. If the average emission rate over countries with similar circumstance is used to estimate the adjusted emission, the uncertainty will be relatively lower than using IPCC Tier 1.

IPCC simple method: Even though default emissions factors values recommended by IPCC[1] do not represent a country's livestock characteristics and manure management practices, the difference of CH_4 emissions from animal waste between using IPCC method and reported by Parties to UNFCCC was as high as 1000 % in some countries. If there are no any reliable CH_4 emissions from animal waste estimates of the country or reliable emission factors from similar Annex B countries, CH_4 emissions from AWMs should be calculated by using IPCC Tier I.

Figure 3.6.1 Decision tree for selecting adjustment method of CH_4 emission from Livestock manure management system



4 N_2O emissions from manure management systems

4.1 Simple IPCC methods using available animal population data

4.1.1 Description of method

N_2O emissions from AWMs could be calculated or recalculated by using IPCC method with available animal population data from FAO database, default manure management system usage data, default nitrogen excretion data and default emission factors recommended by IPCC 1996.

Equation 4.1.1

N_2O emissions $_i$ (Gg N_2O-N/yr) = $EF_i \times \sum MS_{ij}\% / 100 \times Nex_j \times population_j \times (1-Frac_{GASM})(head) \times (10^{-6})$

Where :

N_2O emissions $_i$ = N_2O emission from manure management system i;

i = manure management system

j = animal type

EF_i = default emission factor for manure management system i (kgN_2O-N /KgNitrogen excreted)

Population $_j$ = number of animals of type j

Nex_j = nitrogen excretion by animal type j (kg N/animal/year)

$MS_{ij}\%$ = fraction of animal manure handled using manure system i by animal type j

Frac $_{GASM}$ = fraction of livestock nitrogen excretion that volatilizes as NH3 and NO_x (default =0.2)

4.1.2 Technical preconditions and data requirements

IPCC method could be used for the case of incomplete of a source but availability of the necessary activity data from national statistic data or UN data, or for the case of problem methodology.

IPCC method requires collecting following data:

- Animal population of each subgroups.
- Default values for nitrogen excretion per head of animal by region.
- Default values for percentage of manure management systems
- Default values for N_2O emission factors from animal manure management systems

4.1.3 Availability of data

- Default values:

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook Table 4-6 listed the default values for nitrogen excretion per head of animal by region. Default values for percentage of manure nitrogen produced in different animal waste management systems in different regions and default values for N_2O emission factors from animal manure management systems can be available from T*able 4-7 and Table 4- 8 of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook*

- The data on animal population can be collected from Party's national statistic yearbook or from *FAO database*

4.1.4 Examples

Table 4.1.1 is an example to estimate N_2O emissions from swine manure in New Zealand.

4.1.5 Assessment of reliability

The reliability of this method mainly depends on confidence of default emission factors, default nitrogen excretion data of animals and default manure management system usage data recommended by IPCC 1996. The difference between the results estimated using IPCC method and submitted to UNFCCC by United States was listed in **table 4.1.2.** The difference of total N_2O emission from swine manure management system estimated in different methods reached 798%.

4.1.6 Constraints and limitations

The default emissions factors recommended by IPCC[1] are not based on country - specific data, they did not accurately represent a country's livestock characteristics and manure management practices, and may be highly uncertain as a result.

4.2 Estimation based on Annex B averages and driving factor

4.2.1 Description of method

Method 1: Estimating based on average emission factors for each animal manure management system

If the nitrogen excretion and usage of different manure management system can be obtained from Party which has problem with the N_2O emission from AWMs source, N_2O emissions from AWMs could be recalculated based on the average emission factors of Annex B countries and animal population.

Equation 4.2.1:

$$N_2O\ emission_{ij}\ (Gg/yr) = AVEF_i \times MS_{ij}\%/100 \times Nex_j \times (1\text{-}Frac_{GASM}) \times Population_j\ (head) \times (10^{-6})$$

Where:

$N_2O\ emission_{ij}$ = N_2O emission, by animal manure management system i and by animal type j.

$AVEF_i$ = Average emission factor of Annex B Countries for animal manure management system i ;

$AVEF_i = 1/n \sum (EF_i)$

n- number of Annex B countries

Population = animal population of animal type j

j = animal type and i = Manure managemaent system

Method 2: Estimating based on average emission factors per livestock head

If the nitrogen excretion data of animal and manure management system usage can not be obtained from Party, N_2O emissions from AWMs could be recalculated based on the average emission factors per livestock head and animal population.

Equation 4.2.2

$$Total\ N_2O\ emission\ (Gg/yr) = \sum AVEF_j \times Population_j\ (head) \times (10^{-6})$$

Where:

Total N_2O emission$_j$ = N_2O emission from animal manure management system

$AVEF_j$ = Average emission factor of Annex B Countries of animal type j (kg/head/yr)

Population = Animal population of animal type j

4.2.2 Technical preconditions and data requirements

Method 1:

The technical preconditions for this method is that the emission factors of each animal for different animal manure management system, manure management system usage data, nitrogen excretion of animal, and the fraction of livestock nitrogen excretion that volatilizes as NH3 and NOx are available.

Method 2:

The technical preconditions for this method are that the usage of the different manure management system of Annex B countries are the same, and that the N_2O emission and animal populations of each animal type are available.

4.2.3 Availability of data

Method 1:

- The emission factors of each animal type for different animal manure management system, manure management system usage data, nitrogen excretion of animal, and the fraction of livestock nitrogen excretion that volatilizes as NH3 and NOx are available from the *worksheet 4-1 of submitted by Annex B countries.*
- Animal populations of each animal type are available from *FAO database.*

Method 2:

- N_2O emissions of each animal type of Annex B countries are available from the *worksheet 4-1 of IPCC 1996 Guidelines: Workbook submitted by Annex B countries.*
- Animal populations of each animal type are available from *FAO database.*

4.2.4 Examples

Method 2:

Table 4.2.1 is an example using the average emission rate of different animals of Annex B countries to estimate the N_2O emissions of manure management system of Canada. Because for this analysis N_2O emissions from different animals were only available from USA, the emission rate of USA will be used as the average emission rate of Annex B countries.

4.2.5 Assessment of reliability

Table 4.2.1 shows that average emission rate method will cause a very large difference due to the different manure management usage in different countries, even the USA and Canada have the similar animal production system. The difference of N_2O estimate from manure management system of Canada based on emission rate of USA will be -245% comparing to estimation using nation method/data .

4.2.6 Constraints and limitations

The average emission rate over Annex B countries with different circumstances could not represent a country's livestock manure management system characteristics for various categories livestock.

4.3 Extrapolation based on a driving factor

4.3.1 Description of method

If country X has problem in estimating N_2O emission from AWMs in some years, the N_2O emission from AWMs can be calculated or recalculated based on the changes of animal population.

Equation 4.3.1 :

N_2O emission $_j$ (Gg/yr) = Base year N_2O emission$_j$× (1 + population increase or decrease rate (%)×(p-b)/100)

Where :

Base year N_2O emission $_j$ = N_2O emissions from animal type j in base year (Gg N_2O/yr)

N_2O emission$_j$ = N_2O emissions from animal type j in the year (Gg N_2O/yr).

population increase or decrease rate (%) = Animal population change (%) from the base year

b=the base year (b=1990)

p= specific year

4.3.2 Technical preconditions and data requirements

The technical preconditions for this method is the availability of the base year N_2O emission from AWMs of animal type j followed IPCC 1996 revised Guidelines by any good practice agreed upon by the Conference of the Parities in the previous national communications .

Data requirements for this method are:

- Base year N_2O emission from animal type j
- Animal population increase or decrease rate

4.3.3 Availability of data

- N_2O emission from animal manure management systems by animal type can be obtained from UNFCCC for some countries.
- Animal population can be obtained from national statistic yearbook or FAO. The animal populations increase or decrease rate can be calculated based on animal populations.

4.3.4 Examples

N_2O emission from cattle management system in United States in 1990 was 17.2 Gg. Cattle population increase rate from 1990 to 1995 was 1.34% per year. N_2O emission in 1994 = Emission 1990 (1+population increase rate%×(1994-1990)/100)=14.2×(1+1.34×4/100)=15.7 Gg. **(Table 4.3.1)**.

4.3.5 Assessment of reliability

The reliability depends on the confidence of the estimates in the base year and the population data. Table 4.3.1 shows that the difference caused by the linear assumption is 4.9% and 1.7% compared with that of national estimates in 1994 and 1996, respectively.

4.3.6 Constraints and limitations

The constraint of this method is that N_2O emission from this manure management system and animal type can not be estimated using this method if some sources have never been estimated in some countries, or the manure management system changed a lot from the base year to calculated year.

4.4 Linkages of emissions between sources and gases

1.4.1 Linkage of emissions between gases

There are some linkages of CH4 and N_2O emissions from AWMs. But N_2O emission factor can not be deduced from CH4 emission factor, or CH_4 emission factor can not be deduced from N_2O emission factor. It is not suitable to reckon N_2O emission from AWMs through the results of CH_4 emission from AWMs.

4.5 Interpolation and extrapolation

4.5.1 Description of method

It is assumed that N_2O emission would linearly increase or decrease with the time.

Equation 4.5.1

N_2O emissions $_t$ (Gg/yr) = N_2O emission$_k$ + N_2O emission increase or decrease rate/year ×(t-k)

Where :

N_2O emission $_t$ = N_2O emissions from animal manure management system in the year of t

N_2O Emission$_k$ = N_2O emission from animal manure management system in the year of k.

Equation 4.5.2

N_2O emission increase or decrease rate per year = (Emission $_p$- Emission $_k$)/(p-k)

N_2O Emission $_p$ = N_2O emission from animal manure management system in the year of p

t, p, k = Year number

4.5.2 Technical preconditions and data requirements

The technical precondition for this method is the availability of reliable N_2O emissions from animal manure management system for at least two years.

4.5.3 Availability of data

N_2O emissions from animal manure can be obtained from UNFCCC database. **Table 4.5.1** present the N_2O emissions from all Annex B countries.

4.5.4 Examples

N_2O emissions from manure management systems in 1990 and 1994 were 11 and 9 Gg, respectively in Germany. The N_2O emission increase rate would be:

N_2O emission increase rate = (9-11)/(1994-1990)= 0.67 Gg/year, and

N_2O emission in 1993 =11 + 0.67×(1993-1990)=9.7 Gg

See **table 4.5.2**

4.5.5 Assessment of reliability

Table 4.5.2 shows that the N_2O differences between the national result and the linership interoplated and extrapolated results are –14.8 % to 14.8% form 1990 and 1997 based on the emissions from 1990 and from 1994.

The reliability of this method depends on reliability of the national N_2O emission data and change trend of national emission provided by party. If the N_2O emissions increase or decrease linearly, this method can simulate well. If there are enough data, it is recommend to set up the N_2O emission function over year and simulate N_2O emission from a specific year, Table 4.5.2 suggested that the difference of the simulated results and national results are –8.2% to +8.4%, difference converges by 6%.

4.5.6 Constraints and limitations

Reliable N_2O emissions for at least two years is required. If some countries have only one year values, this method can’t be used as adjustment method.

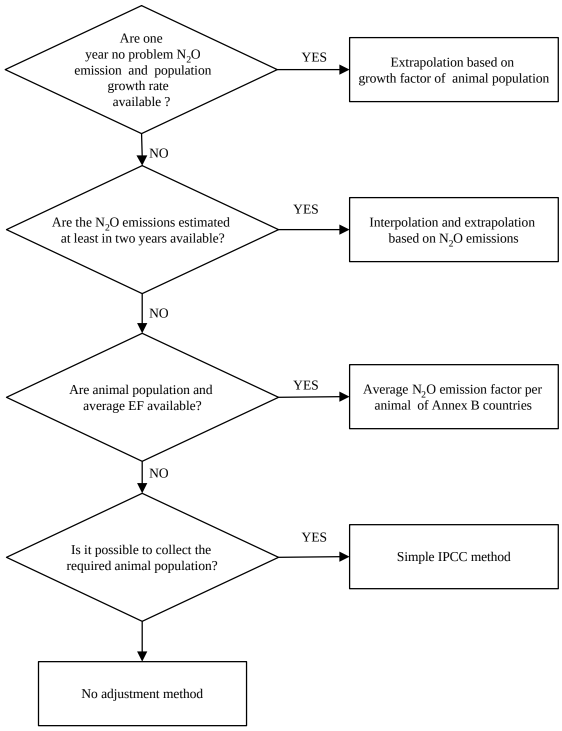
4.6 Comparison and ranking of methods

There are four methods with different reliability that could be used to obtain the revised technical estimates of N_2O emissions from manure management system. The process for determining which adjustment method to use is shown in the decision tree (**see Figure 4.6.1)**

The Extrapolation based on population growth rate: The N_2O emissions could be estimated just based on one year N_2O emission and animal population increase rate by growth rate method. The differences between the N_2O estimates obtained using this method and the estimates reported by USA Parties are 4.9% and 1.7% in 1994 and 1996, respectively. Generally, animal population increase rates for all Annex B countries are available from FAO database. So If the one-year reliable estimates can be obtained, this method would work well.

Interpolation and extrapolation: If two-year reliable N_2O emissions of Parties are available, adjusted N_2O estimates from AWMS could be obtained by interpolation and extrapolation method without additional animal production information requirement. If the country has more than two year no problem N_2O emission data, simulating N_2O emissions by setting up N_2O emission function over year will be relatively better than the estimations based on linear interpolation and extrapolation.
Average emission rate method: If the average emission rate over countries with similar climate and manure management system is used to estimate the adjusted emission, the uncertainty will be relatively lower than using IPCC method.
IPCC simple method: N_2O emissions from AWMS should be calculated using IPCC method, if there are no any reliable estimates submitted to UNFCCC**.**

Figure 4.6.1 Decision tree for selecting adjustment method of N_2O emission from Livestock manure management system



5 CH_4 emissions from rice production

5.1 Simple IPCC methods using available data

5.1.1 Description of method

CH_4 emissions from rice field can be calculated by IPCC simple method just based on IPCC default emission factors and available planting area data.

Equation 5.1.1

$$Fc = \sum_{i} EF \times Scaling\ Factor_i \times A_i \times 10^{-9}$$

Where:

Fc = total CH_4 emissions from rice field (Gg CH_4/yr)

A= annual harvested area under specific water conditions (m^2/year)

Index i = sums all water regime; i=1, continuously flooded; i =2, intermittently flooded; i=3, flood prone, i=4, drought prone; i=5, water depth 50-100; i=6, water depth>100.

EF= default emission factor over integrated cropping season for the i^{th} water regium (g/m^2)

Scaling factor = cofficient for CH_4 emissions for exosystems relative to continuously flooded fields without organic amendment.

5.1.2 Technical preconditions and data requirements

This approach could be used for the case of available emission factors and the rice planting areas under different water regime.

Data requirements for this approach are as follows:

- Harvested rice area by water regime
- Default emission factors for continuously flooded area
- Scaling factors (relative to emission factors for continuously flooded fields).

5.1.3 Availability of data

- The harvested area data of the rice from FAO database can be used if national data are unavailable or inappropriate. **Table 5.1.1** contain the harvested rice area data of all Annex B countries from1990-1997. The harvested rice area by water regime from 1991 to 1997 can be estimated according to the proportion of harvested rice areas under different water regimes in 1990 of Table 4-11 of *IPCC 1996 revised Guidelines manual (IPCC, 1996).*
- Scaling factors (relative to emission factors for continuously flooded fields) can be obtained from Table 4-12 of *IPCC 1996 revised Guidelines manual (IPCC, 1996).*
- For the time being, the default value of emission factor for continuously flooded fields was not available for most of the Annex B countries.

5.1.4 Examples

Table 5.1.2 shows how the emission from rice field of Japan in 1994 is calculated.

5.1.5 Assessment of reliability

Table 5.1.2 suggests that use of the IPCC method could give difference of 56% comparing to the use of national methods/data in Japan.

5.1.6 Constraints and limitations

For the time being, the default value of emission factor for continuously flooded fields was not available for most of the Annex B countries. This method can only calculate CH_4 emission from rice fields for Australia, Italy, Japan and USA, and there is a large difference between estimated result by the IPCC default values listed in table 4-11, table 4-12, table 4-13 of IPCC (IPCC, 1996) and the results reported by the Parties.

5.2 Estimation based on Annex B averages and driving factor

5.2.1 Description of method

Adjusted CH_4 emissions from rice field could be estimated by multiplying average emissions rate over Annex B countries by harvested rice area of the country.

Equation5.2.1

$$Total\ Emissions CH_4\ (Gg/yr) = AVEF \times A \times 10^{-9}$$

Where :

Total Emissions = total emissions from rice field; (Gg CH_4/yr)
A = harvested rice area (m^2)
AVEF = average emissions factor (g/m^2)
AVEF = $1/n \sum EF_i$
i= country

5.2.2 Technical preconditions and data requirements

Average emission factor over Annex B countries can be calculated based on emission factors of each country. Following data are required to support Annex B average method:

- The harvested rice area for country,
- CH_4 emission from rice field of each country, and
- emission factors of all Annex B countries

5.2.3 Availability of data

- Harvested rice area

There are rice area data on FAO database. Table 5.1.1 contains the information on rice area according to the statistics from FAO database.

- CH_4 emission from rice field

The total CH_4 emissions from Annex B countries are available from the first and second national communications and supplemental reports submitted by Annex B Parties.

- Average emission factor

The emission factor for each Annex B country can be calculated based on the harvested rice area and CH_4 emission from rice field of the country.

5.2.4 Examples

Table 5.2.1 shows how to calculate CH_4 emission based on average factors from annex B countries and harvested rice areas.

5.2.5 Assessment of reliability

Table 5.2.1 suggests that use of the Tier1 could give about –44% to + 136% of different estimates compared to using national method/data.

5.2.6 Constraints and limitations

Average emission rate over Annex B countries could not represent a country's various water regime and fertilizer characteristics. This may be highly uncertain as a result.

5.3 Extrapolation based on a driving factor

5.3.1 Description of method

Emissions could be estimated by indexing a Party's baseline emissions with growth factor of the harvested rice field area.

Equation 5.3.1

$$CH_4\ emission\ (Gg/yr) = Base\ year\ emission \times e^{RX}$$

Where:

CH_4 Emissions = CH_4 emissions from rice field; (Gg CH_4/yr)
Base year emission = CH_4 emission from rice field in base year (1990 or other)
R - exponential growth rate of rice area.
X- a specific year (for example : for 1994, X=1994-1990=4)

5.3.2 Technical preconditions and data requirements

If the base year emission and the growth factor of rice area are available, this approach could work.
Data requirements for this method are:

- Base year emission from rice field ;
- Exponential growth rate of rice area.

5.3.3 Availability of data

- Base year emission:

The base year emissions of CH_4 from rice field of all Annex B countries can be obtained from *UNFCCC database.* **Table 5.3.1** contains the information on Ch_4 Emissions from rice field from 1990 - 1997

- Growth rate:

The FAO database contains the information about growth rate of rice area , **Table 5.3.2 present** the growth factor information of rice field of Annex B countries from 1990-1997.

5.3.4 Examples

Table 5.3.3 shows how the emission from rice field in Annex B countries in 1994 are calculated according to *the Exponential growth factor of rice area.*

5.3.5 Assessment of reliability

Table 5.3.3 suggests that the differences of emission between the national method and the growth factor method are –2.8% for Hungary, -6.5% for Japan and 11.6% for USA, respectively.

5.3.6 Constraints and limitations

One year reliable CH_4 emission from rice field of the problem countries must be available.

5.4 Linkages of emissions between sources and gases

Water and fertilizer management systems are the base data for CH_4 emission from rice field. The CH_4 emissions from rice field could not be estimated based on related sources and gases.

5.5 Interpolation and extrapolation

5.5.1 Description of method

CH_4 emissions from rice field could be estimated by indexing the party's emissions trend for several years.

Equation 5.5.1

Total emissions CH_4 (Gg/yr) = f(x)

Where:

Total CH_4 Emissions = total CH_4 emissions from rice field; (Gg CH_4/yr)

f(x) = CH_4 emissions function over year.

5.5.2 Technical preconditions and data requirements

The technical precondition for this method is that at least two years CH_4 emissions of rice field are available

5.5.3 Availability of data

The CH_4 emission from rice field of all annex B countries can be obtained from *UNFCCC database* **Table 5.3.1** contains the information on Ch_4 Emissions from the 1990-1997.

5.5.4 Examples

Table 5.5.1 is a example for setting trend equation for Hungary and Japan.

5.5.5 Assessment of reliability

From the table 5.5.1, the differences of the CH_4 emission by using national method and the extrapolation method are -25% to 32% for Hungary and -2.9 % to 9.3% for Japan, respectively.

5.5.6 Constraints and limitations

5.5.7 The uncertainty will be relatively large if there are only 2 year 's reliable emission data.

5.6 Comparison and ranking of methods

In conclusion, there are four methods with different reliability that could be used to obtain the revised technical estimates of CH_4 emissions from rice field. The ranking criteria for adjustment methods are based on the reliability and data availability. The process for determining which adjustment method to be used was shown in the **decision tree 5.6.1.**

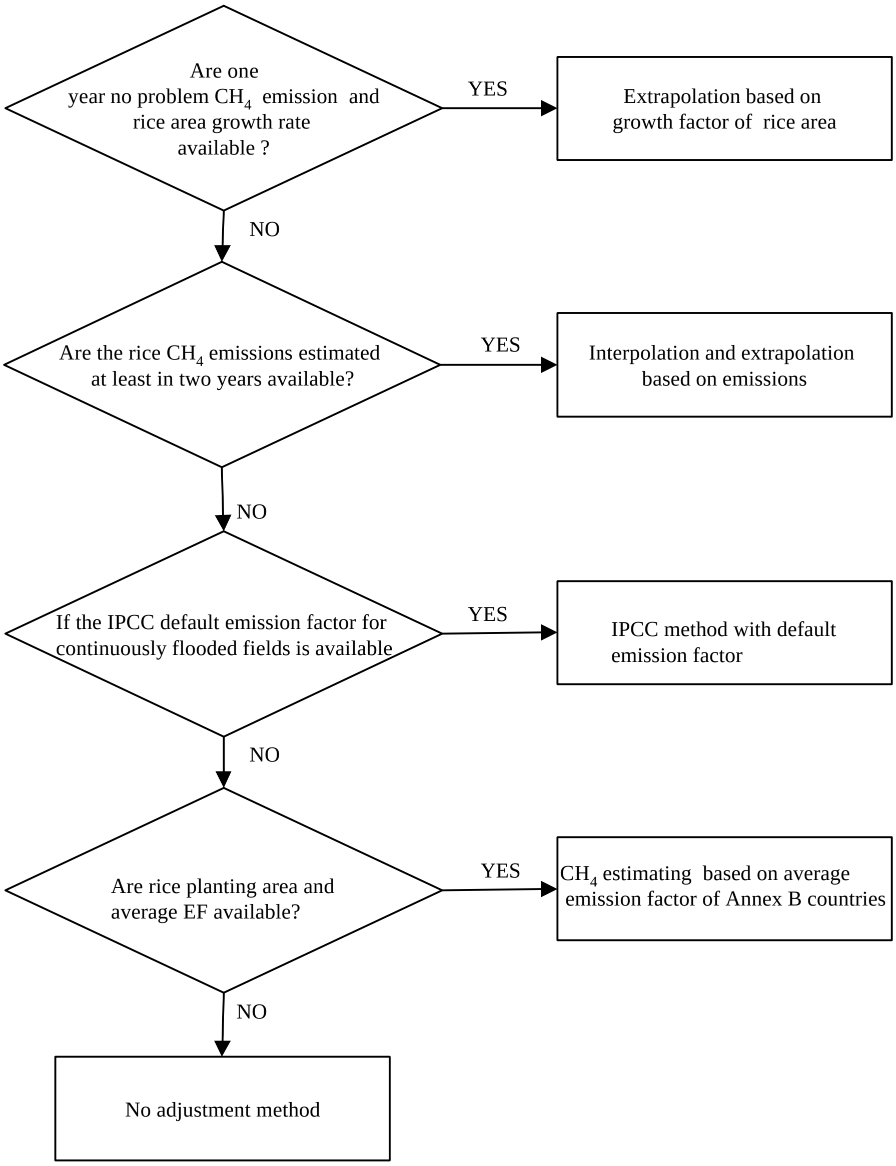
The Extrapolation based on growth rate of rice area: The CH_4 emissions could be estimated just based on one year CH_4 emission and rice area increase rate by growth rate method. The difference between the CH_4 estimates obtained using this method and the estimates reported by Japan is –6.5% in 1994. Because rice area growth rates for all annex B countries are available from FAO database, adjusted estimates can be obtained if the one-year CH_4 emission is reliable.

Interpolation and extrapolation: If there are two-year reliable CH_4 emission from rice fields of Parties. Adjusted CH_4 estimates from rice field could be obtained by interpolation and extrapolation method without information requirement. The reliability depends on the confidence of CH_4 emission from rice fields reported by the Party. The differences between the adjusted estimates and the estimates reported by Parties are smaller than 30%, and which is relative lower than IPCC method and average emission rate method.

IPCC simple method: Most of default emission factors recommended by IPCC[1] are from the field experiments of the countries. CH_4 emissions from rice fields could be recalculated using IPCC Tier I.

Average emission rate method: Considering there are no default emission factors recommended by IPCC for some countries, the average emission rate over Annex B countries with similar circumstance can be used to estimate the adjusted emissions.

Figure 5.6.1 Decision tree for selecting adjustment method of CH_4 emission from rice field



6 CH_4 and N_2O emissions from Burning of Savanna

6.1 Simple IPCC methods using available data

6.1.1 Description of method

CH_4 and N_2O emissions from burning of savanna on IPCC methodology with default values and savanna data can be represented as follows:

Equation 6.1.1:

Area of savanna burned annually (m^2)=Total area of savanna (m^2) $\times$ Fraction burned annually

Equation 6.1.2:

Biomass burned (t dm)= Area of savanna burned annually (m^2) $\times$ Aboveground biomass density (t dm/ m^2) $\times$ Fraction biomass actually burned

Equation 6.1.3:

Carbon released from live biomass (t C)=Biomass burned (t dm) $\times$ Fraction that is live $\times$ Fraction oxidized $\times$ Carbon content of live biomass

Equation 6.1.4:

Carbon released from dead biomass (t C)=Biomass burned (t dm) $\times$ Fraction that is dead $\times$ Fraction oxidized $\times$ Carbon content of dead biomass

Equation 6.1.5:

Total Carbon Released (t C)= Carbon released from live biomass (t C) + Carbon released from dead biomass (t C)

Equation 6.1.6:

CH_4 Emissions = (Carbon released) $\times$ (Emission ratio) $\times$ 16/12

N_2O Emissions = (Carbon released) $\times$ (N/C ratio) $\times$ (Emission ratio) $\times$ 44/28

6.1.2 Technical preconditions and data requirements

This approach could be used for the case of an incomplete source but availability of the necessary savanna data from national statistic data or UN data, or for the case of problem methodology. Data required are listed:

- Area of savanna;
- Fraction of savanna area burned annually;
- Average aboveground biomass density of savanna;
- Fraction of aboveground biomass which actually burns;
- Fraction of aboveground biomass which is living;
- Fraction of living and dead aboveground biomass oxidized;
- Fraction of Carbon in living and dead biomass;
- Emission ratio for savanna burning;
- N/C ratio in savanna biomass

6.1.3 Availability of data

- There are no routine published data on the amount of savanna burned, but FAO forest Resources Assessment 1990: tropical Countries (FAO 1993) provides country estimates of savanna area
- Table 4-12 of the *Revised 1996 IPCC Guideline on GHG workbook* provides much of the basic default data including: Fraction of savanna area burned annually; Average aboveground biomass density; Fraction of biomass actually burned; Fraction of aboveground biomass which is living;
- Table 4-13 of the *Revised 1996 IPCC Guideline on GHG workbook* provides default on Fraction Oxidized and Carbon Fraction
- *Table 4-14 of the Revised 1996 IPCC Guideline on GHG workbook* provides values of emission ratio for savanna burning
- N/C ratio in savanna biomass (default values = 0.006)

6.1.4 Examples and assessment of reliability

There are no routine published data on the amount of savanna burned.

6.1.5 Constraints and limitations

The main constraints are lack of following data: savanna area burned annually; the aboveground biomass density of savanna; the fraction of aboveground biomass that is actually burned; and the fraction that is oxidized.

6.2 Estimation based on Annex B averages and driving factor

6.2.1 Description of method

Adjusted CH_4 and N_2O emissions from savanna burning could be estimated by multiplying average emissions rate over Annex B countries by area of savanna.

Equation 6.2.1

$$Total\ Emissions CH_4\ or\ N_2O\ (Gg/yr) = AVEF \times A \times 10^{-9}$$

Where:

Total Emissions = Total emissions from savanna burning (Gg CH_4 or N_2O/yr)
A = Area of savanna that is burned annually (m^2)
AVEF = CH_4 or N_2O Annex B average emissions rate of savanna burning (g/m^2)

6.2.2 Technical preconditions and data requirements

If the emission factor is inappropriate, the adjusted estimate could be made by applying the average emission rate over the Annex B countries

Following data are required to support this approach:

- Average emission rates of the Annex B countries
- Area of savanna that is burned annually

6.2.3 Availability of data

- The Average emission rates of savanna burning

Only Australia CH_4 and N_2O emission data from savanna burning are available for this analysis from UNFCCC database. **Table 6.2.1** contains the information on CH_4 and N_2O emission data in Australia from 1990-1997.

- Area of savanna that is burned annually

There are no routine published data on the amount of savanna burned.

6.2.4 Constraints and limitations

The major constrain for this method is that there are no published data of emission factors and burned area of savanna. It is important to investigate the emission factors and the activity data.

6.3 Extrapolation based on a driving factor

The savanna burning is a management practice for improving savanna productivity. It was burned every several years. It is impossible to using the growth factor method to estimate the N_2O and CH_4 emissions from savanna burning.

6.4 Linkages of emissions between sources and gases

The CH_4 and N_2O emissions from savanna burning could be deduced each other.

6.4.1 Description of method:

Equation 6.4.1:

CH_4 Emission from savanna burning = N_2O emission from savanna burning $\times$ C/N $\times$ CH_4 Emission ratio/ N_2O emission ratio $\times 28/33$

Equation 6.4.2

N_2O Emission from savanna burning=CH_4 emission from savanna burning $\times$ N/C $\times$ N_2O emission ratio/ CH_4 Emission ratio $\times 33/28$

6.4.2 Technical preconditions and data requirements

This approach could be used for the countries that submitted one of the CH_4 and N_2O emissions. Data required are listed:

- CH_4 or N_2O emission.
- N/C ratio of savanna

- CH_4 and N_2O emission ratios

6.4.3 Availability of data

- One of the CH_4 and N_2O emission values could be available from UNFCCC database
- CH_4 and N_2O emission ratios could be obtained from *Table 4-15 of the Revised 1996 IPCC Guideline on GHG workbook*
- Default value of N/C ratio in savanna biomass is 0.006 (*IPCC, 1996 Reference Manual P 4.80*).

6.4.4 Examples

Table 6.4.1 shows how to estimate CH_4 and N_2O emissions from savanna burning of Australia from 1990-1996.

6.4.5 Assessment of reliability

Table 6.4.1 suggests that use of the linkage method could give large different estimates compared to using national methods/data in Australia, the difference for CH_4 emissions deduced from N_2O emissions is as high as 316%, the difference for N_2O emissions deduced from CH_4 emissions is –76%.

6.4.6 Constraints and limitations

The main constrains for this method are the large uncertainties with the N/C ratio and CH_4 and N_2O emission ratios.

6.5 Interpolation and extrapolation

6.5.1 Description of method

Emissions could be estimated by indexing a Party's emissions trend for several years.

Equation 6.5.1

Total EmissionsCH_4 /N_2O (Gg/yr) = f(x)

Where:

Total Emissions = total emissions from savanna burning; (Gg CH_4 /N_2O /yr)

f(x) = CH_4 /N_2O emission function over year.

6.5.2 Technical preconditions and data requirements

The technical precondition for this method is the availability of CH_4 /N_2O emissions of savanna burning for at least two years.

6.5.3 Availability of data

The CH_4/N_2O from savanna burning for all annex B countries can be obtained from *UNFCCC database.* **Table 6.2.1** contains the information on CH_4/N_2O Emissions from the 1990-1997.

6.5.4 Examples

Table 6. 5.1 is a example for setting trend equation for Australia.

6.5.5 Assessment of reliability

From the table 6.5.1, it seems that the interpolation and extrapolation could be very close to the reported estimations if there are enough year emission data. The differences of emissions by national method and the extrapolation method are –1.9% - 2.6% for N_2O and -1.6 – 2.6% for CH_4 in Australia from 1990 to 1996.

6.5.6 Constraints and limitations

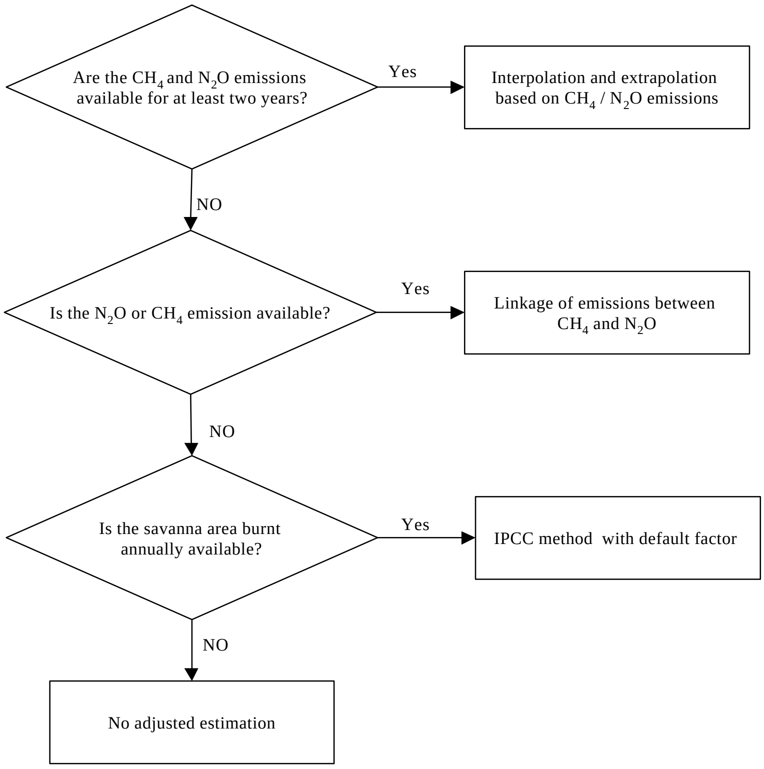
There are no available CH4/N2O emissions from savanna burning data for some countries. The uncertainty will be relatively large if there are only 2 year 's available emission data.

6.6 Comparison and ranking of methods

In conclusion, there are three methods with different reliability that could be used to obtain the revised technical estimates of CH_4 / N_2O emissions from savanna burning. The process for determining which adjustment method to be used is shown in the decision tree (**see Figure 6.6.1)**

Interpolation and extrapolation: If there are two-year reliable CH_4 / N_2O emissions of Parties, adjusted CH_4 /N_2O estimates from savanna burning could be obtained by interpolation and extrapolation methods, the differences between the adjusted estimates and the estimates reported by Parties are less than 10%.
Linkages of emissions between gases: The CH_4 and N_2O emissions from savanna burning could be deduced each other. However, because using default N/C ration of savanna, the difference for CH_4 emissions deduced from N_2O emissions is as high as 316%. The difference for N_2O emissions deduced from CH_4 emissions is –76%.
IPCC simple method: If the savanna areas are available, CH_4/N_2O emissions from savanna burning could be calculated using IPCC Tier I.

Figure 6.6.1 Decision tree for selecting adjustment method of CH_4 and N_2O from savanna burning



7 CH_4 and N_2O emissions from field burning of agricultural residues

7.1 Simple IPCC methods using available data

7.1.1 Description of method

CH_4 and N_2O emissions from field burning of agricultural residues by IPCC methodology with default values and crop production data can be represented as follows:

Equation 7.1.1:

Total Carbon Released (t C)=∑annual producrtion$_i$ (t biomass/year) × ratio of the residue to crop product × the average dry matter fraction of residue (t of dry matter/t of biomass) × fraction actually burned in the field × fraction oxidized × carbon fraction (t of carbon/t of dry matter)

Equation 7.1.2:

CH_4 Emissions = (Carbon released) × (Emission ratio) × 16/12

N_2O Emissions = (Carbon released) × (N/C ratio) × (Emission ratio) × 44/28

7.1.2 Technical preconditions and data requirements

This approach could be used for the case of an incomplete source but availability of the necessary crop production from national statistic data or UN data, or for the case of problem methodology. Data required are listed as follows:

- Amount of the crops produced with residues that are burned;
- Ratio of residues to crop product;
- Fraction of residue burned;
- Dry matter content of residues;
- Fraction oxidized in burning; and
- Carbon content of residues.

7.1.3 Availability of data

- Annual crop production can be found from FAO database.
- There are no reported default data on the fraction burned in the field, but some countries may have data.
- *Table 4-17 of Revised 1996 IPCC Guideline on GHG Reference Manual* provides much of the basic default data, including: ratio of residues to crop product; dry matter fraction; carbon fraction and N/C ratio.
- *Table 4-16* of *Revised 1996 IPCC Guideline on GHG manual* provides default emission ration.
- *Revised 1996 IPCC Guideline on GHG Workbook* recommends that Default values of fraction oxidized in burning can be 0.90

7.1.4 Examples

Table 7.1.1 shows how the emission from field burning of agricultural residues of USA in 1994 is calculated. The emission difference of between using IPCC method and national methods is 135.1% for CH_4 and 65.9% for N_2O, separately. The highest difference estimated by IPCC and national method for various crops is 1131% for CH_4 and 1859 % for N_2O, separately. .

7.1.5 Assessment of reliability

Table 7.1.1 suggests that use of the IPCC method could give very large different estimates compared to using national methods/data in USA

7.1.6 Constraints and limitations

The estimation of GHG emissions from field burning of agricultural residues by simple IPCC method is highly uncertain because of the lack on fraction burned in the field annually.

7.2 Estimation based on Annex I averages and driving factor

7.2.1 Description of method

Adjusted CH_4 emissions from agricultural residues burning could be estimated by multiplying average emissions

rate over Annex B countries by production of the various crop.

Equation7.2.1

Total EmissionsCH$_4$ and N$_2$O (Gg/yr) = AVEF×G× 10^{-9}

Where :

Total Emissions = total emissions from agricultural residues burning (Gg CH_4 and N_2O/yr)

G= amount of the agricultural with residues that are burned annually (ton)

AVEF = Annex B average emissions rate of agricultural residues burning (g/ton)

7.2.2 Technical preconditions and data requirements

If the emission factor is inappropriate, the adjusted estimate could be made by applying the average emission rate over the Annex B countries.

Following data are required to support this approach.

- Average emission rates of the burning of agricultural residues over the Annex B countries
- Amount of agricultural residues that is burned annually

7.2.3 Availability of data

- The average emission rates of field burning of agricultural residues

Average emission rates of field burning of agricultural residues could be calculated from emission factors submitted by the Annex B countries of Worksheet 4-4. But now there are no available data on average emission rates of field burning of agricultural residues

- There are no routine published data on amount of agricultural residues that is burned annually.

7.2.4 Constraints and limitations

The main constrain for this method is that there are no published data on emission factors and amount of agricultural residues burned annually of all Annex B countries.

7.3 Extrapolation based on a driving factor

7.3.1 Description of method

Emissions could be estimated by indexing a Party's baseline emissions using growth factor on the field burning of agricultural residues area.

Equation 6.3.1

CH$_4$ and N$_2$O Emissions (Gg/yr) = Base year emission $\times e^{R X}$

Where :

CH_4 and N_2O Emissions = CH_4 and N_2O emissions from field burning of agricultural residues (Gg CH_4/yr)

Base year emission = CH$_4$ and N$_2$O emissions from field burning of agricultural residues *in base year (1990 or other)*

R **-** *Exponential growth rate of crop Production*

X**-** Number of the year relative to base year.

7.3.2 Technical preconditions and data requirements

If the base year emission and the growth factor of crop production are available, this approach could work.

Data requirements for this method are:

- Base year emission from field burning of agricultural residues;
- Exponential growth rate of crop production.

7.3.3 Availability of data

- Base year emission:

The base year emissions of CH_4 and N_2O from field burning of agricultural residues of all Annex B countries can be obtained from *UNFCCC database.* **Table 7.3.1** contains the information on CH_4 and N_2O emissions from field burning of agricultural residues of all Annex B countries from 1990 – 1997.

- Growth rate:

Exponential growth rates of crop production are available from FAO database.

7.3.4 Constraints and limitations

The main constraint is that only when the fraction of the crop residues burned annually maintains relatively stable, this method could work well.

7.4 Linkages of emissions between sources and gases

The CH_4 and N_2O emissions from field burning of agricultural residues could be deduced each other.

7.4.1 Description of method:

Equation 7.4.1:

CH_4 Emission from field burning of agricultural residues = N_2O Emission from field burning of agricultural residues $\times$ C/N $\times$ CH_4 Emission ratio/ N_2O emission ratio $\times$28/33

Equation 7.4.2

N_2O Emission from field burning of agricultural residues=CH_4 Emission from field burning of agricultural residues $\times$ N/C $\times$ N_2O emission ratio/ CH_4 Emission ratio $\times$33/28

7.4.2 Technical preconditions and data requirements

This approach could be used for the countries that has submitted one of the CH_4 and N_2O emissions. Data required are listed as follows:

- One of the CH_4 and N_2O emission.
- N/C ratio
- CH_4 and N_2O emission ratios

7.4.3 Availability of data

- One of the CH_4 and N_2O emission could be available from UNFCCC database
- CH_4 and N_2O emission ratios could be obtained from Table 4-16 of the *Revised 1996 IPCC Guideline on GHG manual*
- Table 4-17 *of Revised 1996 IPCC Guideline on GHG Reference Manual* provides N/C ratio.

7.4.4 Examples

Table 7.4.1 shows how to estimate CH_4 and N_2O emissions from field burning of agricultural residues of USA in 1994.

7.4.5 Assessment of reliability

Table 7.4.1 suggests that use of the linkage method could give large different estimates compared to using national methods/data in USA. The differences for CH_4 emission estimates for various crops and for total emission are from –52% to 241% and 41%, respectively, and the differences for N_2O emission estimates for various crops and for total emission are from –71% to 108% and -26%, respectively.

7.4.6 Constraints and limitations

The main constrains for this method is the uncertainties in the N/C ratio and CH_4 and N_2O emission ratios.

7.5 Interpolation and extrapolation

7.5.1 Description of method

Emissions could be estimated by indexing a Party's CH_4 /N_2O emissions trend for several years.

Equation 7.5.1

Total Emissions CH_4 /N_2O (Gg/yr) = f(x)

Where:

Total Emissions = total emissions from field burning of agricultural residues; (Gg CH_4 /N_2O /yr)

f(x) = CH_4 /N_2O emission function over year.

7.5.2 Technical preconditions and data requirements

The technical precondition for this method is the availability of CH_4 /N_2O emissions of field burning of agricultural residues for at least two years.

7.5.3 Availability of data

The CH_4/N_2O from field burning of agricultural residues for all annex B countries can be obtained from *UNFCCC database.* **Table7.3.1** contains the information on CH_4/N_2O emissions from the 1990-1997.

7.5.4 Examples

Table 7. 5.1 is an example for setting trend equation for Japan and USA.

7.5.5 Assessment of reliability

From the Table 7.5.1, it seems that the interpolation and extrapolation could simulate well the estimations if emission data over year are enough. The differences between nation method and the extrapolation method are –4.2% to 4.2% for N_2O and –12.7 to 6.7% for CH_4 in Japan from 1990 to 1996, –49% to 5% for N_2O and –11.1 to 14.7% for CH_4 in USA from 1990 to 1996.

7.5.6 Constraints and limitations

The uncertainty will be relatively large if only 2 year's emission data are available, particularly for the countries in economic transition.

7.6 Comparison and ranking of methods

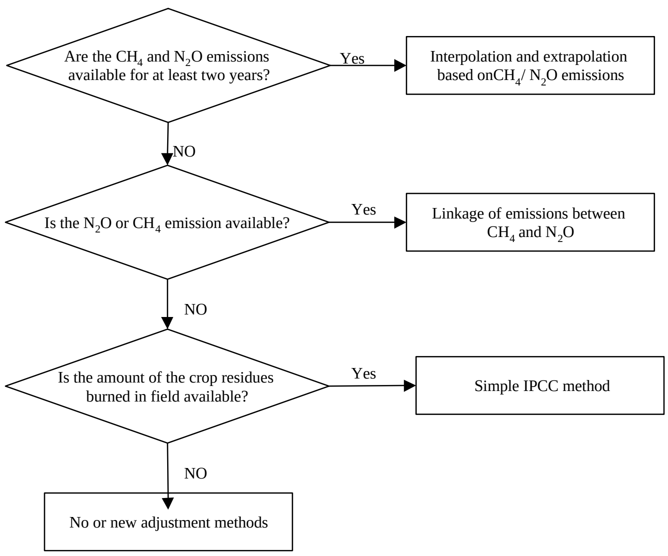
In conclusion, there are three methods with different reliabilities that could be used to obtain the revised technical estimates of CH_4 /N_2O emissions from field residues burning. The process for determining which adjustment method to be used is shown in the decision tree (**see Figure 7.6.1)**

Interpolation and extrapolation: If there are two-year reliable CH_4 / N_2O emissions of Parties, adjusted CH_4 /N_2O estimates from field burning of agricultural residues could be obtained by interpolation and extrapolation method, the differences between the adjusted estimates and the estimates reported by Parties are lowest in all methods.

Linkages of emissions between gases: The CH_4 and N_2O emissions from field burning of agricultural residues could be deduced each other. However, the maximum difference for CH_4 emissions deduced from N_2O emissions is as high as 240%. The difference for N_2O emissions deduced from CH_4 emissions is –71% to 108%.

IPCC simple method: If the annual amount of crop residues burned is available, CH_4/N_2O emissions from field burning of agricultural residues could be calculated using IPCC method .

Figure 7.6.1 Decision tree for selecting adjustment method of CH_4 and N_2O from field burning of agricultural residues



8. N_2O emissions from agricultural soils

8.1 Simple IPCC methods using available data

8.1.1 Description of method

N_2O emission from agricultural soil includes direct and indirect N_2O emissions. Simple IPCC method which relies on IPCC default emission factors and external available data could be used to recalculate the emissions. It could be expressed as following equation:

Equation 8.1.1

$$N_2O = N_2O_{DIRECT} + N_2O_{INDIRECT}$$

Where:

N_2O = N_2O emission from agricultural soil (kg N/y);
N_2O_{DIRECT} = direct N_2O emission from agricultural soils (kg N/y);
$N_2O_{INDIRECT}$ = indirect N_2O emissions from agricultural soils (kg N/y)

Equation 8.1.2

$$N_2O_{DIRECT} = [(F_{SN} + F_{AW} + F_{BN} + F_{CR}) \times EF_1] + F_{OS} \times EF_2$$

Where:

EF_1 = emission factor for direct soil emissions (kg N_2O-N/kg N input),
EF_2 = emission factor for organic soil mineralization due to cultivation (kg N_2O-N/ha/yr);
Fos = area of cultivated organic soils within country (ha of histosol in FAO data base);
F_{SN} = the total synthetic fertilizer excluding emissions of NH_3 and Nox.
F_{AW} = manure nitrogen used as fertilizer in country, corrected for NH_3 and NOx emissions and excluding manure produced during grazing (kg N/yr)
F_{BN} = N fixed by N-fixing crops in country (kg N/yr)
F_{CR} = N in crop residues returned to soils in country (kg N/yr)

Equation 8.1.3

$$F_{SN} = N_{FERT} \times (1-Frac_{GASF})$$

Where:

N_{FERT} = total use of synthetic fertilizer (kg N/yr);
$Frac_{GASF}$ = fraction of total synthetic fertilizer nitrogen that is emitted as NOx + NH_3

Equation 8.1.4

$$F_{AW} = [\ (N_{(T)} \times Nex_{(T)} \times AWMS_{(T)})\ ] \times [(1- (Frac_{FUEL} + Frac_{GRAZ} + Frac_{GASM})];$$

Where :

$N_{(T)}$ = number of animals of type T in the country;
$Nex_{(T)}$ = N excreted by animals of type T in a country (kg N/yr)
$AWMS_{(T)}$ = fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems in a country
$Frac_{FUEL}$ = fraction of livestock nitrogen excretion contained in excrements burned for fuel (kg N/kg N totally excreted)
$Frac_{GRAZ}$ = fraction of livestock nitrogen excreted and deposited onto soil during grazing (kg N/kg N excreted);
$Frac_{GASM}$ = fraction of livestock nitrogen excretion that volatises as NH_3 and NOx;

Equation 8.1.5

$$F_{BN} = 2 \times Crop_{BF} \times Frac_{NCRBF};$$

Where:

$Crop_{BF}$ = seed yield of pulses + soybeans in a country (kg dry biomass/yr);
$Frac_{NCRBF}$ = fraction of nitrogen in N-fixing crop

Equation 8.1.6

$$F_{CR} = 2 \times [Crop_0 \times Frac_{NCR0} + Crop_{BF} \times Frac_{NCRBF}] \times (1-Frac_R) \times (1-Frac_{BURN})$$

Where:

$Crop_0$ = production of all other (i.e. non-N fixing) crops in a country (kg dry biomass/yr);
$Frac_{NCR0}$ = fraction of nitrogen in non-N-fixing crop
$Frac_R$ = fraction of crop residue that is removed from the field as crop
$Frac_{BURN}$ = fraction of crop residue that is burned rather than left on field

Equation 8.1.7

$$N_2O_{INDIRECT} = N_2O_{(G)} + N_2O_{(L)}$$

Where:

$N_2O_{(G)}$ = N_2O produced from atmospheric deposition of NOx and NH_3 (kg/yr)
$N_2O_{(L)}$ = N_2O produced from nitrogen leaching and runoff (kg N/yr)

Equation 8.1.8

$$N_2O_{(G)} = \{N_{FERT} \times Frac_{GASF} + Nex \times Frac_{GASM}\} \times EF_4$$

EF_4 = emission factor for atmospheric deposition (Kg N_2O-N/kg N NH_3 and NO_x-N emitted)

Equation 8.1.9

$$N_2O_{(L)} = [\ (\ N_{FERT} + Nex\ ) \times Frac_{LEACH}\ ] \times EF_5$$

Where:

$Frac_{LEACH}$ = Fraction of nitrogen leaching, the default value is 0.3 (0.1-0.8) kg N/kg of protein
EF_5 = emission factor for leaching and runoff (Kg N_2O-N/kg N leaching/runoff)

8.1.2 Technical preconditions and data requirements

Besides the IPCC default emission factors and default values, the following data are required available for the IPCC method to calculate direct N_2O emissions from agricultural soil:

Emission factor : *(see table 4-18, 4-23 of IPCC 1996 Reference Manual)*

- Direct emission factor for agricultural soil (kg N_2O-N/kg N input), the default value is 0.0125 (in the range of 0.0025-0.0225)
- Emission factor for organic soil mineralization due to cultivation (kg N_2O-N/ha/yr), the default value is 5 and 10 for temperate and tropical regions respetively)
- Emission factors from animal waste management systems
- Indirect N_2O emission factor from nitrogen leaching and runoff (kg N/yr)
- Indirect N_2O emission factor from atmospheric deposition of NOx and NH_3 (kg/yr)

Default Values

See table 4-19, 4-20, 4-21, 4-24 of IPCC 1996 Reference Manual

Data on crop production, consumption of fertilizer, animal population

Data on crop production, consumption of fertilizer and animal population can be obtained from national statistic yearbook or FAO database.

- Total consumption of synthetic nitrogen fertilizer in a country (N_{FERT}, in kg N/yr)
- Number of animals of type T in a country ($N_{(T)}$)
- Seed yield of pulses + soybeans in a country ($Crop_{BF,}$ in kg dry biomass/yr)
- Production of all non-N fixing crops in a country ($Crop_0$, in kg dry biomass/yr)
- Area of cultivated organic soils within a country (Fos in ha)

8.1.3 Examples

Table 8.1.1 shows how to calculate direct N_2O emissions from agricultural soils of synthetic fertilizer in New Zealand (1990-1996)

8.1.4 Assessment of reliability

Table 8.1.1 shows that the difference of direct N_2O emissions resulted from FAO and national data of synthetic fertilizer could be –49 % to 39 %. The reliability of IPCC method depends on the confidence of FAO data on N input. There is large difference of national data and FAO data on N input in New Zealand.

8.1.5 Constraints and limitations

The constrains and limitations are large differences between FAO/IPCC and national data on fertilizer consumption, usage of animal manure management system, nitrogen excretion, etc..

8.2 Estimation based on Annex I averages and driving factor

8.2.1 Description of method

Adjusted emissions could be determined based on Annex I averages emission rate and total consumption of synthetic nitrogen fertilizer in a country, Emissions could be calculated as following:

Equation 8.2.1:

$$\mathbf{N_2O} = AVEF \times N_{FERT}$$

Where:

N_2O Emissions = N_2O emissions from agricultural soil. (Kg N_4/yr)
N_{FERT} = total use of synthetic fertilizer (kg N/yr);
AVFE = the average emission factor for Annex B countries (Kg N_2O /Kg N input)

Equation 8.2.2:

$AVFE = 1/n \sum EF_i$

Where : EF_I = emission factor of the country i (Kg N_2O /Kg N input)

i = specific country

n = Total number of related Annex B countries

Equation 8.2.3:

$EF_I = (N_2O\ Emission)_I / N_{FERT}$

8.2.2 Technical preconditions and data requirements

The adjusted estimate could be made by applying the average emission rate over the Annex B countries with the similar circumstances and with total use of synthetic fertilizer from national statistic data or UN data.

Following data are required to support this approach:

- N_2O emission of Annex B countries
- Total consumption of synthetic nitrogen fertilizer in a country

8.2.3 Availability of data

- N_2O emission of Annex B countries

N_2O emissions from all the Annex B countries are available from UNFCCC database . ***Table 8.2.1*** contain*s* the information on N_2O Emissions of 26 Annex B countries from the 1990-1997.

- Total consumption of synthetic nitrogen fertilizer in a country

Total uses of synthetic fertilizer (NFERT, in kg N/yr) are available from FAO database. **Table 8.2.2** contains the Nitrogen input of all Annex B Countries.

8.2.4 Examples

Table 8.2.3 show how the N_2O emissions from agricultural soil can be estimated from Annex B countries average emission rate.

8.2.5 Assessment of reliability

Table 8.2.3 suggests that the difference of the N_2O emissions from agricultural soil estimated using Annex B countries and national method/data are-4% to +212%.

8.2.6 Constraints and limitations

This average method could not consider difference of N_2O emissions from agricultural soil due to the different fertilizer application method.

8.3 Extrapolation based on a driving factor

8.3.1 Description of method

Method 1: Based on growth factor of nitrogen input

Adjusted emissions could be determined based on the base year emissions and the growth factor of nitrogen input. It could be expressed as follows:

Equation 8.3.1

$$N_2O\ Emissions\,(Gg/yr) = Base\ year\ emission \times e^{R\,X}$$

Where :

N_2O Emissions = N_2O emissions from agricultural soil. (Kg N/yr)

Base year emission = N_2O emissions from agricultural soil *in base year (1990 or other)*

R - Exponential growth rate of nitrogen input.

X- number of the year relative to base year.

Method 2: Based on nitrogen input

Adjusted emissions could be determined based on the nitrogen input. It could be expressed as follows:

Equation 8.3.2

$$N_2O\ Emissions\,(Gg/yr) = A \times Nitrogen\ input + B$$

Where :

N_2O Emissions = N_2O emissions from agricultural soil. (Kg N_2O -N/yr)

A, B = coefficients of the relationship between nitrogen input and N_2O emissions from agricultural soil.

8.3.2 Technical preconditions and data requirements

Method 1:
Following data are needed:
- N_2O Base year emission
- Exponential growth rate of nitrogen input.

Method 2:
- N_2O emission estimates and corresponding nitrogen input for at least two years

8.3.3 Availability of data

Method 1:
N_2O base year emissions from all the Annex B countries are available from UNFCCC database. ***Table 8.2.1*** *Contains* the information on N_2O Emissions of 26 Annex B countries from the 1990-1997.
Exponential growth rates of nitrogen input are available from FAO database. **Table 8.2.2** contains the Nitrogen input of all Annex B Countries.
Method 2:
N_2O emission from all Annex B countries are available from UNFCCC database. ***Table 8.2.1*** Contains the information on N_2O Emissions of 26 Annex B countries from the 1990-1997.
Annual nitrogen input of all Annex B countries are available from **Table 8.2.2** that contains the nitrogen input of all Annex B countries.

8.3.4 Examples

Method 1:
Table 8.3.1 is an example of estimating N_2O emissions from agricultural soil based on growth factor of the nitrogen input from FAO in New Zealand.
Method 2 :
Table 8.3.2show how the N_2O emissions from agricultural soil are simulated based on the relationship between the N_2O emission and nitrogen input in New Zealand..

8.3.5 Assessment of reliability

Method1:
Table 8.3.1 show that the difference of N_2O emissions from agricultural soil between the growth factor of the nitrogen input method and national method will be as high as 224%
Method 2:
Use of the relationship between the N_2O emission and nitrogen input can give the results close to the emission reported by the Party, the difference is only –0.7% to 1%.

8.3.6 Constraints and limitations

N_2O emissions from agricultural soil for some of the Annex B countries are unavailable

8.4 Linkages of emissions between sources and gases

It seems that the N_2O emissions from agricultural soils have no direct linkages with other gases and other sources.

8.5 Interpolation and extrapolation

8.5.1 Description of method

Emissions could be estimated by indexing a Party's emissions trend for several years.
Equation 8.5.1

Total emissions N_2O (Gg/yr) = f(x)

Where:

Total Emissions = total emissions from agricultural soil; (Gg /yr)
f(x) = N_2O emission function over year.

8.5.2 Technical preconditions and data requirements

The technical precondition for this method is the availability of N_2O emissions of agricultural soil for at least two years.

8.5.3 Availability of data

The N_2O emissions from agricultural soil for all annex B countries can be obtained from *UNFCCC database.* **Table 8.2.1** contains the information on N_2O emissions from the 1990-1997.

8.5.4 Examples

Table 8. 5.1 is an example for setting trend equation for Australia.

8.5.5 Assessment of reliability

From the table 8.5.1, It seems that the interpolation and extrapolation could simulate very closely the reported estimations if there are enough year emission data. The differences between national method and the extrapolation method are –6.7% **-** 11.9% for N_2O emission from agricultural soil in Australia from 1990 to 1996.

8.5.6 Constraints and limitations

N_2O emission of agricultural soil for some Annex B countries are unavailable from UNFCCC database.

8.6 Comparison and ranking of methods

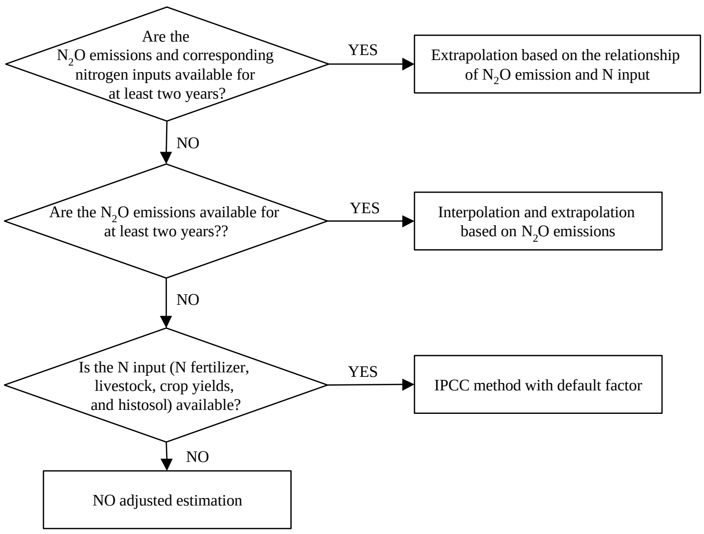
In conclusion, there are three methods with different reliability that could be used to obtain the revised technical estimates of N_2O emissions from agricultural soil. The process for determining which adjustment method to be used is shown in the decision tree (**see Figure 8.6.1)**

The Extrapolation based on nitrogen inputs: The N_2O emissions could be estimated based on the relationship between N_2O emissions and nitrogen inputs if N_2O emission and corresponding nitrogen inputs for two years are available. The differences between the N_2O emission obtained using this method and the estimates reported by New Zealand are – 0.7&-1.0% from 1990-1996.

Interpolation and extrapolation: If there are two-year reliable N_2O emissions of Parties, adjusted N_2O estimates from agricultural soil could be obtained by interpolation and extrapolation method without additional information requirement..

IPCC method: Even though default emissions factors values recommended by IPCC do not represent a country's nitrogen input practices, If there are no any reliable estimates submitted to UNFCCC, N_2O emissions from agricultural soil should be calculated using IPCC method based on the IPCC default values and nitrogen

Figure 8.6.1 Decision tree for selecting adjustment method of N_2O from agricultural soil



Reference:

1 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual
2 Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook
3 FAO database on web: http://apps.fao.org
4 UNFCCC database on GHG inventory on web: http:// www.unfccc.org

Appendix

Table 2.1.1 Animal population data

Stocks (Head)	Item										
1990	Asses	Buffaloes	Cattle	Chickens	Ducks	Goats	Horses	Mules	Pigs	Sheep	Turkeys
Australia	2,310		23,162,208	59,956	276	560,371	310,418		2,647,572	170,296,576	1,240
Austria			2,562,393	14,145	115	36,440	47,595		3,772,724	286,870	485
Belgium-Luxembourg			3,257,000	32,800	75	9,271	66,000	0	6,511,000	174,000	288
Bulgaria	328,587	23,046	1,575,107	35,033	300	432,923	118,902	21,751	4,352,000	8,130,305	605
Canada			11,220,400	111,000	720	27,300	415,000	4,000	10,392,400	595,000	4,300
Denmark			2,239,000	15,498	495		38,000		9,282,000	159,000	213
Finland			1,363,000	5,858	0	3,700	43,900		1,347,700	60,700	
France	25,000		21,394,000	194,166	15,936	1,226,000	319,046	12,973	12,275,500	11,208,800	26,428
Germany			20,287,824	121,270	1,100	76,938	483,900		34,177,504	4,135,247	5,029
Greece	136,987	773	653,860	27,578	123	5,347,827	49,318	65,015	1,000,700	8,723,025	116
Greenland										21,500	
Hungary	4,000		1,597,600	52,821	1,868	15,600	75,000	300	7,660,000	2,069,200	1,750
Iceland			74,889	506		345	71,693		37,000	548,508	
Ireland	15,000		5,969,100	8,187	150		53,500	1,200	1,110,100	5,713,900	993
Italy	74,000	112,400	8,745,900	134,000		1,246,000	271,000	43,100	9,254,300	10,848,000	23,400
Japan			4,760,000	337,857		34,500	23,100		11,817,000	30,700	8
Liechtenstein			6,328			171			3,251	2,781	
Netherlands			4,926,000	92,765	1,000	61,000	70,000		13,915,000	1,702,000	1,053
New Zealand			8,033,976	9,000	15	1,062,900	93,980		394,700	57,852,192	80
Norway			953,100	3,763		88,800	18,800		709,700	2,211,000	
Poland			10,048,929	62,755	6,466		941,157		19,464,224	4,158,465	857
Portugal	170,000		1,335,000	20,000	0	857,000	26,000	80,000	2,598,000	5,567,000	5,250
Romania	35,000	0	6,290,700	113,968	4,700	1,017,200	663,000		11,671,000	15,434,800	900
Spain	90,000		5,187,000	109,000	80	3,780,000	260,000	70,000	16,911,000	22,739,000	1,350
Sweden			1,718,443	11,300			58,000		2,263,943	405,595	290
Switzerland	2,000		1,855,200	5,964	0	68,300	45,300	350	1,787,000	395,200	
United Kingdom			12,079,000	124,636	2,217		169,000		7,450,000	43,828,000	9,596
United States of America	53,000		95,816,000	1,332,000	6,300	1,900,000	5,650,000	28,000	53,788,000	11,358,000	90,000
AGG_COUNTRIES	935,884	136,219	257,111,957	3,035,826	41,936	17,852,586	10,381,609	326,689	246,593,318	388,655,364	174,231

Stocks (Head)	Item										
1991	**Asses**	**Buffaloes**	**Cattle**	**Chickens**	**Ducks**	**Goats**	**Horses**	**Mules**	**Pigs**	**Sheep**	**Turkeys**
Australia	2,638		23,662,256	55,116	364	449,117	308,044		2,531,468	163,237,568	1,426
Austria			2,534,088	13,479	131	37,343	49,270		3,637,980	309,312	525
Belgium-Luxembourg			3,360,000	34,100	93	9,000	65,000	0	6,496,000	177,000	330
Bulgaria	328,579	25,517	1,456,900	26,998	200	498,087	115,425	19,456	4,186,575	7,938,056	500
Canada			11,288,800	112,000	820	27,500	419,000	4,000	10,172,000	628,300	5,200
Denmark			2,222,000	15,086	429		32,000		9,767,000	188,400	389
Finland			1,315,400	5,188	0	4,000	45,400		1,290,100	56,800	
France	25,000		21,450,496	198,943	16,742	1,162,100	322,173	12,662	12,013,300	11,170,200	27,724
Germany			19,488,000	106,054	2,014	90,000	490,954		30,818,832	3,239,482	4,528
Greece	127,373	769	623,514	26,767	114	5,334,105	45,266	59,631	995,517	8,660,000	110
Greenland										21,500	
Hungary	3,946		1,571,000	44,948	1,685	23,500	76,000	222	8,000,000	1,865,000	1,520
Iceland			77,681	430		350	74,069		38,000	510,782	
Ireland	15,000		6,100,500	9,628	140		52,000	1,200	1,249,100	5,863,700	1,244
Italy	50,883	94,500	8,140,000	133,000		1,297,500	287,847	32,970	8,837,000	10,847,600	22,800
Japan			4,873,000	331,526		36,500	24,300		11,335,000	30,300	4
Liechtenstein			6,204			213			3,543	2,689	
Netherlands			5,062,000	93,596	1,000	70,000	76,000		13,217,000	1,882,000	1,236
New Zealand			8,099,996	9,500	17	792,577	91,000		407,306	55,161,648	115
Norway			974,185	3,785		89,698	20,700		720,842	2,211,000	
Poland			8,844,000	52,013	7,163		938,894		21,867,584	3,233,669	888
Portugal	170,000		1,375,000	21,000	0	857,000	26,000	80,000	2,664,000	5,673,000	5,250
Romania	35,000	0	5,380,700	121,379	5,000	1,004,806	670,000		12,003,300	14,061,900	950
Spain	90,000		5,126,000	114,000	80	3,663,000	273,000	70,000	16,001,000	24,037,000	1,500
Sweden			1,706,778	8,725			76,750		2,201,413	418,783	291
Switzerland	2,000		1,828,900	5,730	0	65,200	49,000	300	1,722,600	409,400	
United Kingdom			11,885,000	127,241	2,191		170,400		7,597,000	43,639,000	9,759
United States of America	52,000		96,393,000	1,389,000	6,000	1,830,000	5,650,000	28,000	54,416,000	11,174,000	87,000
AGG_COUNTRIES	902,419	120,786	254,845,398	3,059,232	44,183	17,341,596	10,448,492	308,441	244,189,460	376,648,089	173,289

Stocks (Head)	Item										
1992	Asses	Buffaloes	Camels	Cattle	Chickens	Ducks	Goats	Horses	Mules	Pigs	Sheep
Australia	3,378			23,879,984	60,071	413	347,898	289,346		2,792,386	148,202,896
Austria				2,500,725	12,872	124	39,354	61,390		3,719,653	312,041
Belgium-Luxembourg				3,311,000	36,200	89	10,000	64,000	0	6,597,000	171,000
Bulgaria	329,406	25,164		1,310,454	20,907	150	552,736	114,267	17,405	3,141,402	6,703,372
Canada				11,869,000	108,000	350	27,500	350,000	4,000	10,596,300	647,900
Denmark				2,190,000	18,259	533		28,000		10,345,000	182,000
Estonia				708,273	5,372	61		7,756		798,603	141,882
Finland				1,263,200	4,967	0	5,200	49,260		1,356,700	61,100
France	25,000			20,970,000	207,119	18,244	1,121,136	327,899	12,404	12,539,000	10,639,500
Germany				17,133,800	95,632	2,257	83,000	491,600		26,063,408	2,487,548
Greece	118,412	939		601,831	27,376	112	5,336,400	42,098	54,478	986,200	8,692,000
Greenland											22,000
Hungary	3,900			1,420,046	35,556	1,512	24,215	74,654	220	5,992,960	1,807,943
Iceland				76,034	400		318	75,171		40,000	487,312
Ireland	14,000			6,157,600	9,920	140		51,000	1,100	1,345,500	5,987,600
Italy	40,000	83,300		8,004,000	135,000		1,314,200	316,425	19,000	8,548,800	10,434,600
Japan				4,980,000	334,658		35,100	25,800		10,966,000	29,200
Liechtenstein				6,013			277			2,902	2,878
Lithuania				2,196,600	16,380		6,300	79,700		2,179,800	58,100
Netherlands				4,920,000	99,359	1,140	63,000	86,000		14,161,000	1,954,000
New Zealand				8,144,321	9,600	18	532,767	87,951		411,148	52,568,000
Norway				984,078	3,680		89,422	20,690		765,698	2,363,000
Poland				8,221,359	50,202	7,412		899,521		22,085,824	1,869,566
Portugal	170,000			1,416,000	22,000	0	862,000	25,000	80,000	2,535,000	5,640,000
Romania	35,000	0		4,355,000	106,032	4,900	954,000	749,000		10,954,100	13,879,400
Russian Federation	21,500	23,000	10,000	54,676,704	640,000	2,600	3,060,000	2,590,000	100	35,384,304	52,194,600
Slovenia				483,865	10,684	220	7,500	10,790		529,041	28,482
Spain	90,000			5,063,000	115,000	80	2,972,000	240,000	60,000	17,110,000	24,625,000
Sweden				1,772,551	8,230			77,600		2,279,053	447,461
Switzerland	2,000			1,782,600	5,573	0	58,200	51,700	300	1,705,700	414,700
Ukraine	19,000			23,727,600	202,057	30,000	570,000	717,100		17,838,704	7,259,100
United Kingdom				11,804,000	125,798	2,198		171,600		7,609,000	43,998,000
United States of America	51,000			97,556,000	1,440,000	5,600	2,000,000	5,850,000	28,000	57,649,000	10,797,000
AGG_COUNTRIES	922,596	132,403	10,000	333,485,638	3,966,904	78,153	20,072,523	14,025,318	277,007	299,029,186	415,109,181

Stocks (Head)	Item										
1993	Asses	Buffaloes	Camels	Cattle	Chickens	Ducks	Goats	Horses	Mules	Pigs	Sheep
Czechosl, Former Area of				3,715,234	40,460	557	64,822	31,392		6,868,021	826,138
Australia	2,438			24,061,808	68,087	404	241,191	272,167		2,646,058	138,102,064
Austria				2,532,200	13,466	130	40,265	57,324		3,629,060	323,288
Belgium-Luxembourg				3,303,000	40,100	77	10,000	65,000	0	6,963,000	170,000
Bulgaria	303,030	22,109		973,727	19,022	200	611,225	113,708	20,803	2,679,719	4,814,300
Canada				11,860,000	115,000	100	27,650	370,000	4,000	10,743,700	632,500
Denmark				2,195,000	18,916	449		20,000		10,870,000	157,000
Estonia				614,600	3,336	38		6,616		541,100	124,200
Finland				1,231,600	5,108	0	5,000	49,100		1,308,800	61,700
France	25,000			20,328,000	209,511	18,946	1,070,530	328,723	11,934	13,015,000	10,380,000
Germany				16,207,340	98,400	2,006	88,000	530,957		26,514,000	2,385,960
Greece	110,744	888		587,177	27,385	107	5,364,900	39,880	50,215	1,001,300	8,666,000
Greenland											22,000
Hungary	3,800			1,159,000	36,419	1,329	28,500	73,393	220	5,364,000	1,752,000
Iceland				73,912	239		330	76,726		40,000	488,787
Ireland	14,000			6,264,600	10,062	150		52,000	1,100	1,422,700	6,125,000
Italy	38,945	103,200		7,600,300	136,000		1,322,500	315,838	18,098	8,244,000	10,344,000
Japan				5,024,000	333,814		33,800	26,700		10,783,000	27,200
Liechtenstein				6,000			280			3,000	2,900
Lithuania				1,701,000	8,000		8,800	79,700		1,359,800	51,700
Netherlands				4,797,000	95,919	930	57,000	92,000		14,964,000	1,916,000
New Zealand				8,308,000	9,900	12	353,000	80,000		395,117	50,298,000
Norway				974,700	3,729		57,600	20,938		748,200	2,316,900
Poland				7,642,576	45,623	7,298		841,267		18,860,096	1,267,880
Portugal	160,000			1,345,000	25,000	0	858,000	25,000	70,000	2,547,000	6,125,000
Romania	34,000	0		3,683,100	87,725	4,800	805,000	720,927		9,852,309	12,079,400
Russian Federation	21,500	22,000	10,300	52,226,000	555,500	2,280	3,186,000	2,556,000	100	31,519,700	48,182,500
Slovakia				1,203,497	13,300	100	20,278	12,600		2,269,200	571,837
Slovenia				503,770	10,754	200	9,227	8,898		601,850	20,799
Spain	90,000			4,976,000	112,000	80	2,837,000	263,000	60,000	18,260,000	24,615,000
Sweden				1,809,000	7,673			79,300		2,276,547	470,687
Switzerland	2,000			1,745,087	6,445	0	56,687	54,257	300	1,691,781	424,027
Ukraine	19,000			22,457,008	180,000	25,000	640,000	707,000		16,175,000	6,597,000
United Kingdom				11,729,000	132,300	2,388		172,600		7,754,000	43,901,000
United States of America	52,000			99,176,000	1,498,000	6,100	1,960,000	5,900,000	28,000	58,202,000	10,201,000
AGG_COUNTRIES	876,457	148,197	10,300	332,014,236	3,967,193	73,681	19,757,585	14,043,011	264,770	300,113,058	394,443,767

Stocks (Head) 1994	Asses	Buffaloes	Camels	Cattle	Chickens	Ducks	Goats	Horses	Mules	Pigs	Sheep	Turkeys
Czechosl				3,154,401	36,239	489	69,928	30,521		6,249,927	607,472	723
Australia	2,000			25,757,600	69,208	447	231,567	250,000		2,775,280	132,569,000	839
Austria				2,333,890	13,589	102	47,276	64,924		3,819,800	333,835	793
Belgium-Luxembourg				3,289,000	44,500	78	9,000	66,000	0	6,948,000	167,000	244
Bulgaria	297,161	17,251		750,395	17,111	300	676,432	113,180	23,067	2,071,340	3,763,210	500
Canada				12,012,000	132,000	40	27,800	350,000	4,000	10,533,800	639,300	5,700
Denmark				2,104,904	18,954	509		18,000		10,922,610	145,000	368
Estonia				463,200	3,186	16		5,215		424,300	83,300	20
Finland				1,230,300	5,554	0	4,600	49,000		1,299,600	79,000	
France	25,000			20,099,000	216,810	20,251	1,054,688	331,961	12,684	14,291,000	11,505,000	32,789
Germany				15,896,620	101,139	1,755	89,000	598,800		26,075,150	2,368,760	6,391
Greece	102,674	902		579,038	27,844	105	5,377,810	37,985	47,440	1,013,620	8,706,146	96
Greenland											22,000	
Hungary	3,700			999,000	30,813	1,304	35,716	71,502	210	5,001,920	1,252,000	836
Iceland				71,923	196		337	78,517		41,000	499,110	
Ireland	14,000			6,308,400	10,966	160		48,000	1,100	1,487,200	5,990,800	1,385
Italy	32,786	100,900		7,458,900	132,000		1,378,000	323,305	16,597	8,348,000	10,461,000	22,500
Japan				4,989,000	323,660		31,000	28,000		10,621,000	24,900	4
Liechtenstein				6,000			280			3,000	2,900	
Lithuania				1,384,300	8,200		10,400	81,300		1,196,200	45,000	528
Netherlands				4,716,000	91,902	830	64,000	97,000		14,565,000	1,766,000	1,295
New Zealand				8,887,000	12,000	20	284,000	85,000		422,766	49,466,000	70
Norway				979,500	3,695		61,600	21,800		747,800	2,462,000	
Poland				7,695,680	44,292	7,275		622,000		19,466,500	869,604	896
Portugal	160,000			1,323,000	26,000	0	836,000	25,000	70,000	2,666,000	5,990,800	5,400
Romania	33,000	0		3,956,782	76,532	4,600	776,000	751,000		9,262,000	11,499,200	900
Russian Federation	25,549	17,900	10,400	48,914,000	552,500	2,100	3,097,000	2,500,000	100	28,557,000	40,616,000	5,000
Slovakia				992,963	12,200	74	24,974	12,390		2,179,029	411,442	380
Slovenia				477,548	9,822	200	9,988	8,509		591,514	19,521	300
Spain	90,000			5,018,000	116,000	80	2,947,000	262,000	60,000	18,234,000	23,872,000	1,100
Sweden				1,827,000	8,093			85,628		2,328,405	484,000	200
Switzerland	2,000			1,755,400	6,445	0	56,687	55,000	300	1,660,000	439,000	
Ukraine	15,000			21,607,000	159,000	22,000	745,000	716,000		15,298,000	6,118,000	1,000
Ukraine	15,000			21,607,000	159,000	22,000	745,000	716,000		15,298,000	6,118,000	
United Kingdom				11,834,000	130,027	2,353		172,600		7,892,000	43,295,000	
USA	52,000			100,974,000	1,558,000	6,150	1,960,000	6,000,000	28,000	57,940,000	9,836,000	

Stocks (Head)	Item										
1995	Asses	Buffaloes	Camels	Cattle	Chickens	Ducks	Goats	Horses	Mules	Pigs	Sheep
Czechosl, Former Area of				2,945,983	39,722	538	70,128	31,043		5,903,940	562,388
Australia	2,000			25,731,220	66,004	420	230,000	240,000		2,652,810	120,862,000
Austria				2,328,520	13,266	105	49,749	66,748		3,729,000	342,144

Stocks (Head)	Item										
1996	Asses	Buffaloes	Camels	Cattle	Chickens	Ducks	Goats	Horses	Mules	Pigs	Sheep
Czechosl, Former Area of				2,917,516	40,017	484	67,431	31,625		6,092,689	561,853
Australia	2,000			26,377,400	75,744	411	230,000	230,000		2,526,412	121,116,064
Austria				2,325,820	13,157	100	54,228	72,491		3,706,180	365,250
Belgium-Luxembourg				3,363,000	49,000	70	12,000	66,000	0	7,225,000	161,000
Bulgaria	281,253	13,707		631,739	17,349	400	833,325	150,521	16,645	2,140,010	3,383,034
Canada				13,401,700	142,000	1,250	28,400	376,000	4,000	11,588,000	643,000
Denmark				2,093,256	19,224	309		20,000		10,842,000	170,000
Estonia				370,400	2,860	16		4,600		448,800	49,800
Finland				1,179,300	5,543	0	5,500	52,000		1,395,400	114,500
France	25,000			20,660,760	221,421	20,935	1,187,500	337,667	13,684	14,530,000	10,556,000
Germany				15,889,915	104,000	2,100	94,000	640,900		23,736,564	2,394,741
Greece	89,000	711		550,000	27,683	100	5,847,000	35,000	41,000	917,000	9,606,000
Greenland											22,000
Hungary	3,600			928,000	31,458	1,287	87,848	71,000	200	5,032,000	977,000
Iceland				74,816	187		350	80,518		43,000	463,935
Ireland	14,000			6,756,600	11,221	210		45,000	1,100	1,664,500	5,390,500
Italy	26,000	148,400		7,265,100	130,000		1,372,900	315,000	12,000	8,060,700	10,668,000
Japan				4,828,000	308,768		29,000	27,000		9,900,000	18,000
Liechtenstein				6,000			280			3,000	2,900
Lithuania				1,065,100	8,000		14,300	77,600		1,270,000	32,300
Netherlands				4,557,000	91,441	950	102,000	106,705		13,958,000	1,627,000
New Zealand				9,017,277	12,000	20	228,000	85,000		424,000	47,394,000
Norway				1,005,800	3,461		62,100	22,700		768,000	2,557,600
Poland				7,136,466	43,977	6,231		569,000		17,963,912	551,570
Portugal	150,000			1,324,000	27,000	0	799,000	25,000	60,000	2,402,000	5,800,000
Romania	31,000	0		3,496,300	80,524	4,700	705,300	806,000		7,959,500	10,380,900
Russian Federation	26,500	23,548	10,800	39,696,000	415,000	1,000	2,682,000	2,363,000	100	22,630,600	25,344,600
Slovakia				928,706	13,400	75	25,046	12,450		2,076,439	427,844
Slovenia				495,535	8,550	200	8,669	7,994		592,034	27,707
Spain	90,000			5,512,000	126,000	80	2,605,000	260,000	60,000	18,163,000	21,323,000
Sweden				1,790,200	7,897			85,000		2,348,800	469,000
Switzerland	2,000			1,771,500	6,251	0	53,204	43,021	300	1,580,100	441,900
Ukraine	14,000			17,557,000	123,000	19,000	889,000	756,000		13,144,000	3,209,000
United Kingdom				11,913,000	140,000	2,700		172,600		7,590,000	41,530,000
United States of America	52,000			103,548,000	1,661,000	6,500	1,900,000	6,050,000	28,000	58,201,000	8,465,000
AGG_COUNTRIES	806,353	186,366	10,800	320,433,206	3,967,133	69,128	19,923,381	13,997,392	237,029	280,922,640	336,244,998

Stocks (Head)	**Item**									
1997	**Asses**	**Buffaloes**	**Camels**	**Cattle**	**Chickens**	**Ducks**	**Goats**	**Horses**	**Mules**	**Pigs**
Czechosl, Former Area of				2,757,893	40,589	367	64,388	31,509		6,064,813
Australia	2,000			26,780,000	81,432	390	230,000	230,000		2,555,000
Austria				2,271,950	12,215	102	54,471	73,234		3,663,750
Belgium-Luxembourg				3,280,000	48,000	36	12,000	67,000	0	7,194,000
Bulgaria	286,874	11,438		582,055	15,127	350	848,742	170,469	17,432	1,500,442
Canada				13,452,600	138,000	1,150	28,400	508,000	4,000	11,480,000
Denmark				2,030,000	18,156	348		39,000		11,383,000
Estonia				343,000	2,270	20		4,200		298,400
Finland				1,150,300	5,230	0	6,500	54,600		1,467,000
France	25,000			20,664,336	231,489	22,535	1,202,033	339,862	14,070	14,976,000
Germany				15,759,573	102,731	1,800	103,000	670,000		24,282,980
Greece	85,000	720		597,000	28,000	100	5,668,000	35,000	40,000	928,000
Greenland										
Hungary	3,600			909,000	27,692	1,533	108,290	70,000	200	5,289,000
Iceland				74,791	179		350	79,804		43,000
Ireland	14,000			6,757,000	11,491	230		52,000	1,100	1,717,000
Italy	26,000	171,700		7,162,500	130,000		1,419,100	310,000	12,000	8,170,500
Japan				4,749,000	307,351		28,500	27,000		9,809,000
Liechtenstein				6,000			280			3,000
Lithuania				1,054,100	7,300		16,900	81,400		1,127,600
Netherlands				4,366,000	93,106	995	119,000	112,336		14,253,000
New Zealand				9,008,000	12,000	30	227,000	85,000		399,738
Norway				1,017,800	3,240		63,100	23,700		691,700
Poland				7,307,382	53,285	2,049		558,000		18,134,776
Portugal	150,000			1,311,000	29,000	0	781,000	22,000	60,000	2,344,000
Romania	30,000	0		3,434,900	78,478	4,550	654,400	816,000		8,234,500
Russian Federation	26,000	20,840	11,000	35,102,800	364,500	1,000	2,445,400	2,197,000	100	19,115,000
Slovakia				891,991	14,100	75	26,147	12,450		1,985,223
Slovenia				486,198	8,550	200	8,600	8,450		559,465
Spain	90,000			5,925,000	126,000	80	2,935,000	260,000	60,000	18,652,000
Sweden				1,781,000	7,606			87,477		2,351,201
Switzerland	2,000			1,672,900	6,352	0	58,000	45,799	300	1,394,900
Ukraine	13,000			15,313,000	125,000	19,000	854,000	753,500		11,236,000
United Kingdom				11,633,000	145,000	2,800		172,600		8,072,000
United States of America	52,000			101,656,000	1,706,000	7,200	1,650,000	6,150,000	28,000	56,124,000
AGG_COUNTRIES	805,474	204,698	11,000	311,288,069	3,979,469	66,940	19,612,601	14,147,390	237,202	275,499,988

Table 2.1.2 IPCC default emission rates(kg/head/year) for the various livetock types

	North America	western Europe	Esat Europe	Oceania	Latin America	Asia	Africa and Middle East	Indian Subcontinnent
Dairy cattle	118.0	100.0	81.0	68.0	57.0	56.0	36.0	46.0
Non Dairy cattle	47.0	48.0	56.0	53.0	49.0	44.0	32.0	25.0
cattle*	82.5	74.0	68.5	60.5	53.0	50.0	34.0	35.5
Buffalo		55.0	55.0	55.0	55.0	55.0	55.0	55.0
Sheep		8.0	8.0	8.0	8.0	8.0	8.0	8.0
Goats		5.0	5.0	5.0	5.0	5.0	5.0	5.0
Camels		46.0	46.0	46.0	46.0	46.0	46.0	46.0
Horse & Mulus		18.0	18.0	18.0	18.0	18.0	18.0	18.0
Swine		1.5	1.5	1.5	1.5	1.5	1.5	1.5
Poultry								
* Emission rate from cattle is estimated by the average of Dairy cattle and Non-dairy cattle								

Table 2.1.3 Comparison of CH4 emissions from enteric fermentation using IPCC tier1 and national methods/data in New Zealand in 1994

Livestock type	A Number of animals (1000)		B Emissions factors Kg/head/year		C Emissions in New Zealand Gg/year		D Difference %
	Fao Data	National Data	IPCC Tier 1	National methods	IPCC Tier 1	National methods	
Diary cattle	3,929	3,929	68	76.8	267.17	301.7472	11.5
Non-diary cattle	5,012	5,012	53	67.5	265.64	338.31	21.5
Cattle	8,887		60.5[1]		537.75	0	
Buffalo			55		0	0	
Sheep	49,043	49,043	8	15.1	392.34	740.5493	47.0
Goats	304	304	5	16.5	1.52	5.016	69.7
Camels			46	30.6		0	
Horses			10			0	
Mules and Asses			1.5			0	
Swine			Not Estimated			0	
Poultry						0	
Deer		1,182	18			0	
Total					931.61(926.67)	1385.6225	
Difference					-454.01(-458.95)		-454.01(-458.95)
%					32.8(33.1)		32.8(33.1)

Table 2.2.1 Average emission rates(kg/head/year) for various livetock types based on the data provided by Annex B countries in 1994 .

	Oceania				Europe				
	New Zealand	Australia	......	Average	Hungary	Austria	Netherland	......	Average
Dairy cattle	76.8	68		72.4	100				100
Non Dairy cattle	67.5	53		60.25	48				48
cattle				66.33					
Buffalo		55		55	55				55
Sheep	15.1	8		11.55	8				8
Goats	16.5	5		10.75	5				5
Camels		46		46	46				46
Horse & Mulus		18		18	18				18
Swine		1.5		1.5	1.5				1.5
Poultry									

Table 2.2.2 CH_4 Emissions of Enteric Fermentation (in Gigagrams)									
	Base year	1990	1991	1992	1993	1994	1995	1996	1997
Australia	2,795	2,795	2,799	2,751	2,741	2,724	2,732	2,705	
Austria	146	146	139	140	142	146	146	144	140
Belgium	374	374	369	368	374	375	212	210	
Bulgaria	196	180	166	137	107	90	85		79
Canada	760	760	770	760	800	830	860	860	870
Czech Republic	156	156	138	122	106	100	99	98	93
Denmark	167	167	167	166	168	155	155	154	150
Estonia									27
Finland	83	83	86	83	83	83	72	72	73
France	1,431	1,431	1,404	1,369	1,354	1,351	1,358	1,358	1,341
Germany	1,248	1,248	1,103	1,043	1,024	1,024	1,018	1,012	1,048
Greece	140	140	138	137	137	140	142	142	
Hungary	157	126	122	105	90	85	84	82	
Iceland	11	11	11	11	10	11	10		
Ireland	551	551	544	546	547	548	551	567	
Italy	643	643				607	607		
Japan	345	345	350	351	348	344	339	335	333
Latvia	98	98	95	79	49	41	39	37	39
Liechtenstein									
Lithuania	157	157							
Luxembourg	16	16				16	16		
Monaco									
Netherlands	402	402	412	401	393	382	377	377	
New Zealand	1,474	1,474	1,441	1,418	1,416	1,422	1,420	1,414	1,398
Norway	86	86	87	89	88	91	92	92	92
Poland	806	793		647		596		545	550
Portugal	124	124	126	121	119	119			
Russian Federation	4,430	4,430	4,300	4,140	3,950	3,300	3,260		
Slovakia	121	121	111	97	82	76	70	66	
Slovenia	38	38							
Spain	346	346	338	342	351	345	343		
Sweden	147	147					179	146	147
Switzerland	151	151					128	126	124
Ukraine									
United Kingdom	913	913	900	899	900	907	897	905	893
United States of America	5,700	5,700	5,700	5,800	5,900	6,000	6,100	6,000	5,963
Total	24,212	24,151	21,815	22,122	21,281	21,907	21,392	17,446	13,360
Average	757	755	873	851	851	782	764	759	742

Table 2.2.3 Livestock Unit Population for all Annex B countries from 1990-1997

	1990	1991	1992	1993	1994	1995	1996	1997
Australia	45820955.02	45377566	45377566	42425872	43382651	41805057	42482103.8	
Austria	2607744.182	2582321	2582321	2584105	2389261	2385392.84	2386886.01	2334881.014
Belgium-Luxembourg	3293163.507	3396254	3396254	3338685	3324625	3404036.12	3398270.97	3315601.345
Bulgaria	2235104.431	2106252	2106252	1402954	1107826	981849.927	981752.752	911988.562
Canada	11372891.27	11445442	11445442	12006416	12155030	12856237.2	13526717.6	13629177.27
Czech Republic				2550240	2184154	2050471.69	2007128.8	1882928.175
Denmark	2265760.932	2250474	2250474	2217241	2125360	2111184.23	2116901.61	2055222.426
Estonia				625454	473539.2	425348.482	375286.146	346998.7591
Finland	1380609.284	1332959	1332959	1250655	1251183	1206427.59	1204811.01	1180353.311
France	22772753.42	22821617	22821617	21609355	21501978	21801522.2	21971885.3	21967286.76
Germany	20860364.06	19965999	19965999	16602536	16306585	16382149.8	16313346.5	16183015.33
Greece	1979575.331	1939759	1939759	1903581	1899827	1913258.22	1998173.3	1993814.865
Hungary	1770350.934	1729553	1729553	1308846	1154853		1057552.09	999433.0073
Iceland	151659.5676	150949.8	150949.8	145444.1	145006.3	141798.905	150184.482	145830.7095
Ireland	6600183.716	6747448	6747448	6939787	6968132	7044287.14	7350717.6	7379171.115
Italy	10077779.73	9478013	9478013	8890406	8766943	8500222.97	8592574.32	8522046.622
Japan	4786813.95	4900192	4900192	5051359	5015874	4941326.2	4852763.16	4773398.65
Latvia								
Liechtenstein	6543.474453	6415.825	6415.825	6232.117	6232.117	6232.11679	6232.11679	6232.116788
Lithuania				1726480	1409835	1176902.91	1089015.97	1078894.818
Luxembourg								
Monaco								
Netherlands	5133070.635	5290618	5290618	5032355	4936744	4866292.66	4767637.18	4561678.851
New Zealand	15799882.09	15486914	15486914	15012198	15477019	15780791.1	15328684.2	15267622.31
Norway	1202776.277	1224385	1224385	1234236	1255202	1280991.68	1292085.02	1292521.081
Poland	10600800.96	9327628	9327628	7956970	7923366	7525542.85	7326991.14	7490651.255
Portugal	2012390.203	2063870	2063870	2081292	2043318	2037866.22	2019881.76	2059040.541
Romania	7667540.409	6658377	6658377	4814372	5051323	4537671.2	4518565.09	4403614.569
Russian Federation				56655406	52769848	46462833.6	42368797.1	37347719.71
Slovakia				1250229	1028259	950438.766	965237.606	927954.7226
slovenia				508464.1	482088.6	481764.686	500423.35	491237.0511
Spain		8050302	8050302	7903146	7872091	8027913.78	8067130	8789888.784
Sweden		1770904	1770904	1879333	1900321	1847262.86	1861742.51	1850231.23
Switzerland		1889640	1889640	1808127	1820239	1820458.05	1833499.66	1733577.162
Ukraine				23174044	22298752	20226817.5	18056868.6	15735525.55
UK		16647000	16647000	16519975	16559453	16401832.1	16447857.4	16279204.05
USA		98850515	98850515	1.02E+08	1.03E+08	105112263	105839348	103912064.2

The CH_4 emission of per livestock unit = Average CH_4 emission of the cattle and dairy cattle for each region recommended by IPCC .
one sheep in the westen Europe region = (100 + 48)/8 = 18.5 LU
one buffalo in the westen Europe region = (100 + 48)/55 = 2.7 LU

Table 2.2.4 Average Emission rate per LU for all Annex B countries

	1990	1991	1992	1993	1994	1995	1996	*1997*	*8-year Average*
Australia	60.998	61.68	63.11	64.61	62.79	65.35	63.67		**63.17**
Austria	55.98709	53.83	54.85	54.95	61.11	61.21	60.33	60.0	**57.78**
Belgium	113.5686	108.65	109.97	112.02	112.79	62.28	61.80		**97.30**
Bulgaria	80.53315	78.81	73.15	76.27	81.24	86.57		86.6	**80.46**
Canada	66.82558	67.28	63.18	66.63	68.28	66.89	63.58	63.8	**65.81**
Czech Republic				41.56	45.78	48.28	48.83	49.4	**46.77**
Denmark	73.70592	74.21	74.97	75.77	72.93	73.42	72.75	73.0	**73.84**
Estonia								77.8	**77.81**
Finland	60.11838	64.52	64.79	66.37	66.34	59.68	59.76	61.8	**62.93**
France	62.83825	61.52	61.44	62.66	62.83	62.29	61.81	61.0	**62.05**
Germany	59.82638	55.24	59.50	61.68	62.80	62.14	62.04	64.8	**61.00**
Greece	70.72224	71.14	71.35	71.97	73.69	74.22	71.06		**72.02**
Hungary	71.17233	70.54	64.18	68.76	73.60	70.52	77.54		**70.90**
Iceland	72.53087	72.87	83.72	68.75	75.86	78.22			**75.33**
Ireland	83.48252	80.62	80.09	78.82	78.64	71.41	77.14		**78.60**
Italy	63.80374				69.24	68.61			**67.22**
Japan	72.07299	71.43	70.09	68.89	68.58		69.03	69.8	**69.98**
Latvia									
Liechtenstein									
Lithuania									
Luxembourg									
Monaco									
Netherlands	78.3157	77.87	77.74	78.09	77.38	77.47	79.07		**78.0**
New Zealand	93.29184	93.05	93.50	94.32	91.88	89.98	92.25	91.6	**92.5**
Norway	71.50124	71.06	71.16	71.30	72.50	71.82	71.20	71.2	**71.5**
Poland	74.80567		75.28		75.22		74.38	73.4	**74.6**
Portugal	61.61827		57.58	57.18	58.24				**58.7**
Romania		18.92							**18.9**
Russian Federation			69.70	69.72	62.54				**67.3**
Slovakia				65.59	73.91	70.16	68.38		**69.5**
Slovenia						73.65			73.7
Spain	43.38222	41.99	42.78	44.41	43.83				**43.0**
Sweden	82.74073	0.00				42.73	78.42	79.4	**70.8**
Switzerland	78.90366					96.90	68.72	71.5	**79.0**
Ukraine						70.31			**70.3**
UK	54.14851	54.06	54.14	54.48	54.77	54.69	55.02	54.9	**54.5**
USA	57.98893	57.66	57.98	58.07	58.03	58.03	56.69	57.4	**57.7**

Average emission rate per LU in the specific year = National emissions/ LU population of the specific year.

Table 2.2.5 Comparison of CH_4 emissions from enteric fermentation using average emission rate over Annex B and national methods/data in New Zealand in 1994

Livestock type	A Number of animals (1000)		B Emissions factors Kg/head/year		C Emissions in New Zealand Gg/year	
	FAO Data	National Data	Average Annex B	National methods	Average Annex B	National methods
Diary cattle		3,929	72.4	76.8	0	301.7472
Non-diary cattle		5,012	60.25	67.5	0	338.31
Cattle	8,887		66.325		589.43	0
Buffalo			55	15.1	0	0
Sheep	49,043	49,043	11.55	16.5	566.45	809.2095
Goats	304	304	10.75		3.268	0
Camels			46	30.6	0	0
Horses			18		0	0
Mules and Asses			1.5		0	0
Swine					0	0
Poultry					0	0
Deer		1,182		18	0	21.276
Total					1159.14	1470.5427
Difference					311.4	
%					21.1	

Table 2.2.6 Comparation cH4 of enteric fermentation between using Lu rate and national method for all AnnexB Parties in 1994

	LU rate	LU population in 1994	CH4 emissions Gg		Difference
			LU method	National method	
Australia	63.2	43382651	2740.6	2,724	0.6
Austria	57.8	2389261	138.0	146	-5.4
Belgium	97.3	3324625	323.5	375	-13.7
Bulgaria	80.5	1107826	89.1	90	-1.0
Canada	65.8	12155030	800.0	830	-3.6
Czech Republic	46.8	2184154	102.2	100	2.2
Denmark	73.8	2125360	156.9	155	1.3
Estonia	77.8	473539.2	36.8		
Finland	62.9	1251183	78.7	83	-5.1
France	62.1	21501978	1334.3	1,351	-1.2
Germany	61.0	16306585	994.7	1,024	-2.9
Greece	72.0	1899827	136.8	140	-2.3
Hungary	70.9	1154853	81.9	85	-3.7
Iceland	75.3	145006.3	10.9	11	-0.7
Ireland	78.6	6968132	547.7	548	-0.1
Italy	67.2	8766943	589.3	607	-2.9
Japan	70.0	5015874	351.0	344	2.0
Latvia			0.0	41	
Liechtenstein		6232.117	0.0		
Lithuania		1409835	0.0		
Luxembourg			0.0	16	
Monaco			0.0		
Netherlands	78.0	4936744	385.0	382	0.8
New Zealand	92.5	15477019	1431.3	1,422	0.7
Norway	71.5	1255202	89.7	91	-1.4
Poland	74.6	7923366	591.3	596	-0.8
Portugal	58.7	2043318	119.8	119	0.7
Romania	18.9	5051323	95.6		
Russian Federation	67.3	52769848	3552.3	3,300	7.6
Slovakia	69.5	1028259	71.5	76	-6.0
Slovenia	73.7	482088.6	35.5		
Spain	43.0	7872091	338.4	345	-1.9
Sweden	70.8	1900321	134.6		
Switzerland	79.0	1820239	143.8		
Ukraine	70.3	22298752	1567.9		
United Kingdom	54.5	16559453	902.8	907	-0.5
USA	57.7	1.03E+08	5946.2	6,000	-0.9

Sheep	Year								
Stocks (Head)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**GRRE**
Australia	170,296,600	163,237,600	148,202,900	138,102,100	132,569,000	120,862,000	121,116,100	120,228,000	-5.31
Austria	286,870	309,312	312,041	323,288	333,835	342,144	365,250	380,861	3.79
Bel-Lux	174,000	177,000	171,000	170,000	167,000	161,000	161,000	162,000	-1.39
Bulgaria	8,130,305	7,938,056	6,703,372	4,814,300	3,763,210	3,397,610	3,383,034	3,019,600	-14.83
Canada	595,000	628,300	647,900	632,500	639,300	617,300	643,000	628,100	0.43
Czech Republic				254301	196,030	165,345	134,009	120,921	-17.03
Denmark	159,000	188,400	182,000	157,000	145,000	145,000	170,000	142,000	-2.43
Estonia			141,882	124,200	83,300	61,500	49,800	39,200	-23.72
Finland	60,700	56,800	61,100	61,700	79,000	80,200	114,500	150,100	13.86
France	11,208,800	11,170,200	10,639,500	10,380,000	11,505,000	10,320,000	10,556,000	10,463,300	-0.89
Germany	4,135,247	3,239,482	2,487,548	2,385,960	2,368,760	2,340,139	2,394,741	2,324,017	-6.6
Greece	8,723,025	8,660,000	8,692,000	8,666,000	8,706,146	8,802,152	9,606,000	9,244,000	1.16
Greenland	21,500	21,500	22,000	22,000	22,000	22,000	22,000	22,000	0.33
Hungary	2,069,200	1,865,000	1,807,943	1,752,000	1,252,000	947,000	977,000	872,000	-12.85
Iceland	548,508	510,782	487,312	488,787	499,110	458,341	463,935	477,306	-1.91
Ireland	5,713,900	5,863,700	5,987,600	6,125,000	5,990,800	5,772,300	5,390,500	5,634,200	-0.77
Italy	10,848,000	10,847,600	10,434,600	10,344,000	10,461,000	10,681,500	10,668,000	10,946,800	0.07
Japan	30,700	30,300	29,200	27,200	24,900	20,000	18,000	16,300	-9.36
Liechtensten	2,781	2,689	2,878	2,900	2,900	2,900	2,900	2,900	0.83
Lithuania			58,100	51,700	45,000	40,000	32,300	28,200	-13.67
Netherlands	1,702,000	1,882,000	1,954,000	1,916,000	1,766,000	1,674,000	1,627,000	1,465,000	-2.73
New Zealand	57,852,190	55,161,650	52,568,000	50,298,000	49,466,000	48,816,000	47,394,000	47,003,000	-2.88
Norway	2,211,000	2,211,000	2,363,000	2,316,900	2,462,000	2,524,200	2,557,600	2,447,800	2.04
Poland	4,158,465	3,233,669	1,869,566	1,267,880	869,604	713,172	551,570	490,831	-27.55
Portugal	5,567,000	5,673,000	5,640,000	6,125,000	5,990,800	5,900,000	5,800,000	6,300,000	1.31
Romania	15,434,800	14,061,900	13,879,400	12,079,400	11,499,200	10,896,600	10,380,900	9,662,600	-6.42
Russian Fed			52,194,600	48,182,500	40,616,000	31,818,000	25,344,600	20,327,000	-17.86
Slovenia			28,482	20,799	19,521	18,491	27,707	28,189	2.18
Slovakia				571,837	411,442	397,043	427,844	418,823	-5.67
Spain	22,739,000	24,037,000	24,625,000	24,615,000	23,872,000	23,058,000	21,323,000	23,982,000	-0.54
Sweden	405,595	418,783	447,461	470,687	484,000	461,800	469,000	442,102	1.55
Switzerland	395,200	409,400	414,700	424,027	439,000	436,500	441,900	420,400	1.2
UK	43,828,000	43,639,000	43,998,000	43,901,000	43,295,000	42,771,000	41,530,000	42,559,000	-0.66
Ukraine			7,259,100	6,597,000	6,118,000	4,792,000	3,209,000	2,193,000	-21.32
USA	11,358,000	11,174,000	10,797,000	10,201,000	9,836,000	8,989,000	8,465,000	8,024,000	-5.11
Czech F Area				826,138	607,472	562,388	561,853	539,744	-8.88
AGG_COUNTRIES	388,655,400.00	376,648,100.00	415,109,200.00	394,443,800.00	376,409,300.00	348,901,300.00	336,245,000.00	331,084,400.00	-2.65

Goats	Year									
Stocks (Head)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE	formulae
Australia	560,371	449,117	347,898	241,191	231,567	230,000	230,000	230,000	-12.13	y= 530302e
Austria	36,440	37,343	39,354	40,265	47,276	49,749	54,228	54,471	6.82	y = 32959e
Bel-Lux	9,271	9,000	10,000	10,000	9,000	9,000	12,000	12,000	3.42	y = 8567.3e
Bulgaria	432,923	498,087	552,736	611,225	676,432	795,436	833,325	848,742	10.62	y = 405589
Canada	27,300	27,500	27,500	27,650	27,800	28,000	28,400	28,400	0.59	y = 27085e
Czech Republic				44544	44,954	44,933	42,385	38,241	-3.57	y = 47885e
Finland	3,700	4,000	5,200	5,000	4,600	4,500	5,500	6,500	6.16	y = 3673.1e
France	1,226,000	1,162,100	1,121,136	1,070,530	1,054,688	1,069,000	1,187,500	1,202,033	-0.22	y = 1E+06e
Germany	76,938	90,000	83,000	88,000	89,000	89,000	94,000	103,000	3	y= 77783e[0]
Greece	5,347,827	5,334,105	5,336,400	5,364,900	5,377,810	5,443,520	5,847,000	5,668,000	1.11	y = 5E+06e
Hungary	15,600	23,500	24,215	28,500	35,716	52,281	87,848	108,290	31.01	y = 11315e
Iceland	345	350	318	330	337	350	350	350	0.49	y = 333.66e
Italy	1,246,000	1,297,500	1,314,200	1,322,500	1,378,000	1,447,600	1,372,900	1,419,100	1.83	y = 1E+06e
Japan	34,500	36,500	35,100	33,800	31,000	30,000	29,000	28,500	-3.56	y = 37875e
Liechtensten	171	213	277	280	280	280	280	280	5.95	y = 195.92e
Lithuania			6,300	8,800	10,400	12,400	14,300	16,900	20.64	y = 5680.9e
Netherlands	61,000	70,000	63,000	57,000	64,000	76,000	102,000	119,000	9	y = 50255e
New Zealand	1,062,900	792,577	532,767	353,000	284,000	337,000	228,000	227,000	-19.89	y = 1E+06e
Norway	88,800	89,698	89,422	57,600	61,600	61,900	62,100	63,100	-6.08	y = 93533e
Portugal	857,000	857,000	862,000	858,000	836,000	819,000	799,000	781,000	-1.39	y= 887477e
Romania	1,017,200	1,004,806	954,000	805,000	776,000	745,100	705,300	654,400	-6.49	y = 1E+06e
Russian Fed			3,060,000	3,186,000	3,097,000	2,722,400	2,682,000	2,445,400	-4.92	y = 3E+06e
Slovenia			7,500	9,227	9,988	10,668	8,669	8,600	1.62	y = 8555.4e
Slovakia				20,278	24,974	25,135	25,046	26,147	5.25	y = 20777e
Spain	3,780,000	3,663,000	2,972,000	2,837,000	2,947,000	3,157,000	2,605,000	2,935,000	-3.8	y = 4E+06e
Switzerland	68,300	65,200	58,200	56,687	56,687	52,200	53,204	58,000	-2.92	y = 66653e
Ukraine			570,000	640,000	745,000	782,000	889,000	854,000	9.12	y = 543563
USA	1,900,000	1,830,000	2,000,000	1,960,000	1,960,000	1,850,000	1,900,000	1,650,000	-1.22	y = 2E+06e
Czech F Area				64,822	69,928	70,128	67,431	64,388	-0.5	y= 68308e
AGG_COUNTRIES	17,852,590.00	17,341,600.00	20,072,520.00	19,757,580.00	19,906,080.00	19,969,650.00	19,923,380.00	19,612,600.00	1.61	y = 2E+07e

Pigs	Year									
Stocks (Head)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE	formulae
Australia	2,647,572	2,531,468	2,792,386	2,646,058	2,775,280	2,652,810	2,526,412	2,555,000	-0.43	y = 3E+06e
Austria	3,772,724	3,637,980	3,719,653	3,629,060	3,819,800	3,729,000	3,706,180	3,663,750	-0.06	y = 4E+06e
Bel-Lux	6,511,000	6,496,000	6,597,000	6,963,000	6,948,000	7,053,000	7,225,000	7,194,000	1.72	y = 6E+06e
Bulgaria	4,352,000	4,186,575	3,141,402	2,679,719	2,071,340	1,986,180	2,140,010	1,500,442	-13.77	y = 5E+06e
Canada	10,392,400	10,172,000	10,596,300	10,743,700	10,533,800	11,290,500	11,588,000	11,480,000	1.82	y = 1E+07e
Czech Republic				4,598,821	4,070,898	3,866,570	4,016,250	4,079,590	-2.5	y = 4E+06e
Denmark	9,282,000	9,767,000	10,345,000	10,870,000	10,922,610	11,083,910	10,842,000	11,383,000	2.61	y = 9E+06e
Estonia			798,603	541,100	424,300	459,800	448,800	298,400	-14.3	y = 813007
Finland	1,347,700	1,290,100	1,356,700	1,308,800	1,299,600	1,295,100	1,395,400	1,467,000	1	y = 1E+06e
France	12,275,500	12,013,300	12,539,000	13,015,000	14,291,000	14,593,000	14,530,000	14,976,000	3.5	y = 1E+07e
Germany	34,177,500	30,818,830	26,063,410	26,514,000	26,075,150	24,698,120	23,736,560	24,282,980	-4.51	y = 3E+07e
Greece	1,000,700	995,517	986,200	1,001,300	1,013,620	1,008,600	917,000	928,000	-1.02	y = 1E+06e
Hungary	7,660,000	8,000,000	5,992,960	5,364,000	5,001,920	4,356,000	5,032,000	5,289,000	-6.82	y = 8E+06e
Iceland	37,000	38,000	40,000	40,000	41,000	42,000	43,000	43,000	2.22	y = 36648e
Ireland	1,110,100	1,249,100	1,345,500	1,422,700	1,487,200	1,498,300	1,664,500	1,717,000	5.95	y = 1E+06e
Italy	9,254,300	8,837,000	8,548,800	8,244,000	8,348,000	8,023,400	8,060,700	8,170,500	-1.78	y = 9E+06e
Japan	11,817,000	11,335,000	10,966,000	10,783,000	10,621,000	10,250,000	9,900,000	9,809,000	-2.58	y = 1E+07e
Liechtensten	3,251	3,543	2,902	3,000	3,000	3,000	3,000	3,000	-1.53	y = 3302.4e
Lithuania			2,179,800	1,359,800	1,196,200	1,259,800	1,270,000	1,127,600	-9.38	y = 2E+06e
Netherlands	13,915,000	13,217,000	14,161,000	14,964,000	14,565,000	14,397,000	13,958,000	14,253,000	0.55	y = 1E+07e
New Zealand	394,700	407,306	411,148	395,117	422,766	431,000	424,000	399,738	0.6	y = 399692
Norway	709,700	720,842	765,698	748,200	747,800	768,400	768,000	691,700	0.18	y = 733726
Poland	19,464,220	21,867,580	22,085,820	18,860,100	19,466,500	20,417,820	17,963,910	18,134,780	-1.98	y = 2E+07e
Portugal	2,598,000	2,664,000	2,535,000	2,547,000	2,666,000	2,416,000	2,402,000	2,344,000	-1.58	y = 3E+06e
Romania	11,671,000	12,003,300	10,954,100	9,852,309	9,262,000	7,758,000	7,959,500	8,234,500	-6.44	y = 1E+07e
Russian Fed			35,384,300	31,519,700	28,557,000	24,859,000	22,630,600	19,115,000	-11.34	y = 4E+07e
Slovenia			529,041	601,850	591,514	570,774	592,034	559,465	0.56	y = 562521
Slovakia				2,269,200	2,179,029	2,037,370	2,076,439	1,985,223	-3.11	y = 2E+06e
Spain	16,911,000	16,001,000	17,110,000	18,260,000	18,234,000	18,345,000	18,163,000	18,652,000	1.83	y = 2E+07e
Sweden	2,263,943	2,201,413	2,279,053	2,276,547	2,328,405	2,313,137	2,348,800	2,351,201	0.78	y = 2E+06e
Switzerland	1,787,000	1,722,600	1,705,700	1,691,781	1,660,000	1,610,700	1,580,100	1,394,900	-2.77	y = 2E+06e
UK	7,450,000	7,597,000	7,609,000	7,754,000	7,892,000	7,627,000	7,590,000	8,072,000	0.69	y = 7E+06e
Ukraine			17,838,700	16,175,000	15,298,000	13,946,000	13,144,000	11,236,000	-8.28	y = 2E+07e
USA	53,788,000	54,416,000	57,649,000	58,202,000	57,940,000	59,738,000	58,201,000	56,124,000	0.88	y = 5E+07e
Czech F Area				6,868,021	6,249,927	5,903,940	6,092,689	6,064,813	-2.7	y = 7E+06e
AGG_COUNTRIES	246,593,300.00	244,189,500.00	299,029,200.00	300,113,100.00	294,932,800.00	288,421,700.00	280,922,600.00	275,500,000.00	1.62	y = 3E+08e[0.]

Table 2.3.1 Exponential growth rate of various animal population

Cattle	Year									
Stocks (Head)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**GRRE**	formulae
Australia	23,162,210	23,662,260	23,879,980	24,061,810	25,757,600	25,731,220	26,377,400	26,780,000	2.23	$y = 2E+07e^{0.022x}$
Austria	2,562,393	2,534,088	2,500,725	2,532,200	2,333,890	2,328,520	2,325,820	2,271,950	-1.85	$y = 3E+06e^{-0.0186x}$
Bel-Lux	3,257,000	3,360,000	3,311,000	3,303,000	3,289,000	3,369,000	3,363,000	3,280,000	0.12	$y = 3E+06e^{0.0012x}$
Bulgaria	1,575,107	1,456,900	1,310,454	973,727	750,395	638,238	631,739	582,055	-14.91	$y = 2E+06e^{-0.1615x}$
Canada	11,220,400	11,288,800	11,869,000	11,860,000	12,012,000	12,708,700	13,401,700	13,452,600	2.83	$y = 1E+07e^{0.0279x}$
Czech Republic				2,511,737	2,161,438	2,029,830	1,988,810	1,865,902	-6.55	$y = 3E+06e^{-0.0678x}$
Denmark	2,239,000	2,222,000	2,190,000	2,195,000	2,104,904	2,090,733	2,093,256	2,030,000	-1.38	$y = 2E+06e^{-0.0139x}$
Estonia			708,273	614,600	463,200	419,500	370,400	343,000	-13.91	$y = 793615e^{-0.1498x}$
Finland	1,363,000	1,315,400	1,263,200	1,231,600	1,230,300	1,185,300	1,179,300	1,150,300	-2.27	$y = 1E+06e^{-0.0229x}$
France	21,394,000	21,450,500	20,970,000	20,328,000	20,099,000	20,524,000	20,660,760	20,664,340	-0.6	$y = 2E+07e^{-0.006x}$
Germany	20,287,820	19,488,000	17,133,800	16,207,340	15,896,620	15,962,240	15,889,920	15,759,570	-3.53	$y = 2E+07e^{-0.036x}$
Greece	653,860	623,514	601,831	587,177	579,038	578,522	550,000	597,000	-1.65	$y = 641925e^{-0.0166x}$
Hungary	1,597,600	1,571,000	1,420,046	1,159,000	999,000	910,000	928,000	909,000	-9.15	$y = 2E+06e^{-0.096x}$
Iceland	74,889	77,681	76,034	73,912	71,923	73,199	74,816	74,791	-0.4	$y = 76003e^{-0.004x}$
Ireland	5,969,100	6,100,500	6,157,600	6,264,600	6,308,400	6,410,100	6,756,600	6,757,000	1.81	$y = 6E+06e^{0.0179x}$
Italy	8,745,900	8,140,000	8,004,000	7,600,300	7,458,900	7,163,600	7,265,100	7,162,500	-2.72	$y = 9E+06e^{-0.0276x}$
Japan	4,760,000	4,873,000	4,980,000	5,024,000	4,989,000	4,916,000	4,828,000	4,749,000	-0.13	$y = 5E+06e^{-0.0013x}$
Liechtensten	6,328	6,204	6,013	6,000	6,000	6,000	6,000	6,000	-0.65	$y = 6247.1e^{-0.0065x}$
Lithuania			2,196,600	1,701,000	1,384,300	1,152,400	1,065,100	1,054,100	-13.95	$y = 2E+06e^{-0.1503x}$
Netherlands	4,926,000	5,062,000	4,920,000	4,797,000	4,716,000	4,654,000	4,557,000	4,366,000	-1.83	$y = 5E+06e^{-0.0185x}$
New Zealand	8,033,976	8,099,996	8,144,321	8,308,000	8,887,000	9,272,325	9,017,277	9,008,000	2.16	$y = 8E+06e^{0.0214x}$
Norway	953,100	974,185	984,078	974,700	979,500	998,400	1,005,800	1,017,800	0.8	$y = 951121e^{0.0079x}$
Poland	10,048,930	8,844,000	8,221,359	7,642,576	7,695,680	7,305,594	7,136,466	7,307,382	-4.25	$y = 1E+07e^{-0.0435x}$
Portugal	1,335,000	1,375,000	1,416,000	1,345,000	1,323,000	1,329,000	1,324,000	1,311,000	-0.62	$y = 1E+06e^{-0.0062x}$
Romania	6,290,700	5,380,700	4,355,000	3,683,100	3,956,782	3,480,800	3,496,300	3,434,900	-7.99	$y = 6E+06e^{-0.0832x}$
Russian Fed			54,676,700	52,226,000	48,914,000	43,296,000	39,696,000	35,102,800	-8.64	$y = 6E+07e^{-0.0903x}$
Slovenia			483,865	503,770	477,548	477,400	495,535	486,198	-0.07	$y = 488548e^{-0.0007x}$
Slovakia				1,203,497	992,963	916,153	928,706	891,991	-6.44	$y = 1E+06e^{-0.0666x}$
Spain	5,187,000	5,126,000	5,063,000	4,976,000	5,018,000	5,248,000	5,512,000	5,925,000	1.69	$y = 5E+06e^{0.0168x}$
Sweden	1,718,443	1,706,778	1,772,551	1,809,000	1,827,000	1,777,000	1,790,200	1,781,000	0.6	$y = 2E+06e^{0.006x}$
Switzerland	1,855,200	1,828,900	1,782,600	1,745,087	1,755,400	1,756,200	1,771,500	1,672,900	-1.09	$y = 2E+06e^{-0.011x}$
UK	12,079,000	11,885,000	11,804,000	11,729,000	11,834,000	11,733,000	11,913,000	11,633,000	-0.31	$y = 1E+07e^{-0.0031x}$
Ukraine			23,727,600	22,457,010	21,607,000	19,624,000	17,557,000	15,313,000	-8.28	$y = 3E+07e^{-0.0864x}$
USA	95,816,000	96,393,000	97,556,000	99,176,000	100,974,000	102,785,000	103,548,000	101,656,000	1.13	$y = 9E+07e^{0.0113x}$
Czech F Area				3,715,234	3,154,401	2,945,983	2,917,516	2,757,893	-6.52	$y = 4E+06e^{-0.0674x}$
AGG_COUNTRIES	257,112,000.00	254,845,400.00	333,485,600.00	332,014,200.00	329,845,800.00	323,766,100.00	320,433,200.00	311,288,100.00	2.88	$y = 3E+08e^{0.0284x}$

Chickens	Year									
Stocks (1000)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**GRRE**	
Australia	59,956	55,116	60,071	68,087	69,208	66,004	75,744	81,432	4.92	$y = 53554e^{0.048x}$
Austria	14,145	13,479	12,872	13,466	13,589	13,266	13,157	12,215	-1.24	$y = 14029e^{-0.0125x}$
Bel-Lux	32,800	34,100	36,200	40,100	44,500	47,400	49,000	48,000	6.63	$y = 30749e^{0.0642x}$
Bulgaria	35,033	26,998	20,907	19,022	17,111	17,822	17,349	15,127	-9.81	$y = 32482e^{-0.1033x}$
Canada	111,000	112,000	108,000	115,000	132,000	136,000	142,000	138,000	4.3	$y = 102212e^{0.0421x}$
Czech Republic				27,160	24,039	25,522	26,617	26,489	0.52	$y = 25541e^{0.0052x}$
Denmark	15,498	15,086	18,259	18,916	18,954	18,673	19,224	18,156	2.89	$y = 15642e^{0.0284x}$
Estonia			5,372	3,336	3,186	3,082	2,860	2,270	-12.82	$y = 5226.3e^{-0.1372x}$
Finland	5,858	5,188	4,967	5,108	5,554	5,561	5,543	5,230	-0.05	$y = 5380.5e^{-0.0005x}$
France	194,166	198,943	207,119	209,511	216,810	219,069	221,421	231,489	2.37	$y = 190785e^{0.0234x}$
Germany	121,270	106,054	95,632	98,400	101,139	101,139	104,000	102,731	-1.26	$y = 109630e^{-0.0127x}$
Greece	27,578	26,767	27,376	27,385	27,844	27,979	27,683	28,000	0.43	$y = 27052e^{0.0042x}$
Hungary	52,821	44,948	35,556	36,419	30,813	33,906	31,458	27,692	-7.57	$y = 51256e^{-0.0787x}$
Iceland	506	430	400	239	196	186	187	179	-15.28	$y = 561.99e^{-0.1659x}$
Ireland	8,187	9,628	9,920	10,062	10,966	11,906	11,221	11,491	4.59	$y = 8462.4e^{0.0449x}$
Italy	134,000	133,000	135,000	136,000	132,000	130,000	130,000	130,000	-0.56	$y = 135854e^{-0.0056x}$
Japan	337,857	331,526	334,658	333,814	323,660	313,536	308,768	307,351	-1.47	$y = 346002e^{-0.0148x}$
Lithuania			16,380	8,000	8,200	8,300	8,000	7,300	-10.87	$y = 13420e^{-0.1151x}$
Netherlands	92,765	93,596	99,359	95,919	91,902	89,561	91,441	93,106	-0.53	$y = 95668e^{-0.0053x}$
New Zealand	9,000	9,500	9,600	9,900	12,000	12,700	12,000	12,000	5.14	$y = 8577.6e^{0.0502x}$
Norway	3,763	3,785	3,680	3,729	3,695	3,656	3,461	3,240	-1.8	$y = 3929.9e^{-0.0181x}$
Poland	62,755	52,013	50,202	45,623	44,292	46,395	43,977	53,285	-2.64	$y = 55833e^{-0.0268x}$
Portugal	20,000	21,000	22,000	25,000	26,000	26,000	27,000	29,000	5.38	$y = 19213e^{0.0524x}$
Romania	113,968	121,379	106,032	87,725	76,532	70,157	80,524	78,478	-6.94	$y = 124598e^{-0.0719x}$
Russian Fed			640,000	555,500	552,500	463,000	415,000	364,500	-10.46	$y = 720545e^{-0.1105x}$
Slovenia			10,684	10,754	9,822	9,424	8,550	8,550	-5.13	$y = 11530e^{-0.0527x}$
Slovakia				13,300	12,200	14,200	13,400	14,100	2.13	$y = 12599e^{0.0211x}$
Spain	109,000	114,000	115,000	112,000	116,000	122,000	126,000	126,000	2.08	$y = 106977e^{0.0206x}$
Sweden	11,300	8,725	8,230	7,673	8,093	7,912	7,897	7,606	-3.89	$y = 9999.6e^{-0.0397x}$
Switzerland	5,964	5,730	5,573	6,445	6,445	6,064	6,251	6,352	1.35	$y = 5737.2e^{0.0134x}$
UK	124,636	127,241	125,798	132,300	130,027	130,939	140,000	145,000	1.97	$y = 120742e^{0.0195x}$
Ukraine			202,057	180,000	159,000	136,000	123,000	125,000	-10.03	$y = 219328e^{-0.1057x}$
USA	1,332,000	1,389,000	1,440,000	1,498,000	1,558,000	1,611,000	1,661,000	1,706,000	3.64	$y = 1E+06e^{0.0357x}$
Czech F Area				40,460	36,239	39,722	40,017	40,589	1.06	$y = 1E+06e^{0.0357x}$
AGG_COUNTRIES	3,035,826.00	3,059,232.00	3,966,904.00	3,967,193.00	3,998,477.00	3,942,559.00	3,967,133.00	3,979,469.00	3.86	$y = 3E+06e^{0.0379x}$

Buffaloes	Year									
Stocks (Head)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE	formulae
Bulgaria	23,046	25,517	25,164	22,109	17,251	13,666	13,707	11,438	-11.32	$y = 31267e^{-0.120}$
Greece	773	769	939	888	902	692	711	720	-2.11	$y = 874.16e^{-0.02}$
Italy	112,400	94,500	83,300	103,200	100,900	108,300	148,400	171,700	7.39	$y = 81538e^{0.071}$
Russian Fed			23,000	22,000	17,900	23,500	23,548	20,840	-0.05	$y = 21738e^{-0.000}$
AGG_COUNTRIES	136,219.00	120,786.00	132,403.00	148,197.00	136,953.00	146,158.00	186,366.00	204,698.00	6.43	$y = 112756e^{0.06}$

Ducks	Year								
Stocks (1000)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Australia	276	364	413	404	447	420	411	390	3.86
Austria	115	131	124	130	102	105	100	102	-3.43
Bel-Lux	75	93	89	77	78	110	70	36	-6.79
Bulgaria	300	200	150	200	300	417	400	350	10.02
Canada	720	820	350	100	40	380	1,250	1,150	5.78
Czech Republic				457	415	463	409	292	-8.9
Denmark	495	429	533	449	509	472	309	348	-5.04
Estonia			61	38	16	17	16	20	-20.68
France	15,936	16,742	18,244	18,946	20,251	19,636	20,935	22,535	4.67
Germany	1,100	2,014	2,257	2,006	1,755	1,550	2,100	1,800	2.89
Greece	123	114	112	107	105	104	100	100	-2.75
Hungary	1,868	1,685	1,512	1,329	1,304	1,806	1,287	1,533	-2.6
Ireland	150	140	140	150	160	150	210	230	6.5
Netherlands	1,000	1,000	1,140	930	830	955	950	995	-1.11
New Zealand	15	17	18	12	20	30	20	30	9.61
Poland	6,466	7,163	7,412	7,298	7,275	5,172	6,231	2,049	-11.04
Romania	4,700	5,000	4,900	4,800	4,600	4,200	4,700	4,550	-1.23
Russian Fed			2,600	2,280	2,100	1,100	1,000	1,000	-20.2
Slovenia			220	200	200	200	200	200	-1.35
Slovakia				100	74	75	75	75	-5.46
Spain	80	80	80	80	80	80	80	80	0
UK	2,217	2,191	2,198	2,388	2,353	2,505	2,700	2,800	3.71
Ukraine			30,000	25,000	22,000	20,000	19,000	19,000	-8.74
USA	6,300	6,000	5,600	6,100	6,150	5,800	6,500	7,200	1.74
Czech F Area				557	489	538	484	367	-8.1
AGG_COUNTRIES	41,936.00	44,183.00	78,153.00	73,681.00	71,238.00	65,822.00	69,128.00	66,940.00	6.09

Mules	Year								
Stocks (Head)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Bulgaria	21,751	19,456	17,405	20,803	23,067	15,855	16,645	17,432	-2.94
Canada	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	-0.01
France	12,973	12,662	12,404	11,934	12,684	12,729	13,684	14,070	1.31
Greece	65,015	59,631	54,478	50,215	47,440	44,267	41,000	40,000	-6.84
Hungary	300	222	220	220	210	200	200	200	-4.3
Ireland	1,200	1,200	1,100	1,100	1,100	1,100	1,100	1,100	-1.24
Italy	43,100	32,970	19,000	18,098	16,597	15,770	12,000	12,000	-16
Portugal	80,000	80,000	80,000	70,000	70,000	70,000	60,000	60,000	-4.48
Russian Fed			100	100	100	100	100	100	-0.01
Spain	70,000	70,000	60,000	60,000	60,000	60,000	60,000	60,000	-2.18
Switzerland	350	300	300	300	300	300	300	300	-1.28
USA	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	0
AGG_COUNTRIES	326,689.00	308,441.00	277,007.00	264,770.00	263,498.00	252,321.00	237,029.00	237,202.00	-4.47

Asses	Year								
Stocks (Head)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Australia	2,310	2,638	3,378	2,438	2,000	2,000	2,000	2,000	-4.84
Bulgaria	328,587	328,579	329,406	303,030	297,161	275,627	281,253	286,874	-2.68
France	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	0
Greece	136,987	127,373	118,412	110,744	102,674	95,360	89,000	85,000	-6.74
Hungary	4,000	3,946	3,900	3,800	3,700	3,600	3,600	3,600	-1.73
Ireland	15,000	15,000	14,000	14,000	14,000	14,000	14,000	14,000	-0.98
Italy	74,000	50,883	40,000	38,945	32,786	30,300	26,000	26,000	-12.99
Portugal	170,000	170,000	170,000	160,000	160,000	160,000	150,000	150,000	-1.98
Romania	35,000	35,000	35,000	34,000	33,000	32,000	31,000	30,000	-2.33
Russian Fed			21,500	21,500	25,549	26,000	26,500	26,000	4.66
Spain	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	0
Switzerland	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	0
Ukraine			19,000	19,000	15,000	14,500	14,000	13,000	-7.81
USA	53,000	52,000	51,000	52,000	52,000	52,000	52,000	52,000	-0.09
AGG_COUNTRIES	935,884.00	902,419.00	922,596.00	876,457.00	854,870.00	822,387.00	806,353.00	805,474.00	-2.33

Horses	Year								
Stocks (Head)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Australia	310,418	308,044	289,346	272,167	250,000	240,000	230,000	230,000	-4.88
Austria	47,595	49,270	61,390	57,324	64,924	66,748	72,491	73,234	6.54
Bel-Lux	66,000	65,000	64,000	65,000	66,000	66,000	66,000	67,000	0.34
Bulgaria	118,902	115,425	114,267	113,708	113,180	133,045	150,521	170,469	5.25
Canada	415,000	419,000	350,000	370,000	350,000	380,000	376,000	508,000	1.28
Czech Republic				18,792	18,131	18,653	19,175	19,059	0.85
Denmark	38,000	32,000	28,000	20,000	18,000	18,000	20,000	39,000	-4.19
Estonia			7,756	6,616	5,215	5,000	4,600	4,200	-11.31
Finland	43,900	45,400	49,260	49,100	49,000	49,500	52,000	54,600	2.68
France	319,046	322,173	327,899	328,723	331,961	338,435	337,667	339,862	0.94
Germany	483,900	490,954	491,600	530,957	598,800	652,400	640,900	670,000	5.6
Greece	49,318	45,266	42,098	39,880	37,985	36,151	35,000	35,000	-4.87
Hungary	75,000	76,000	74,654	73,393	71,502	78,000	71,000	70,000	-0.85
Iceland	71,693	74,069	75,171	76,726	78,517	78,202	80,518	79,804	1.57
Ireland	53,500	52,000	51,000	52,000	48,000	40,000	45,000	52,000	-2.04
Italy	271,000	287,847	316,425	315,838	323,305	323,900	315,000	310,000	1.78
Japan	23,100	24,300	25,800	26,700	28,000	27,000	27,000	27,000	2.17
Lithuania			79,700	79,700	81,300	78,200	77,600	81,400	-0.04
Netherlands	70,000	76,000	86,000	92,000	97,000	100,004	106,705	112,336	6.78
New Zealand	93,980	91,000	87,951	80,000	85,000	85,000	85,000	85,000	-1.28
Norway	18,800	20,700	20,690	20,938	21,800	22,400	22,700	23,700	2.85
Poland	941,157	938,894	899,521	841,267	622,000	636,000	569,000	558,000	-8.55
Portugal	26,000	26,000	25,000	25,000	25,000	23,000	25,000	22,000	-1.9
Romania	663,000	670,000	749,000	720,927	751,000	784,000	806,000	816,000	3.09
Russian Fed			2,590,000	2,556,000	2,500,000	2,431,000	2,363,000	2,197,000	-3.06
Slovenia			10,790	8,898	8,509	7,959	7,994	8,450	-4.5
Slovakia				12,600	12,390	12,390	12,450	12,450	-0.19
Spain	260,000	273,000	240,000	263,000	262,000	260,000	260,000	260,000	-0.01
Sweden	58,000	76,750	77,600	79,300	85,628	82,938	85,000	87,477	4.46
Switzerland	45,300	49,000	51,700	54,257	55,000	55,000	43,021	45,799	-0.45
UK	169,000	170,400	171,600	172,600	172,600	172,600	172,600	172,600	0.27
Ukraine			717,100	707,000	716,000	737,000	756,000	753,500	1.37
USA	5,650,000	5,650,000	5,850,000	5,900,000	6,000,000	6,000,000	6,050,000	6,150,000	1.23
Czech F Area				31,392	30,521	31,043	31,625	31,509	0.43
AGG_COUNTRIES	##########	##########	##########	##########	##########	##########	##########	##########	4.41

Camels	Year						
Stocks (Head)	1992	1993	1994	1995	1996	1997	GRRE
Russian Fed	10,000	10,300	10,400	10,500	10,800	11,000	1.81
AGG_COUNTRIES	10,000.00	10,300.00	10,400.00	10,500.00	10,800.00	11,000.00	1.81

Table 2.3.2 CH_4 emissions from enteric fermentation using growth factor of New Zealand in 1994

Livestock type	B Base yeare emission (Gg)	C Extrapolatio growth factor	D CH_4 emission in 1994 (Gg) Growth factor mrthod	National method emission
Cattle	574.52	2.16	624.72	640.05
Buffalo				
Sheep	853.565	-2.88	763.36	740.55
Goats	15.032	-19.89	6.95	5.01
Camels				
Horses				
Mules and Asses				
Swine				
Poultry				
Deer	31.274		36.159	36.16
Total	1474.391		1431.19	1421.76
Difference				-9.43
%				-0.66

Table 2.5.1 CH_4 trend and comparation of Enteric Fermentation in Fifth method (in Gigagrams)

	1990	1991	1992	1993	1994	1995	1996	1997	Base year	
	0	1	2	3	4	5	6	7		
Canada	760	770	760	800	830	860	860	870	760	National method
	749.17	767.622	786.074	804.526	822.978	841.43	859.882	878.334		Fifth method
	-1.43	-0.31	3.43	0.57	-0.85	-2.16	-0.01			Difference %
New Zealand	1,474	1,441	1,418	1,416	1,422	1,420	1,414	1,398	1,474	National method
	1,453	1,445	1,437	1,429	1,422	1,414	1,406	1,398		Fifth method
	-1.45	0.27	1.35	0.94	-0.03	-0.44	-0.57	0.01		Difference %
USA	5,700.0	5,700	5,800	5,900	6,000	6,100	6,000	5,963	5,700	National method
	5,715	5,766	5,818	5,870	5,921	5,973	6,025	6,076		Fifth method
	0.25	1.16	0.31	-0.52	-1.31	-2.08	0.41	1.90		Difference %

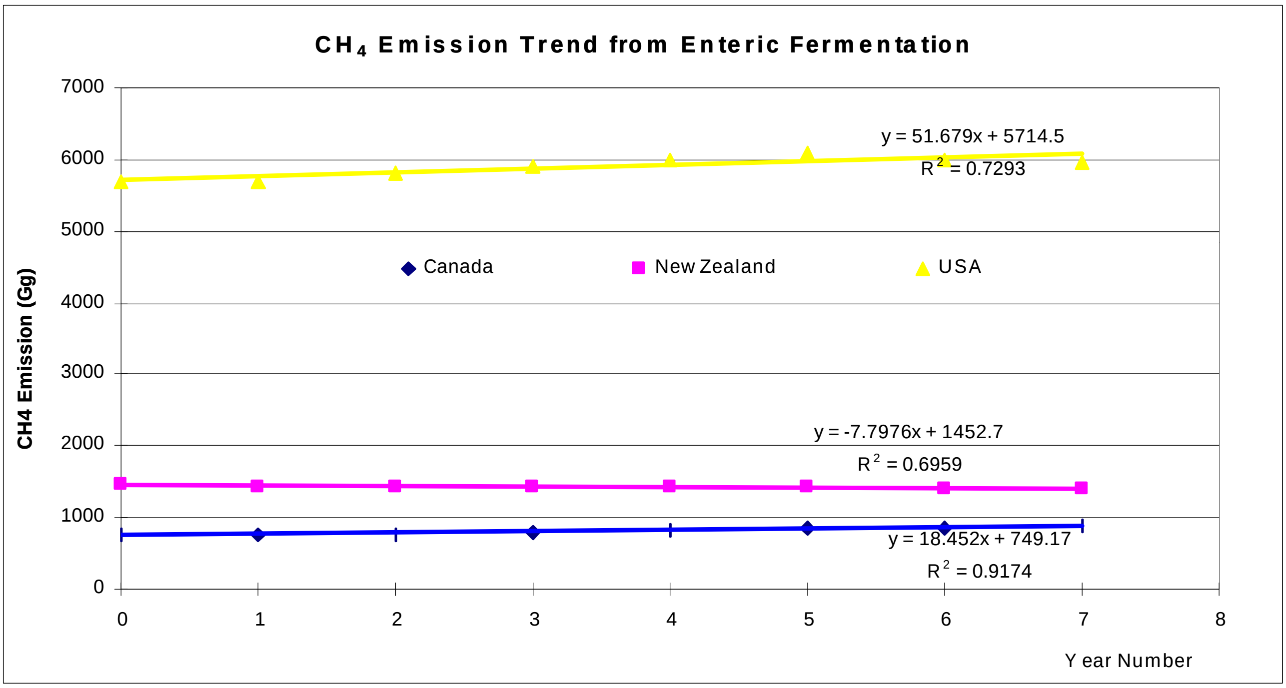


Table 3.1.1 CH_4 / Manure Management of Annex B countries (in Gigagrams)

	Base year	1990	1991	1992	1993	1994	1995	1996	1997
Australia	74	74	75	76	79	79	80	79	
Austria	27	27	26	26	27	27	27	27	27
Belgium							131	130	
Bulgaria	102	77	68	55	45	38	38		30
Canada	190	190	190	190	190	200	210	210	200
Czech Republic	48	48	48	47	41	39	40	36	36
Denmark	161	161	163	169	180	171	172	167	172
Estonia									8
Finland	11	11	11	10	10	10	10	10	10
France	168	168	168	168	169	170	172	175	174
Germany	630	630	552	531	523	520	515	515	499
Greece	24	24	23	23	24	26	28	28	
Hungary	48	44	42	37	34	34	32	33	
Iceland	1	1	1	1	1	1	1		
Ireland	52	52	53	54	55	56	56	58	
Italy	192	192				182	182		
Japan	119	119	117	115	113	110	108	106	106
Latvia	13	13	13	10	6	5	5	5	5
Liechtenstein									
Lithuania	23	23							
Luxembourg	1	1				1	1		
Monaco									
Netherlands	103	103	105	104	104	101	99	99	
New Zealand	18	18	17	17	17	17	17	17	17
Norway	15	15	15	16	15	16	16	16	16
Poland	56	55		56		49		45	46
Portugal	68	68	68	66	62	63			
Russian Federation	500	500	490	470	430	400	360		
Slovakia	66	66	61	54	48	45	45	43	
Slovenia	6	6							
Spain	465	465	477	487	484	499	505		
Sweden	13	13					19	16	16
Switzerland							20	19	19
Ukraine									
United Kingdom	111	111	110	110	111	112	110	111	111
USA	2,600	2,600	2,700	2,800	2,800	2,900	2,900	2,900	2,971
Total	5,906	5,876	5,592	5,691	5,568	5,871	5,897	4,845	4,464
Average	197	196	233	228	232	217	211	211	248

Table 4.1.1: Example of calculating N2O emission from swine manure using IPCC method for New Zealand

AWMS	Manure management system usage (%)	EF	Population	N excretion (kg N/h/year)	F_{gasm}	N2O emission (kg N2O-N)
Anaerobic Lagoon	55	0.001	404000	16	0.2	2844.16
Liquid/Slurry	0	0.001				0
Daily spread		0				0
Solid storage	17	0.02				17582.08
Pasture	0	0.02				0
Other system	28	0.005				7239.68
Total						0

Table 4.1.2. Comparison of N2O emissions from swine manure estimated using IPCC and national method of USA in 1990

	Manure management system usage (%)	EF	Population	N excretion (kg N/h/year)	N2O emission using IPCC (Gg N2O) IPCC	National method/data	Difference (%)
Anaerobic Lagoon	25	0.001	53788000	20	0.338		
Liquid/Slurry	50	0.001			0.676		
Daily spread	0	0			0.000		
Solid storage	18	0.02			4.869		
Pasture	0	0.02			0.000		
Other system	6	0.005			0.406		
Total					6.289	0.7	798.4

Table 4.2.1 Comparison of N2O emissions from manure management using average emission rate and national method of Canada in 1994

	USA			Canada			
Livestock type	Number of animals	N2O emision Gg	Average emission rate	Number of animals	N_2O Emission Gg		Difference (%)
					Average EF	National method	
Cattle	100,974,000	15.7	0.16	12,012,000	1.87		
Swine	57,940,000	0.8	0.01	10,533,800	0.15		
Poultry	1,564,150,000	17.4	0.01	132,040,000	1.47		
Other	17,824,000	1	0.06	10,201,100	0.57		
Total		**34.90**			**4.05**	**14**	**-245.3**

Table 4.3.1 Comparasion of N_2O emission from cattle manure using growth factor in USA

	Animal type	Base year emission(Gg)	Population (head)		Populatin increase rate per year	N_2O emission (Gg)	
Year			1990	1996		1994	1995
Increase rate method	Cattle	14.2	95816000	1.04E+08	1.34	14.96	15.15
Nationalmethod						15.7	14.9
Difference (%)						4.92	-1.68

Table 4.5.1 N_2O / Manure Management (in Gigagrams)

	Base year	1990	1991	1993	1994	1995	1996	1997
Australia	17.6	17.6	17.6	17.2	17.1	17.1	1	
Austria								
Belgium						0.5	0.5	
Bulgaria								2
Canada	13	13	13	13	14	15	15	15
Czech Republic							1.5	1.5
Denmark								5.7
Estonia								0
Finland								
France	10.5	10.5	10.3	10.1	10.1	10.1	10.2	10.1
Germany	11	11	9	9	9	8.6	9	8
Greece	0.4	0.4	0.4	0.4	0.5	0.5	0.6	
Hungary								
Iceland								
Ireland								
Italy	12.9	12.9			12.4	12.4		
Japan	4.8	4.8	4.8	4.6	4.5	4.4	4.8	4.8
Latvia								
Liechtenstein								
Lithuania								
Luxembourg								
Monaco								
Netherlands	0.7	0.7	0.7	0.8	0.8	0.8	0.8	
New Zealand	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Norway			<td bgcolor="fffff f"					

Table 4.5.2 Comapration of N_2O / Manure Management bsed on Linear and national method/data (Gg)								
	Base year	1990	1991	1993	1994	1995	1996	1997
		0	1	2	3	4	5	6
Germany	11	11	9	9	9	8.6	9	8
Increase rate (Gg/year)between 1990 and 1994	-0.7							
Estimated on Linear		11.0	10.3	9.7	9.0	8.3	7.7	7.0
simulated N2O		10.1	9.8	9.4	9.1	8.8	8.4	8.1
Difference(%)on Linear		-	14.81	7.41	-	-3.10	-14.81	-12.50
Difference(%)on Simulated		-8.2	8.4	4.7	1.0	1.7	-6.5	1.0

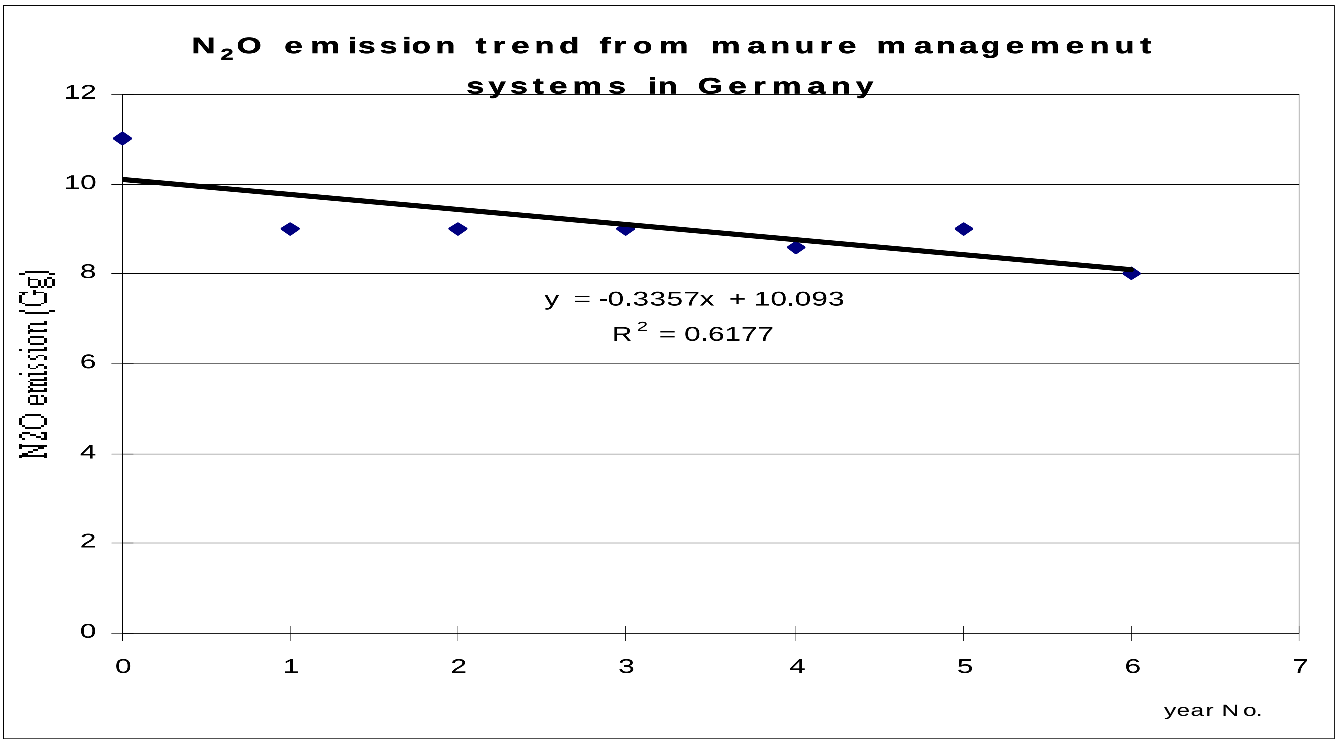


Table 5.1.1 Rice Paddy area of Annex B countries

	Rice Paddy Area (ha)								
year	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Australia	104,545	88,925	113,699	106,453	124,733	118,893	136,506	164,000	6.88
Bulgaria	10,590	8,203	4,525	3,119	827	1,380	2,606	3,794	-19.1
France	20,400	21,300	23,800	25,700	27,220	25,200	21,950	20,500	0.49
Greece	16,500	16,200	14,400	20,200	23,218	26,105	28,909	29,682	11.22
Hungary	11,741	8,620	4,899	4,846	4,810	4,208	3,114	2,194	-18.61
Italy	214,124	204,996	216,410	231,740	235,951	239,259	245,000	232,835	2.16
Japan	2,074,000	2,049,000	2,106,000	2,139,000	2,212,000	2,118,000	1,977,000	1,953,000	-0.65
Portugal	33,824	33,466	21,118	13,200	24,051	21,726	28,278	28,540	-1.59
Romania	39,900	21,600	16,400	12,009	4,638	6,166	8,532	3,986	-25.44
Russian Fed			265,300	260,730	192,900	170,950	172,450	151,270	-11.23
Spain	90,387	93,721	85,699	48,444	66,700	54,500	105,100	112,200	1.26
Ukraine			24,326	23,000	22,000	22,000	23,100	22,500	-1.07
USA	1,142,400	1,125,400	1,267,500	1,146,500	1,341,950	1,251,700	1,134,700	1,255,700	0.98
AGG_COUNTRIES	3,758,411.00	3,671,431.00	4,164,076.00	4,034,941.00	4,280,998.00	4,060,087.00	3,887,245.00	3,980,201.00	0.8

Table 5.1.2 Comparison of CH_4 emissions from Rice Field by IPCC and national methods/data in Japan 1994

					CH4 emission (Gg)		
Water Regime	%	Area under DWR (ha)	EF (g/m2)	Scaling factor	IPCC method	National Method	Difference (%)
Continioues flooded	2	44240	15	1	6.6		
intermittently flooded	97	2145640	15	0.2-0.5	160.9		
Upland	1	22120	15	0	0.0		
Rainfed	0	0	15	0.4-0.8	0.0		
Deep water	0	0	15	0.6-08	0.0		
Total	100	2,212,000			167.6	389	57

Table 5.2.1 Comapration of CH_4 emission from rice bwteen using average emission rate and national method/data

Country	CH_4 emission (Gg)in 1990	Harvested rice area($10^7 m^2$)	Emission factor for each country ($g/m^2/yr$)	Average emission factor for Annex B Parties ($g/m^2/yr$)	CH4 emission using average method in 1990 (Gg)	The difference using this method with national method (%)
Australia	23	102	22.5	32.1	32.76	42
Bulgaria	5	11	45.5		3.53	-29
France	9	20	45.0		6.42	-29
Greece	5	15	33.3		4.82	-4
Hungary	3	11	27.3		3.53	18
Italy	73	208	35.1		66.80	-8
Japan	373	2074	18.0		666.09	79
Portugal	19	33	57.6		10.60	-44
Russian Federation	100	624	16.0		200.41	100
Spain	11	81	13.6		26.01	136
United States of America	439	1114	39.4		357.78	-19

Table 5.3.1 CH_4 / Rice Cultivation of all Annex B countries (in Gigagrams)

	Base year	1990	1991	1992	1993	1994	1995	1996	1997
Australia	23	23	25	25	28	29	31	33	
Austria									
Belgium									
Bulgaria	6	5	4	2	1	0	1		2
Canada									
Czech Republic									
Denmark									
Estonia									
Finland									
France	9	9	9	10	11	11	11	10	9
Germany									
Greece	5	5	4	4	6	7	7	8	
Hungary	4	3	4	2	2	2	2	1	
Iceland									
Ireland									
Italy	73	73				80	81		
Japan	373	373	374	378	388	389	379	364	345
Latvia									
Liechtenstein									
Lithuania									
Luxembourg									
Monaco									
Netherlands									
New Zealand									
Norway									
Poland									
Portugal	19	19	19	12	8	13			
Russian Federation	100	100	100	100	100	100	100		
Slovakia									
Slovenia									
Spain	11	11	11	10	6	8	7		
Sweden									
Switzerland									
Ukraine									
United Kingdom									
USA	439	439	429	486	443	516	482	431	475
Total	1,060	1,058	978	1,030	993	1,156	1,101	847	831

Table 5.3.2 Rice Paddy area growth rate of Annex B

Rice Paddy	Year								
Area Harv (Ha)	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Australia	104,545	88,925	113,699	106,453	124,733	118,893	136,506	164,000	6.88
Bulgaria	10,590	8,203	4,525	3,119	827	1,380	2,606	3,794	-19.1
France	20,400	21,300	23,800	25,700	27,220	25,200	21,950	20,500	0.49
Greece	16,500	16,200	14,400	20,200	23,218	26,105	28,909	29,682	11.22
Hungary	11,741	8,620	4,899	4,846	4,810	4,208	3,114	2,194	-18.61
Italy	214,124	204,996	216,410	231,740	235,951	239,259	245,000	232,835	2.16
Japan	2,074,000	2,049,000	2,106,000	2,139,000	2,212,000	2,118,000	1,977,000	1,953,000	-0.65
Portugal	33,824	33,466	21,118	13,200	24,051	21,726	28,278	28,540	-1.59
Romania	39,900	21,600	16,400	12,009	4,638	6,166	8,532	3,986	-25.44
Russian Fed			265,300	260,730	192,900	170,950	172,450	151,270	-11.23
Spain	90,387	93,721	85,699	48,444	66,700	54,500	105,100	112,200	1.26
Ukraine			24,326	23,000	22,000	22,000	23,100	22,500	-1.07
USA	1,142,400	1,125,400	1,267,500	1,146,500	1,341,950	1,251,700	1,134,700	1,255,700	0.98
AGG_COUNTRIES	3,758,411.00	3,671,431.00	4,164,076.00	4,034,941.00	4,280,998.00	4,060,087.00	3,887,245.00	3,980,201.00	0.8

Table 5.3.3 CH_4 emissions from rie using growth factor in 1994

	B	C	D		
			CH_4 emission Gg		
	Base Emission Gg	Extrapolatio growth factor	Growth fator method	National method/data	Difference %
Hungary	4	-18.61	1.94	2.00	-2.8
Japan	373	-0.65	363.71	389.00	-6.5
USA	439	0.98	456.01	516.00	-11.6

Table 5.5.1 Comparison of CH4 emision from rice field between using Fifth method and national method

.	1990	1991	1992	1993	1994	1995	1996	1997	Base year		
	0	1	2	3	4	5	6	7			
Hungary	3	4	2	2	2	2	1		4	National method	
	3.36	3.00	2.64	2.29	1.93	1.57	1.21			Linear extrapolaion	
	11.90	-25.00	32.15	14.29	-3.57	-21.42	21.45			Difference %	
Japan	373	374	378	388	389	379	364	345	373	National method	
	378.50	378.29	378.07	377.86	377.64	377.43	377.21	377.00		Linear extrapolaion	
	1.47	1.15	0.02	-2.61	-2.92	-0.41	3.63	9.28		Difference %	

Table 6.2.1 CH_4 and N_2O / Prescribed Burning of Savannas (in Gigagrams)

Table 6.2.1-1: N_2O / Prescribed Burning of Savannas (in Gigagrams)

	Base year	1990	1991	1992	1993	1994	1995	1996	1997
Australia	15.4	15.4	15.3	14.2	14.2	13.6	13.1	13.9	
Austria									
Belgium									
Bulgaria									
Canada									
Czech Republic									
Denmark									
Estonia									
Finland									
France									
Germany									
Greece									
Hungary									
Iceland									
Ireland									
Italy									
Japan									
Latvia									
Liechtenstein									
Lithuania									
Luxembourg									
Monaco									
Netherlands									
New Zealand									
Norway									
Poland									
Portugal									
Russian Federation									
Slovakia									
Slovenia									
Spain									
Sweden									
Switzerland									
Ukraine									
United Kingdom									
USA									

Table 6.2.1-2: CH_4 / Prescribed Burning of Savannas (in Gigagrams)									
	Base year	1990	1991	1992	1993	1994	1995	1996	1997
Australia	301	301	299	277	276	266	255	272	
Austria									
Belgium									
Bulgaria									
Canada									
Czech Republic									
Denmark									
Estonia									
Finland									
France									
Germany									
Greece									
Hungary									
Iceland									
Ireland									
Italy									
Japan									
Latvia									
Liechtenstein									
Lithuania									
Luxembourg									
Monaco									
Netherlands									
New Zealand									
Norway									
Poland									
Portugal									
Russian Federation									
Slovakia									
Slovenia									
Spain									
Sweden									
Switzerland									
Ukraine									
United Kingdom									
United States of America									
Total	301	301	299	277	276	266	255	272	

Table 6.4.1: Comparison of of CH_4 and N_2O emission estimated using linkage with national method in 1994 in Australia

	1990	1991	1992	1993	1994	1995	1996	
National data on CH_4	301	299	277	276	266	255	272	National method
National data on N_2O	15.4	15.3	14.2	14.2	13.6	13.1	13.9	National method
CH_4 ratio	0.004	0.004	0.004	0.004	0.004	0.004	0.004	
N_2Oratio	0.007	0.007	0.007	0.007	0.007	0.007	0.007	
N/C	0.006	0.006	0.006	0.006	0.006	0.006	0.006	
Entimated CH_4	1244.44	1236.36	1147.47	1147.47	1098.99	1058.59	1123.23	Linkage method
Estimated N_2O	3.72	3.70	3.43	3.42	3.29	3.16	3.37	Linkage methd
Difference for CH_4	313	313	314	316	313	315	313	
Difference for N_2O	-76	-76	-76	-76	-76	-76	-76	

Table 6.5.1-1 Comparasion of N_2O emissions from burning of Savannas by using extrapolation in Australia (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997
	0	1	2	3	4	5	6	7
National data	15.4	15.3	14.2	14.2	13.6	13.1	13.9	
Estimated data	15.4	15.1	14.6	13.9	13.5	13.3	13.8	15.1
Difference %	0.1	-1.1	2.6	-1.8	-1.0	1.9	-0.6	

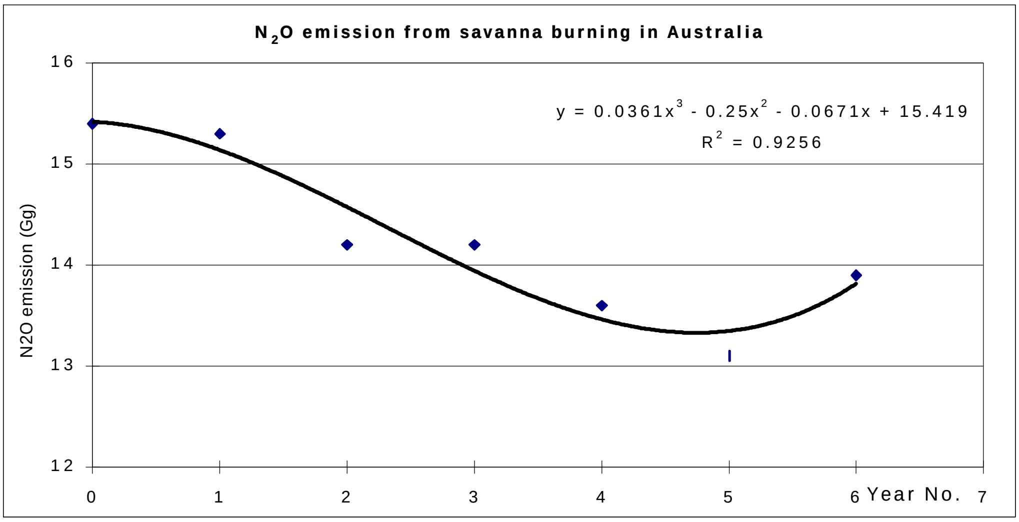


Table 6.5.1-2 Comparasion of CH_4 emissions from burning of Savannas by using extrapolation in Australia (Gg)

	Base year	1990	1991	1992	1993	1994	1995	1996	1997
		0	1	2	3	4	5	6	7
National method	301	301	299	277	276	266	255	272	
Simulating method		301	296	284	272	262	260	270	
Difference %		0.1	-1.1	2.6	-1.6	-1.4	2.1	-0.6	

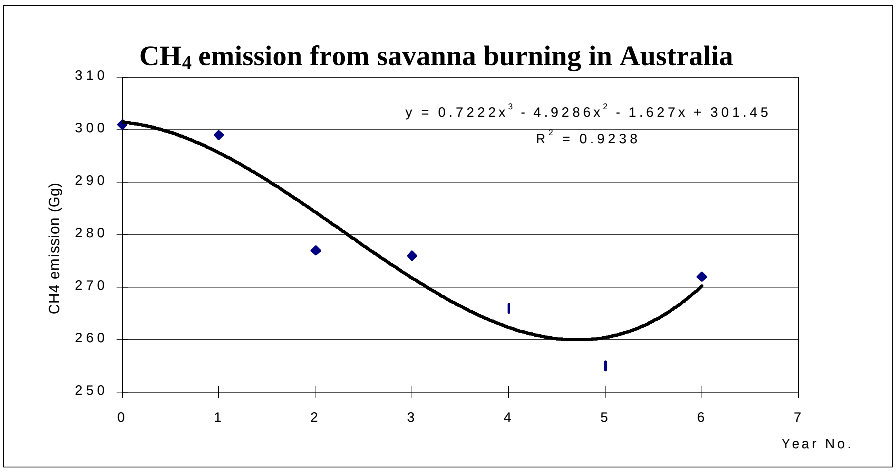


Table 7.1.1 Comparison of CH_4 and N_2O emission estimated by using IPCC method and national method in 1994 in USA

	Wheat	Rice	Sugarcane	Corn	Barley	Soybean	Peanut	Total
Production (ton)	63,168,000	8,971,100	8,161,000	255,293,000	28,058,000	68,445,000		
Ratio of residue to production	1.3	1.4	1.2	1	1.2	2.1		
Dry matter fraction	0.83	0.83	0.4	0.4	0.83	0.83		
Fraction of burned	0.1	0.1	0.1	0.1	0.1	0.1		
Fraction oxidized	0.9	0.9	0.9	0.9	0.9	0.9		
Carbon fraction of residues	0.4853	0.4144	0.4709	0.4709	0.4567	0.5		
N/C	0.012	0.014	0.015	0.02	0.015	0.015	0.015	
CH4 emission ratio	0.005	0.005	0.005	0.005	0.005	0.005		
N2O emission ratio	0.007	0.007	0.007	0.007	0.007	0.007		
CH4 emission (IPCC)	19.846	2.592	1.107	28.852	7.658	35.790		95.8
N2O emission (IPCC)	0.393	0.060	0.027	0.952	0.190	0.886		2.5
CH4 on national method	5.540	4.120	0.965	20.300	0.622	9.220		40.8
N2O on national method	0.053	0.110	0.015	0.575	0.010	0.777		1.5
Difference (%)-CH4	258.2	-37.1	14.7	42.1	1131.1	288.2		135.1
Difference (%)-N2O	644.2	-45.6	82.6	65.6	1860.0	14.0		62.9

Table 7.3.1 CH_4-N2O / Field Burning of Agricultural Residues (in Gigagrams)

Table 7.3.1-1 CH_4 Field Burning of Agricultural Residues (in Gigagrams)

	Base year	1990	1991	1992	1993	1994	1995	1996	1997
Australia	7	7	7	7	6	5	8	7	
Austria	0	0	0	0	0	0	0	0	0
Belgium									
Bulgaria	2	3	3	2	2	2	2		2
Canada									
Czech Republic									
Denmark									
Estonia									
Finland									
France									
Germany									
Greece	5	5	8	6	6	6	6	6	
Hungary			0	0	0	0	0	0	
Iceland									
Ireland	2	2							
Italy	1	1				1	1		
Japan	5	5	5	5	6	5	6	5	5
Latvia									
Liechtenstein									
Lithuania									
Luxembourg									
Monaco									
Netherlands									
New Zealand	0	0	0	0	0	0	0	0	0
Norway									
Poland	1	2		1		1		1	1
Portugal									
Russian Federation	30	30	30	30	30	30	30		
Slovakia									
Slovenia	0	0							
Spain	22	22	21	19	19	19	16		
Sweden									
Switzerland								0	0
Ukraine									
United Kingdom	13	13	11	8	0				
United States of America	36	36	34	39	32	41	33	37	40
Total	124	126	119	117	101	111	102	57	48
Average	8.86	9.00	10.82	9.75	9.18	9.17	9.27	6.22	6.86

Table 7.3.1 CH_4-N2O / Field Burning of Agricultural Residues (in Gigagrams)									
7.3.1-2 N_2O / Field Burning of Agricultural Residues (in Gigagrams)									
	Base year	1990	1991	1992	1993	1994	1995	1996	1997
Australia	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	
Austria	0	0	0	0	0	0	0	0	0
Belgium									
Bulgaria		0.1	0.1						0
Canada									
Czech Republic									
Denmark									
Estonia									
Finland									
France									
Germany									
Greece	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	
Hungary			0	0	0	0	0	0	
Iceland									
Ireland									
Italy									
Japan	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.7
Latvia									
Liechtenstein									
Lithuania									
Luxembourg									
Monaco									
Netherlands									
New Zealand	0	0	0	0	0	0	0	0	0
Norway									
Poland								0.1	0.1
Portugal									
Russian Federation									
Slovakia									
Slovenia	0	0							
Spain									
Sweden									
Switzerland									
Ukraine									
United Kingdom	0.3	0.3	0.2	0.2	0				
United States of America	1	1	1	1	1	2	1	1	1.6
Total	2.3	2.4	2.5	2.3	2.2	3	2.1	2.1	2.4

Table 7.5.1-1 CH_4 trend and comparision of burning of agri. resudies(Gg)in Janpan and USA

	0	1	2	3	4	5	6	7	
	1990	1991	1992	1993	1994	1995	1996	1997	
Japan	5	5	5	6	5	6	5	5	National method
	5.17	5.19	5.21	5.24	5.26	5.29	5.31	5.33	Simulated method
	3.33	3.81	4.29	-12.70	5.24	-11.91	6.19	6.67	Difference %
USA	36	34	39	32	41	33	37	40	National method
	35.83	35.09	36.00	36.69	36.45	35.70	35.99	40.02	Simulated method
	-0.48	3.22	-7.70	14.65	-11.11	8.17	-2.73	0.05	Difference %

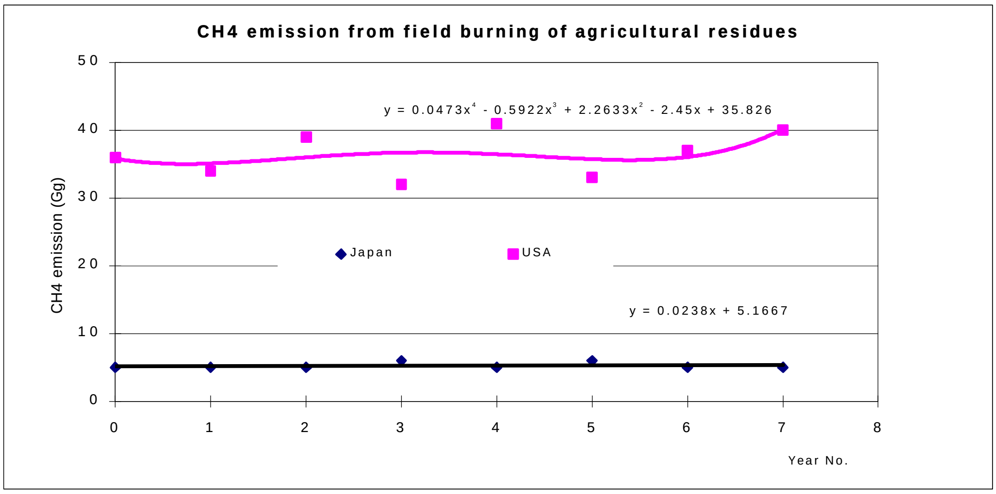


Table 7.5.1 CH_4- N_2O trend and comparation of Burning of Agri. Resudies(Gg)

Table 7.5.1-2 N_2O Trend and Comparision of Burning of Agri. Resudies(Gg)in Janpan and USA

	1990	1991	1992	1993	1994	1995	1996	1997	Base year	
	0	1	2	3	4	5	6	7		
Janpan	0.70	0.70	0.80	0.80	0.80	0.80	0.80	0.70	0.7	National method
	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69		Fifth method
Difference	-1	-1	-13	-13	-13	-13	-13	-1		Difference
United States of America	1.00	1.00	1.00	1.00	2.00	1.00	1.00	1.60	1.00	National method
	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05		Fifth method
	5	5	5	5	-48	5	5	-34		Difference

Japan y = -0.0013x3 + 0.0043x2 + 0.0337x + 0.6924

USA y = 0.0062x5 - 0.0952x4 + 0.4844x3 - 0.893x2 + 0.4778x + 1.0066

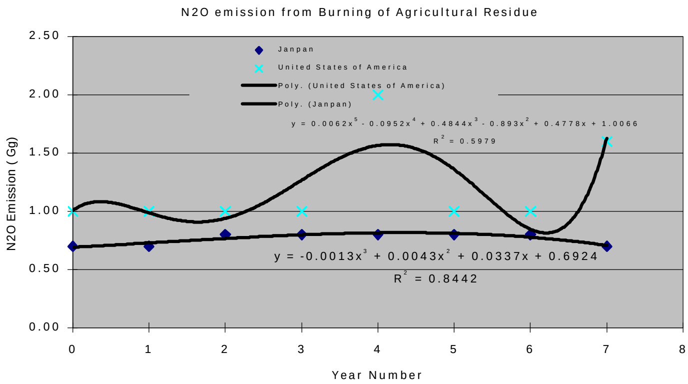


Table 8.1.1 Comparison of the direct N2O emission from agricultural soil between using IPCC method and national method/data in New Zealand from 1990 to 1996

	Amount of N input to soil(kg)			Direct soil emissions (excel histosols)(Gg N2O-N)		
	FAO	National data	Emission factor(Kg N2O-N/Kg N)	IPCC method based on FAO data	National method/ data	Difference(%)
1990	45,800,000	89,514,000	0.0125	0.5725	1.119	-49
1991	64,400,000	91,419,650	0.0125	0.805	1.143	-30
1992	90,000,000	106,442,550	0.0125	1.125	1.331	-15
1993	103,000,000	116,094,300	0.0125	1.2875	1.451	-11
1994	125,600,000	119,256,900	0.0125	1.57	1.491	5
1995	155,600,000	119,250,000	0.0125	1.945	1.491	30
1996	166,000,000	119,250,000	0.0125	2.075	1.491	39

Table 8.2.1 N_2O from Agricultural Soils of all Annex B Countries (Gg)

	Base year	1990	1991	1993	1994	1995	1996	1997
Australia	29.8	29.8	30.1	31.1	31.4	33	46.9	
Austria	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Belgium	10.9	10.9	10.9	10.7	10.8	9.4	9.4	
Bulgaria	13.4	8.2	5.9	2.8	2.6	2.5		2.5
Canada	100.0	100.0	100.0	100.0	100.0	110.0	100.0	100.0
Czech Republic	2.3	2.3	2.0	1.8	1.8	1.7	12.0	11.3
Denmark	33.0	33.0	32.0	31.0	30.0	30.0	30.2	24.1
Estonia								0.0
Finland	10.1	10.1	6.0	5.0	5.0	9.3	9.0	8.8
France	171.3	171.3	169.7	159.6	160.9	161.7	164.5	167.6
Germany	85.0	85.0	78.0	73.0	77.0	76.6	76.0	76.0
Greece	20.0	20.0	19.9	18.7	19.1	17.9	18.7	
Hungary			1.7	1.5	1.8	1.6	1.7	
Iceland	0.2	0.2	0.2	0.2	0.2	0.2		
Ireland	23.3	23.3	18.7	19.0	19.1	19.1	19.0	
Italy	62.1	62.1			63.5	63.5		
Japan	3.8	3.8	3.6	3.5	3.5	3.3	2.1	1.0
Latvia	22.0	22.0	19.3	17.0	16.3	15.7	15.6	
Liechtenstein								
Lithuania								
Luxembourg	0.5	0.5			0.5	0.5		
Monaco								
Netherlands	21.5	21.5	22.2	25.4	25.6	26.8	26.7	
New Zealand	36.1	36.1	35.7	36.1	36.4	36.5	36.4	36.1
Norway	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Poland	43.0	41.0			30.0		30.4	31.2
Portugal	7.3	7.3	7.4	7.1	7.2			
Romania	25.1	20.5	6.5					
Russian Federation								
Slovakia	9.5	9.5	8.5	5.0	5.4	5.4	5.5	
Slovenia	4.6	4.6						
Spain	63.2	63.2	62.4	59.8	57.2	58.4		
Sweden	15.0	15.0				0.2	15.0	14.0
Switzerland						8.8	8.7	8.5
Ukraine								
United Kingdom	95.1	95.1	94.6	87.5	89.9	90.4	90.9	93.9
USA	773.0							
Total								
Average								

Table 8.2.2 Nitrogen input of All Annex B Countries.

	Nitrogenous fertilizers consumption (Mt)								
	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Australia	439,400	462,300	488,000	565,000	583,200	671,300	825,000	910,000	11.28
Austria	135,000	132,000	124,000	124,000	121,000	125,000	123,000	112,200	-1.94
Bel-Lux	186,000	182,000	173,000	169,000	168,000	165,000	170,000	176,000	-1.04
Bulgaria	450,000	377,268	189,175	180,644	207,700	159,930	165,258	147,613	-13.62
Canada	1,157,764	1,253,287	1,317,640	1,405,920	1,456,136	1,576,205	1,670,630	1,708,000	5.79
Denmark	394,900	369,500	332,900	326,181	315,943	291,000	287,600	291,400	-4.44
Belarus			250,000	227,000	188,200	247,300	260,000	200,000	-1.24
Estonia			39,000	29,949	26,068	18,905	16,560	21,100	-13.73
Finland	206,800	166,450	174,000	172,585	198,470	183,020	174,510	175,000	-0.76
France	2,492,000	2,569,000	2,154,000	2,222,000	2,308,500	2,392,000	2,525,100	2,518,000	0.4
Germany	1,788,000	1,720,000	1,680,000	1,612,000	1,787,000	1,769,190	1,758,000	1,788,393	0.44
Greece	426,554	408,300	393,000	338,000	346,000	315,000	323,000	307,000	-4.78
Hungary	358,000	159,486	144,433	152,088	221,867	246,752	321,098	287,010	4.8
Croatia			133,522	91,000	95,000	93,357	99,555	119,485	-0.86
Iceland	11,788	12,126	14,000	12,800	11,181	10,001	11,592	11,780	-1.62
Ireland	370,000	358,000	353,000	401,000	433,000	425,000	396,000	395,000	1.92
Italy	878,960	906,720	910,000	917,900	879,200	918,900	894,000	915,000	0.23
Japan	612,000	574,000	572,000	600,000	581,000	528,000	512,000	494,000	-2.75
Latvia			63,000	40,000	40,000	40,000	14,000	25,000	-19.91
Lithuania			88,000	30,000	43,000	40,000	79,000	81,100	7.17
Netherlands	390,000	391,759	389,872	371,555	405,765	390,000	400,615	370,000	-0.2
New Zealand	45,800	64,400	90,000	103,000	125,600	155,600	166,000	153,000	19.58
Norway	110,790	110,933	109,299	106,800	110,700	114,000	112,000	111,000	0.27
Czech Rep				203,161	239,400	232,700	262,300	225,900	3.08
Poland	735,179	619,017	683,300	757,699	836,149	851,946	890,310	890,972	4.78
Portugal	150,100	135,000	127,000	130,000	126,500	125,000	132,000	116,000	-2.34
Romania	656,100	274,000	481,500	413,170	227,600	233,000	266,000	220,000	-11.82
Russian Fed			2,622,000	2,051,000	900,000	1,000,000	1,200,000	1,000,000	-16.53
Slovenia			47,806	38,796	33,938	32,464	31,712	34,095	-6.47
Slovakia				64,883	78,656	72,029	77,644	78,690	3.8
Spain	1,063,114	998,705	817,621	929,300	982,500	912,800	1,153,100	1,041,900	1.15
Sweden	211,716	174,741	210,838	226,447	210,230	192,270	204,567	205,620	0.28
Switzerland	63,400	63,000	64,000	63,000	63,000	65,000	62,000	60,000	-0.5
Turkey	1,199,663	1,099,495	1,206,144	1,335,200	1,006,590	1,053,685	1,147,700	1,167,000	-0.79
UK	1,525,000	1,365,000	1,219,000	1,268,000	1,339,000	1,328,000	1,438,000	1,251,000	-0.96
Ukraine			1,338,000	841,000	634,510	648,380	621,454	606,835	-12.91
USA	10,239,260	10,383,900	10,303,600	11,469,000	10,630,800	11,161,400	11,205,580	11,162,760	1.38
Cent Africa	18,177	22,000	23,051	19,421	23,568	24,758	31,700	26,700	6.04
AGG_COUNTRIES	26,315,460.00	25,352,390.00	29,325,700.00	30,008,500.00	27,984,970.00	28,808,890.00	30,028,580.00	29,404,550.00	1.8

Table 8.2.3 Comparision of N_2O from Agricultural Soils By using Annex B average emission rate and national method in 1990 (Gg)

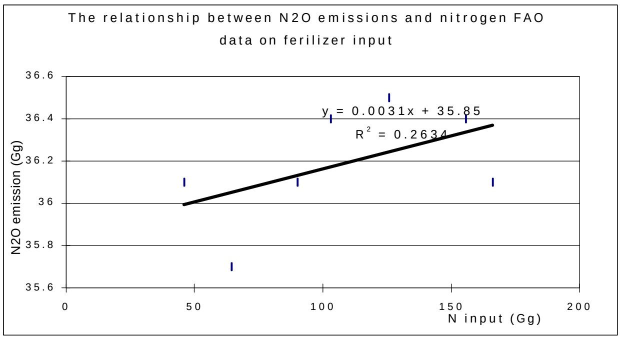
	1990					
	N2O emission of National method(Gg)	N input (t)	Emission factor (10^{-6}g/t-N input)	Average emission factor (10^{-6}g/t-N input)	N2O emission of average Annex B countries method(Gg)	difference%
Australia	29.8	439,400	67.82	52.94	23.26	-21.9
Austria	3.3	135,000	24.44		7.15	116.6
Belgium	10.9	186,000	58.60		9.85	-9.7
Bulgaria	8.2	450,000	18.22		23.82	190.5
Canada	100.0	1,157,764	86.37		61.29	-38.7
Czech Republic	2.3					
Denmark	33.0	394,900	83.57		20.91	-36.6
Estonia						
Finland	10.1	206,800	48.84		10.95	8.4
France	171.3	2,492,000	68.74		131.93	-23.0
Germany	85.0	1,788,000	47.54		94.66	11.4
Greece	20.0	426,554	46.89		22.58	12.9
Hungary		358,000			18.95	
Iceland	0.2	11,788	16.97		0.62	212.0
Ireland	23.3	370,000	62.97		19.59	-15.9
Italy	62.1	878,960	70.65		46.53	-25.1
Japan					0.00	
Latvia	22.0				0.00	
Liechtenstein						
Lithuania						
Luxembourg	0.5				0.00	
Monaco					0.00	
Netherlands	21.5	390,000	55.13		20.65	-4.0
New Zealand	36.1	45,800			2.42	-93.3
Norway	4.0	110,790	36.10		5.87	46.6
Poland	41.0	735,179	55.77		38.92	-5.1
Portugal	7.3	150,100	48.63		7.95	8.9
Romania	20.5	656,100	31.25		34.73	69.4
Russian Federation						
Slovakia	9.5					
Slovenia	4.6				0.00	
Spain	63.2	1,063,114	59.45		56.28	-10.9
Sweden	15.0	211,716	70.85		11.21	-25.3
Switzerland		63,400			3.36	
Ukraine					0.00	
United Kingdom	95.1	1,525,000	62.36		80.73	-15.1
USA		10,239,260			542.07	
Total						
Average						

Table 8.3.1. The N2O emission from agricultural soil using growth factor of N input in New Zealand

	Year								
	1990	1991	1992	1993	1994	1995	1996	1997	GRRE
Number of year	0	1	2	3	4	5	6	7	8
FAO Nitrogenous Fertilizers (Gg)	45.8	64.4	90.0	103.0	125.6	155.6	166.0	153,000.0	19.6
N_2O emission using nation method (Gg)	36.1	35.7	36.1	36.4	36.5	36.4	36.1		
N_2O emission using growth factor(FAO)	36.1	43.9	53.4	65.0	79.1	96.2	117.0		
Difference(%)	0.00	23.02	47.99	78.55	116.62	164.25	224.14		

Table 8.3.2: Simulated N_2O emissions from agricultural soil based on the relationship between the N_2O emission and Nitrogen input in New Zealand

	Year								
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**GRRE**
FAO data on nitrogenous fertilizers consumption Gg	46	64	90	103	126	156	166	153,000	19.58
National data on nitrogenous fertilizers consumption Gg	89.51	91.42	106.44	116.09	119.26	119.25	119.25		
N2O emission on national method Gg	36.1	35.7	36.1	36.4	36.5	36.4	36.1		
N2O emission using simulated relationship based on FAO data Gg	36.0	36.0	36.1	36.2	36.2	36.3	36.4		
N2O emission using simulated relationship based on national data Gg	35.8	35.9	36.1	36.3	36.3	36.3	36.3		
Difference besed on FAO data (%)	-0.30	0.98	0.08	-0.63	-0.71	-0.19	0.73		
Difference based on national data (%)	-0.70	0.49	0.02	-0.39	-0.53	-0.25	0.57		



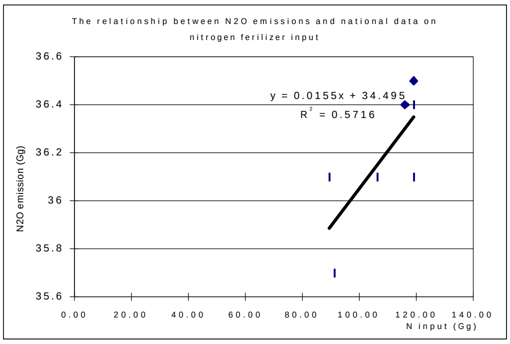


Table 8.5.1 N_2O from Agricultural Soils of Australia (Gg)								
	Base year	1990	1991	1993	1994	1995	1996	1997
		0	1	2	3	4	5	6
National method /data	29.8	29.8	30.1	31.1	31.4	33	46.9	
Simuated method(1)	31.2	31.2	28.8	29.0	31.7	36.9	44.7	
Difference(%)		4.6	-4.2	-6.7	1.0	11.9	-4.8