The 4th Workshop on GHG Inventories in Asia (WGIA4)
14-15 February 2007, Jakarta, Indonesia

Methane Emissions from Rice Cultivation:

Methodology of the 2006 IPCC Guidelines and Emission Factors in Japanese Inventory Estimation

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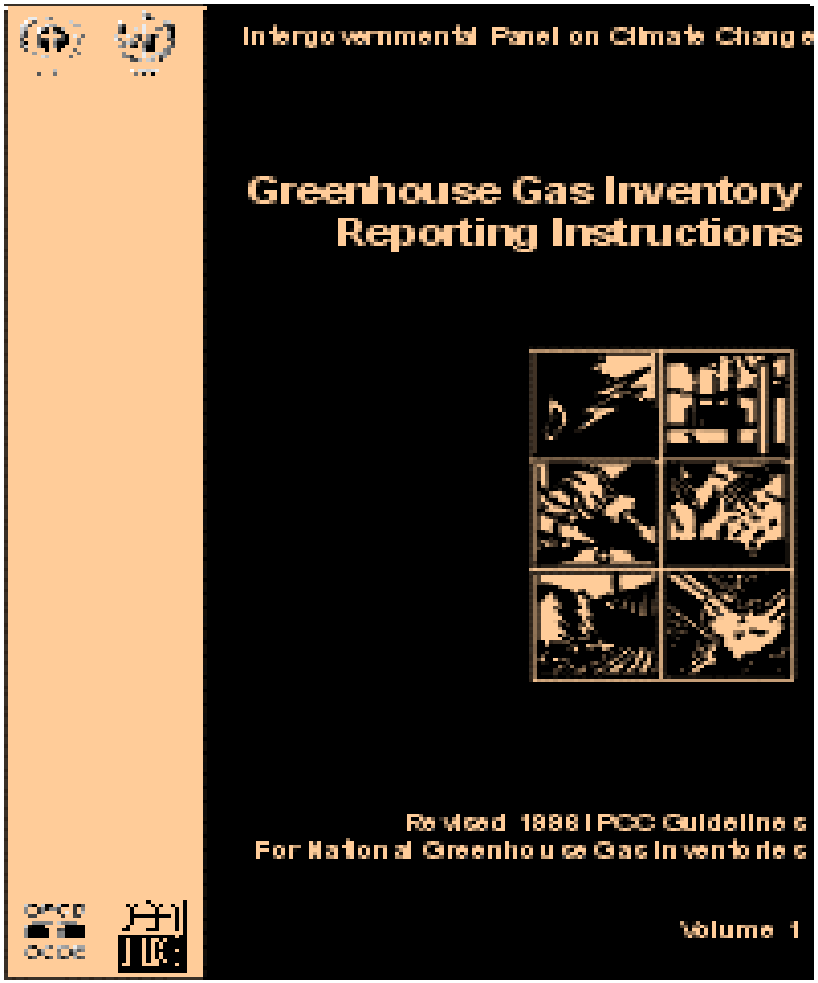
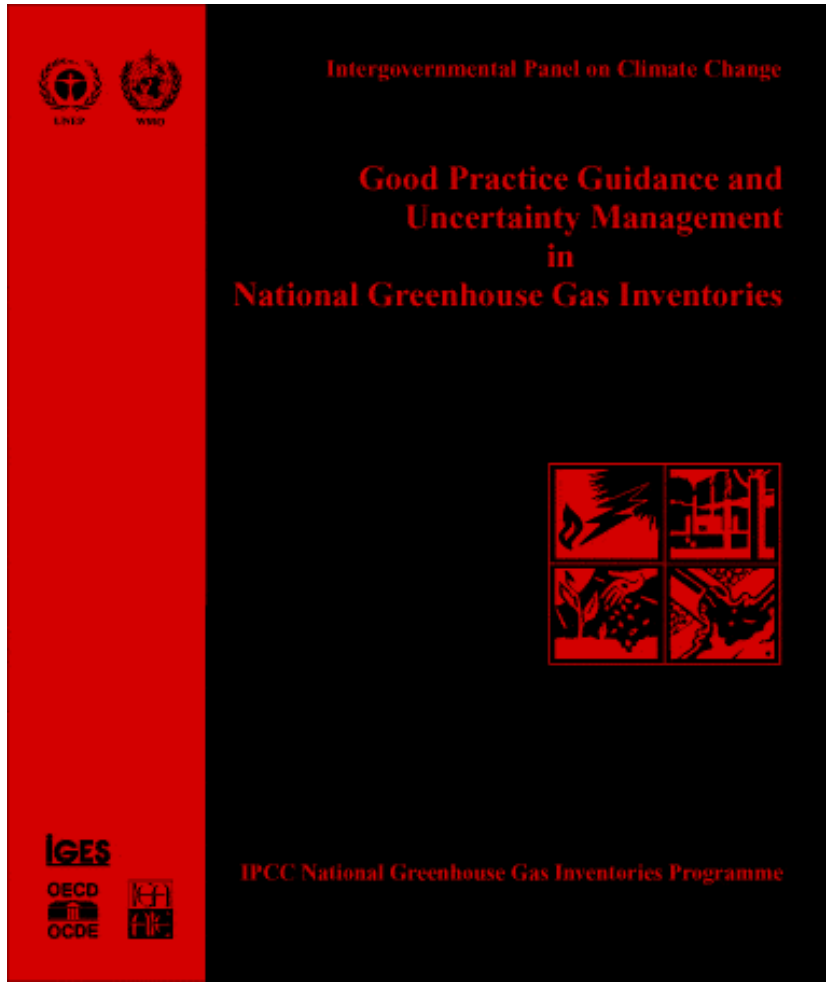


Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (1996)



Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2001)

http://www.ipcc.ch/

Revised 2006 IPCC Guidelines

Volume 1: Cross-Cutting Issues and Reporting Tables

Volume 2: Energy

Volume 3: Industrial Processes and Product Use

Volume 4: Agriculture, Forestry and Other Land Use (AFOLU)

Volume 5: Waste

Volume 4, Chapter 5.5
(p. 5-44 to -53)
Methane Emissions from Rice Cultivation

Has just published in the web-site:
http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm

2006 IPCC Guidelines
Methodology for CH_4 Emissions from Rice Cultivation

Basic Equations

$$\text{Emissions (Gg/yr)} = \Sigma_{ijk} (EF_{ijk} \bullet t_{ijk} \bullet A_{ijk} \bullet 10^{-6}) \quad \text{Eq. (1)}$$

$$EFi = EFc \bullet SFw \bullet SFp \bullet SFo \bullet SFs,r \quad \text{Eq. (2)}$$

Here: EF_{ijk} = a daily emission factor for i, j, and k conditions, kg CH_4 ha^{-1} day^{-1}

t_{ijk} = cultivation period of rice for i, j, and k conditions, day

A_{ijk} = annual harvested area of rice for i, j, and k conditions, ha yr^{-1}

EFc = baseline emission factor, kg CH_4 ha^{-1} day^{-1}

SFw = scaling factor for water regime during the cultivation period

SFp = scaling factor for water regime in the pre-season

SFo = scaling factor for organic amendment applied

SFs,r = scaling factor for soil type, rice cultivar, etc., if available

2006 IPCC Guidelines
Methodology for CH_4 Emissions from Rice Cultivation

Baseline Emission Factor (EFc)

TABLE 5.11
DEFAULT CH_4 BASELINE EMISSION FACTOR ASSUMING NO FLOODING FOR LESS THAN 180 DAYS PRIOR TO RICE CULTIVATION, AND CONTINUOUSLY FLOODED DURING RICE CULTIVATION WITHOUT ORGANIC AMENDMENTS

	Emission factor	Error range
CH_4 emission (kg CH_4 ha^{-1} d^{-1})	1.30	0.80-2.20

Source: Yan et al., 2005

A baseline emission factor for:

- no flooded fields for less than 180 days prior to rice cultivation
- Continuously flooded during the rice cultivation period
- without organic amendments

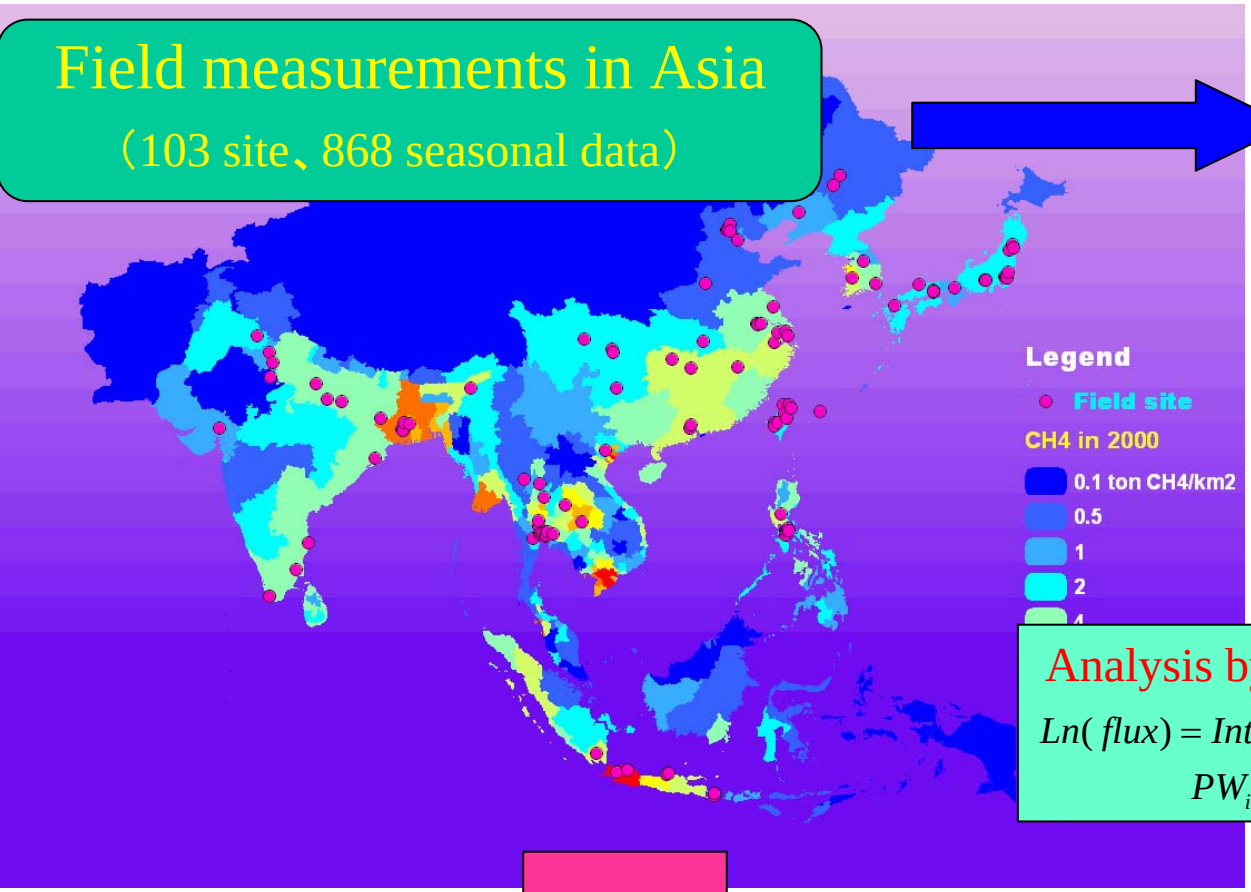
EFc in the 1996 Guidelines & 2000 GPG
= 200 kg ha^{-1} $season^{-1}$

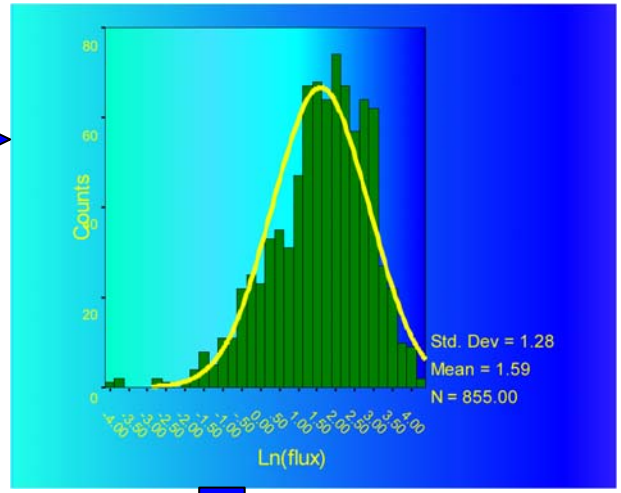
- ◆Without statistical analysis
- ◆Regardless of the length of the cultivation period

CH_4 & N_2O Source Database for Rice Fields

Field measurements in Asia

（103 site、868 seasonal data）





Analysis by a mixed linear model

$$Ln(\,flux) = Intercept + a \times \ln(OC) + b \times pH + PW_i + Water_j + Climate_k + OM_l \times \ln(1 + AOM)$$

Publishing DB at web sites

- CH_4 from rice → JAMSTEC web
- N_2O from rice → NIAES web（under const.）

- Baseline emission factors
- Various scaling factors
- Uncertainty analysis

2006 IPCC Guidelines

Methodology for CH_4 Emissions from Rice Cultivation

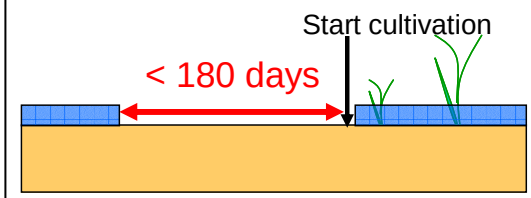
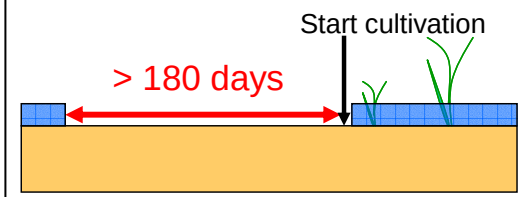
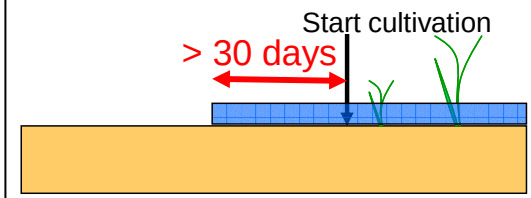
Scaling Factors for Water Regime during the Cultivation Period (SFw)

Water Regime		Aggregated case		Disaggregated case	
		Scaling Factor (SF_w)	Error Range	Scaling Factor (SF_w)	Error Range
Upland		0	-	0	-
Irrigated	Continuously flooded	0.78	0.62-0.98	1	0.79-1.26
	Intermittently flooded – single aeration			0.60	0.46-0.80
	Intermittently flooded – multiple aeration			0.52	0.41-0.66
Rainfed and deep water	Regular rainfed	0.27	0.21-0.34	0.28	0.21-0.37
	Drought prone			0.25	0.18-0.36
	Deep water			0.31	ND

2006 IPCC Guidelines

Methodology for CH_4 Emissions from Rice Cultivation

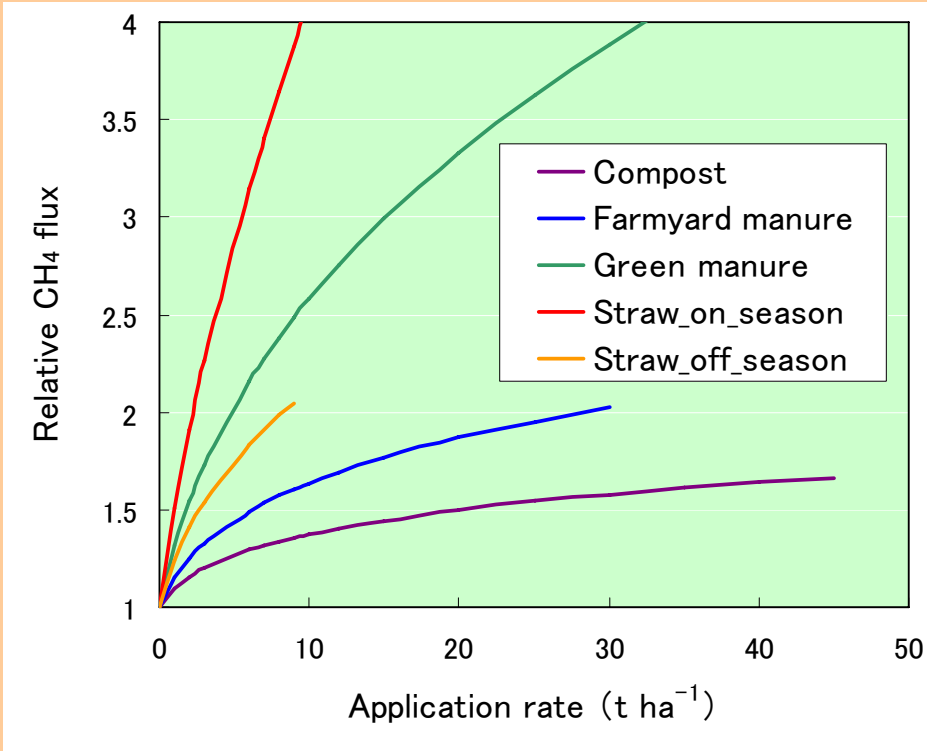
Scaling Factors for Water Regime in the Pre-season (SFp)

Water regime prior to rice cultivation		Aggregated case		Disaggregated case	
		Scaling factor (SF_p)	Error range	Scaling factor (SF_p)	Error range
Non flooded pre-season <180 d		1.22	1.07-1.40	1	0.88-1.14
Non flooded pre-season >180 d				0.68	0.58-0.80
Flooded pre-season (>30 d)				1.90	1.65-2.18

2006 IPCC Guidelines

Methodology for CH_4 Emissions from Rice Cultivation

Scaling Factors for Organic Amendment applied (SFo)



Relationship between application rate of different organic amendment in fresh weight and CH_4 emissions

$$SFo = (1 + \Sigma_i ROA_i \ CFOA_i)^{0.59} \quad \text{Eq. (3)}$$

Here:

SFo =scaling factor for organic amendment

ROA_i = application rate of organic amendment i in fresh weight (t/ha)

CFOAi = conversion factor for organic amendment as shown in the following table

Organic amendment	Conversion factor (CFOA)	Error range
Straw incorporated shortly (<30 days) before cultivation	1	0.97-1.04
Straw incorporated long (>30 days) before cultivation	0.29	0.20-0.40
Compost	0.05	0.01-0.08
Farm yard manure	0.14	0.07-0.20
Green manure	0.50	0.30-0.60

2006 IPCC Guidelines
Methodology for CH_4 Emissions from Rice Cultivation

Major Revisions

- Baseline emission factor (EFc) has revised to the daily rate, on the basis of statistical analysis of monitoring data
- New scaling factor for water regime in the pre-season (SFp) has incorporated
- Other scaling factors have revised on the basis of statistical analysis of monitoring data

2006 IPCC Guidelines
Methodology for CH_4 Emissions from Rice Cultivation

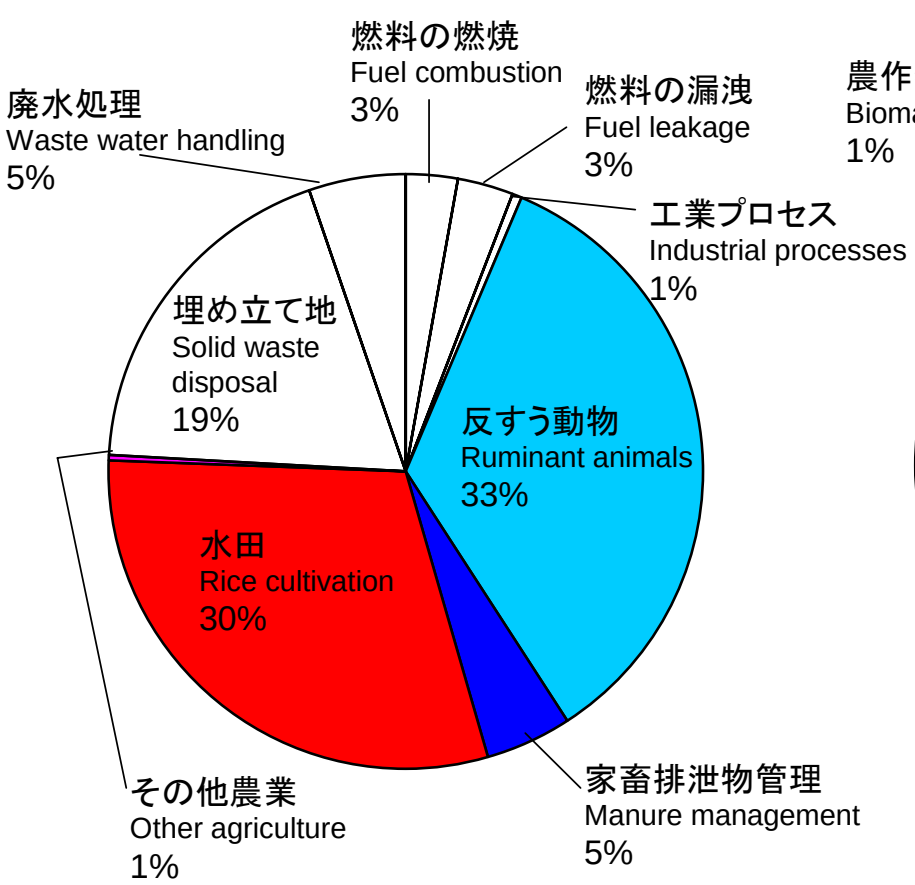
Implementation

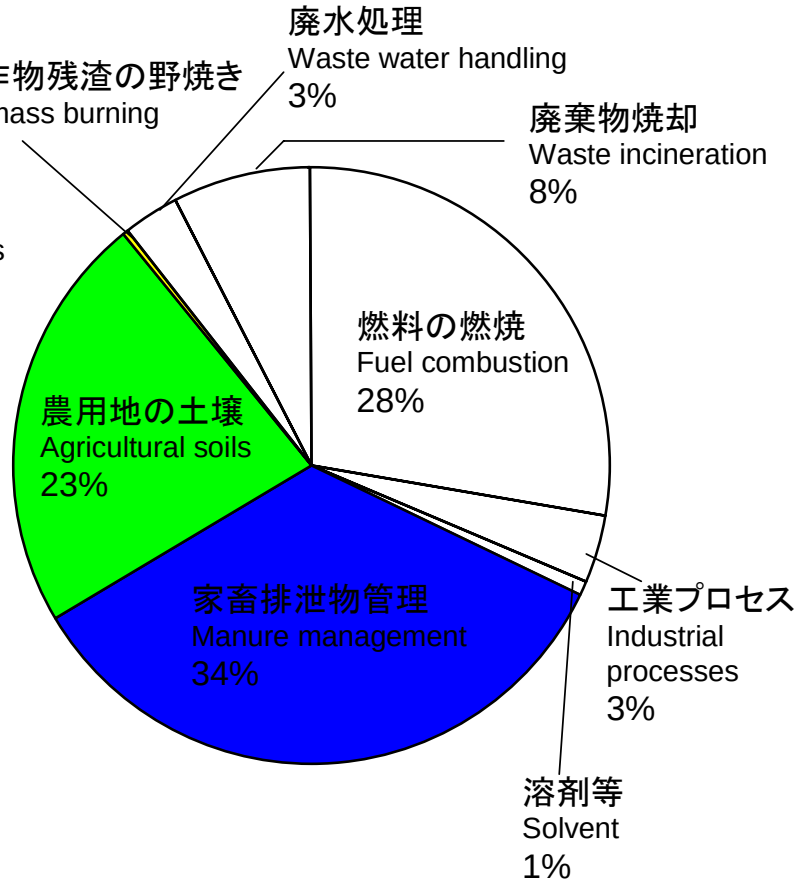
- Reliable and universal emission and scaling factors, on the basis of statistical analysis of monitoring data, have provided.
- As a results, priority for developing country-specific factors became low.
- More importance to collect reliable activity data in each country for developing better emission inventory

National Inventory for Japan
Anthropogenic Sources for CH_4 and N_2O

CH_4: 9.2 Mt (193 Mt CO_2 equivalent)

N_2O: 0.72 Mt N (346 Mt CO_2 equivalent)





Inventory in 2005 (Colored parts indicate agricultural sources)

National Inventory for Japan
CH_4 Emissions from Rice Cultivation

Methodology

- Tier 2 methodology
- Country-specific emission factors for 5 soil types, which are based on seasonal field monitoring at 35 sites over the country during 1992-94
- Country-specific scaling factors for 3 organic amendment
- Water management was assumed to be homogeneous intermittent-irrigation for 98% of the rice fields

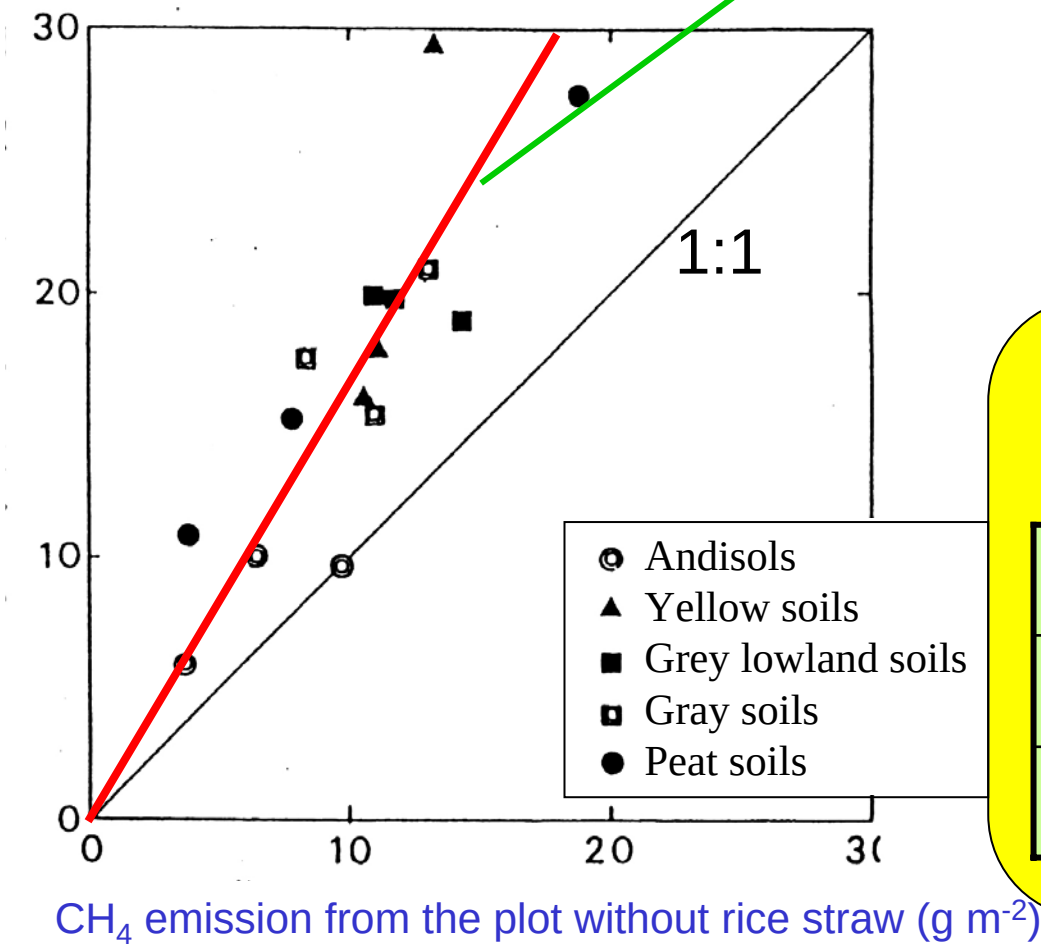
National Inventory for Japan
CH_4 Emissions from Rice Cultivation
Emission Factors

Type of soil	No. of data	Straw amendment	Various compost amendment	No-amendment	Proportion of area
		[$gCH_4/m^2/year$]			%
Andosol	2	8.50	7.59	6.07	11.9
Yellow soil	4	21.4	14.6	11.7	9.4
Lowland soil	21	19.1	15.3	12.2	41.5
Gley soil	6	17.8	13.8	11.0	30.8
Peat soil	2	26.8	20.5	16.4	6.4

- Based on field monitoring campaign during 1992-1994 at 35 sites over Japan
- Measured by conventional water management with mid-season drainage followed by intermittent flooding

National Inventory for Japan
CH_4 Emissions from Rice Cultivation

Calculation for Organic Amendment Applied



SFo for straw: 1.68

SFo for various compost: 1.25

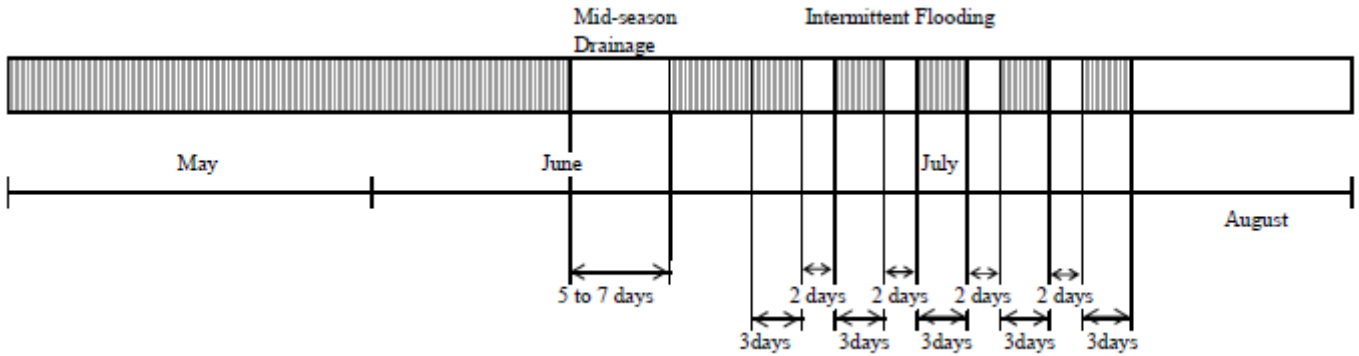
Activity data based on interview with ca. 2,000 farmers by MAFF

Straw	60%
Compost	20%
No	20%

National Inventory for Japan
CH_4 Emissions from Rice Cultivation

Water Management Categorization

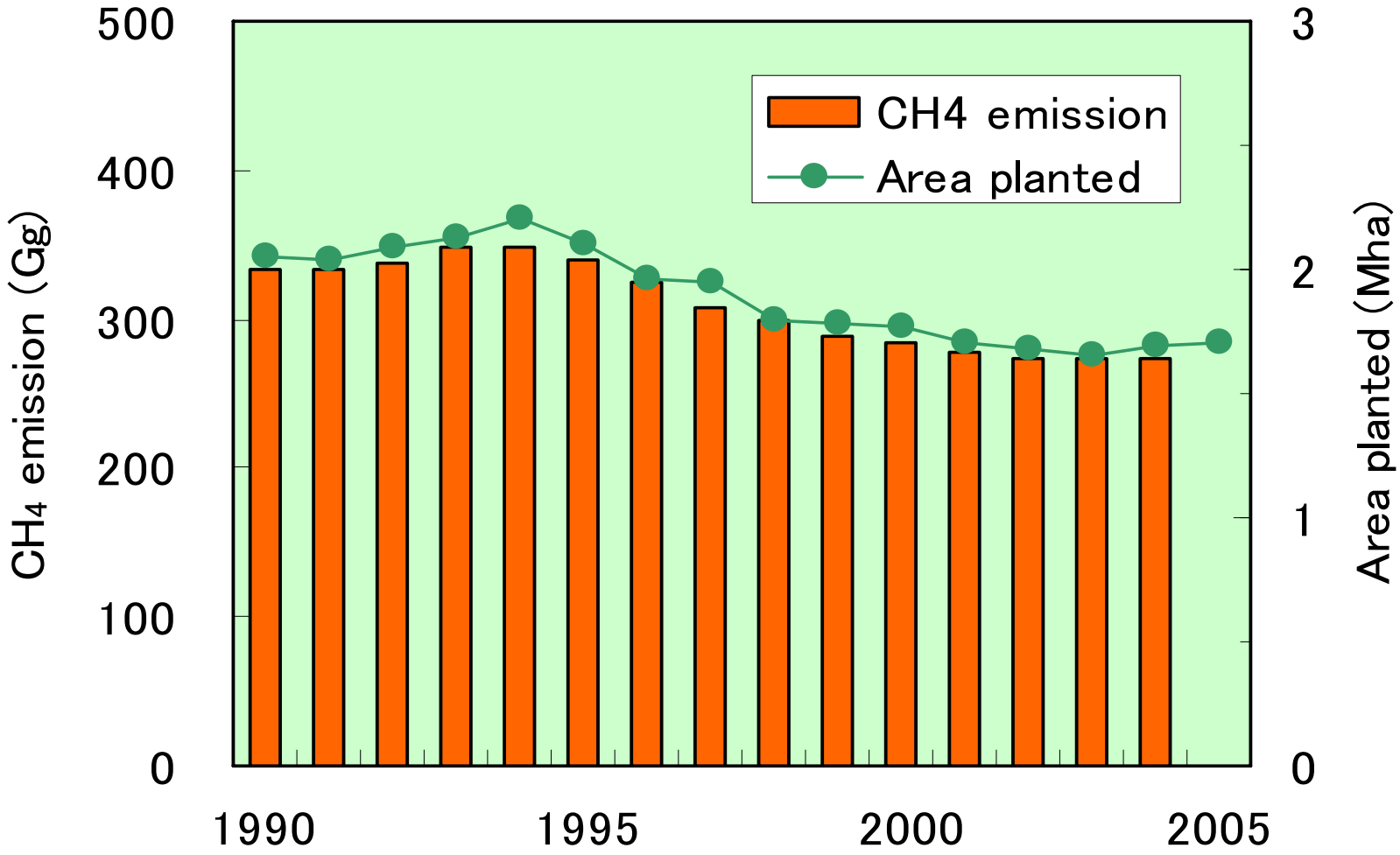
- Water management was assumed to be homogeneous intermittent-irrigation for 98% of the rice fields



- A scaling factor of 1.77 is applied for continuous flooding fields which accounted for 2% of the area
- No consideration for water regime in the pre-season

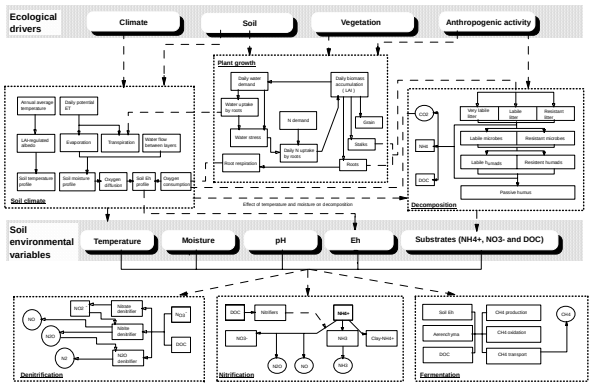
National Inventory for Japan
CH_4 Emissions from Rice Cultivation

Trend of CH_4 Emission

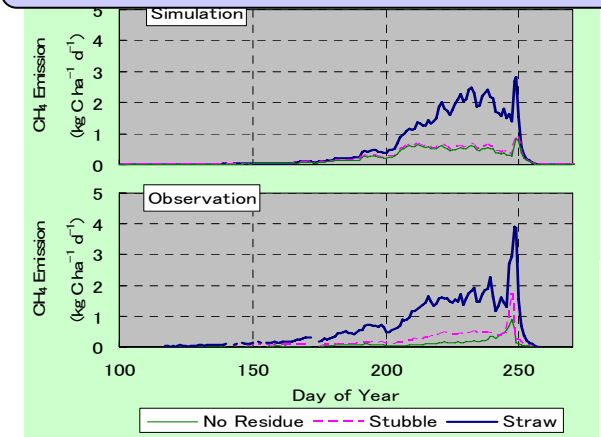


Estimation of GHG Emissions by a Process-Based Model

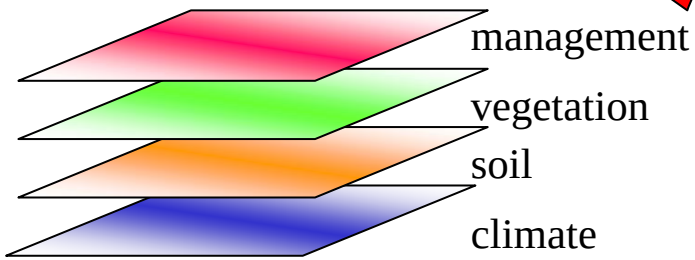
DNDC model



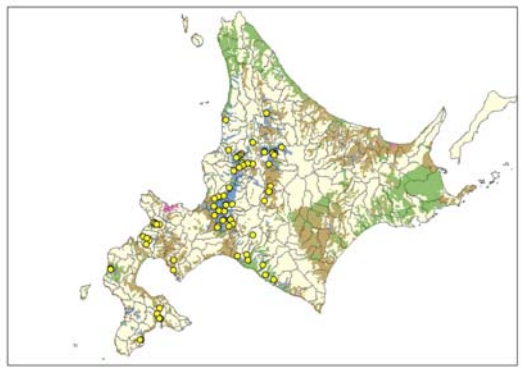
Simulation and validation



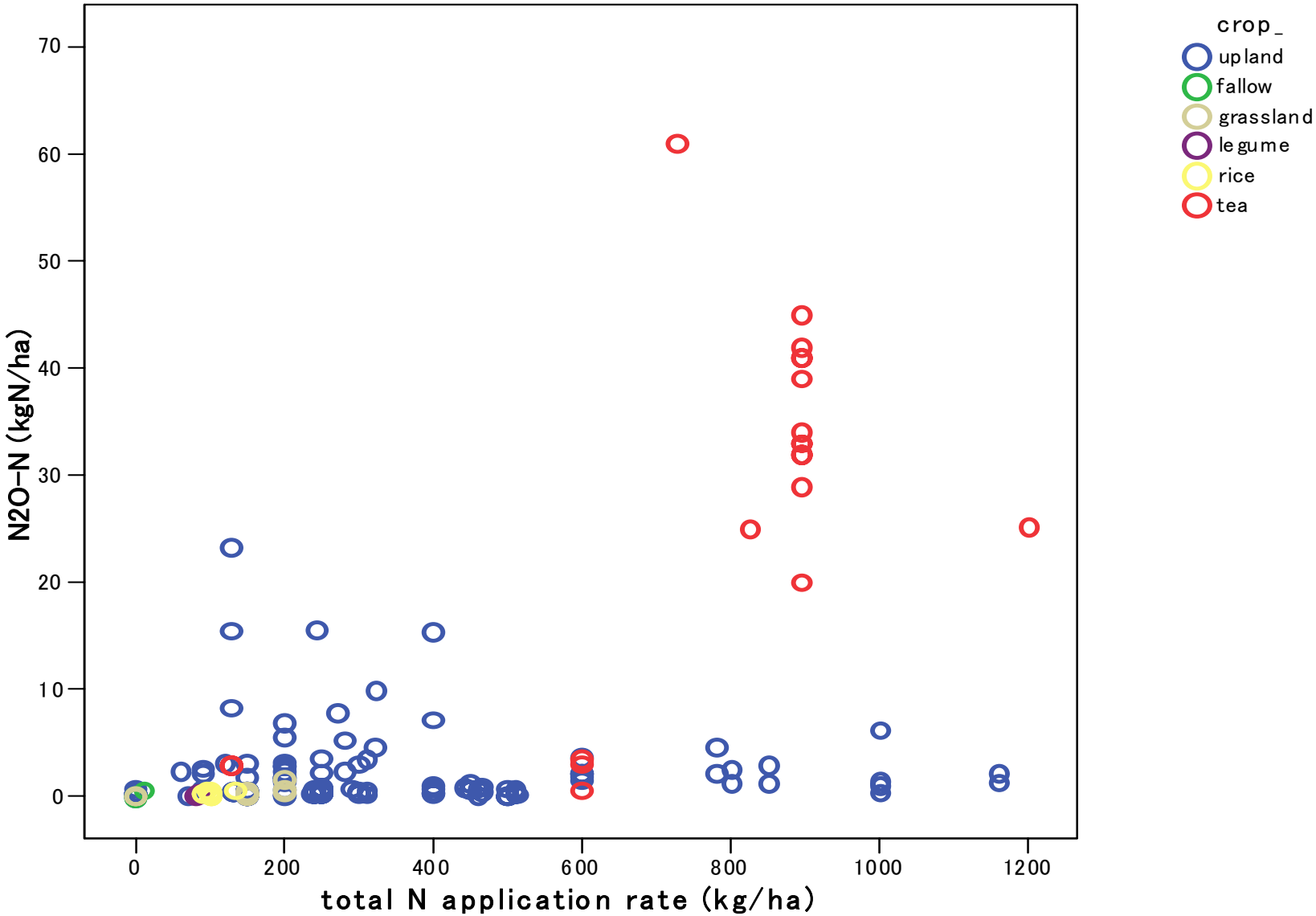
GIS data for parameters



Regional estimation



Direct N_2O Emissions from Chemical Fertilizer and Organic Matter Application



Emission Factors for N_2O from Rice

Direct N_2O: Mineral fertilizer/Animal manure

Paddy rice: 0.31 % (from global data analysis)
Tea: 2.9 % (from national data analysis)
Other crops: 0.62 % (from national data analysis)

Direct N_2O: Crop residues/Legumes

IPCC default values

Direct N_2O: Organic soils

IPCC default values

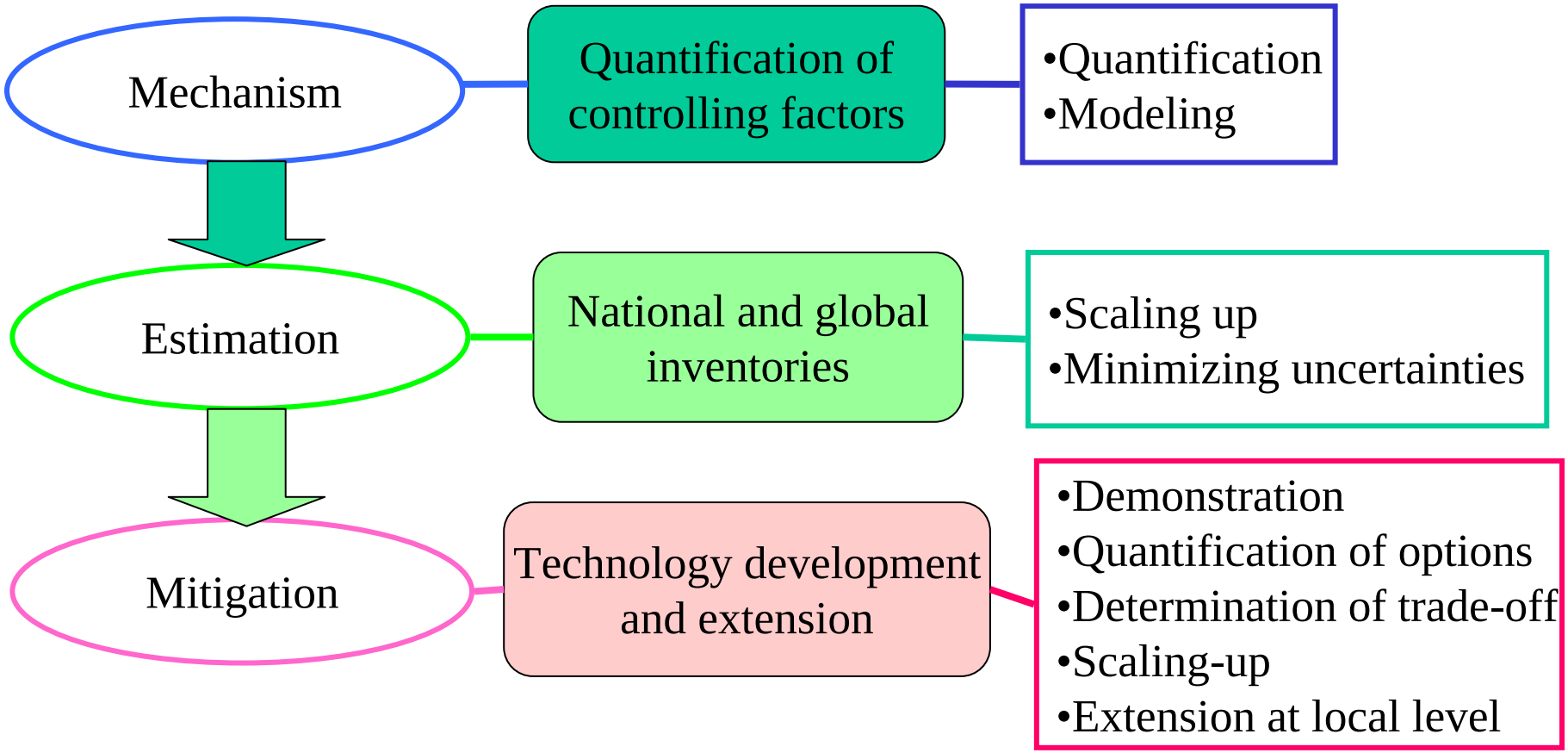
Indirect N_2O

Atmospheric deposition (IPCC default values)
Leaching and run-off: 1.24 % (from global data analysis)

Greenhouse Gas Studies in the Agricultural Sector

Research Tasks

NIAES



MAGES-Workshop

International Workshop on Monsoon Asia Agricultural Greenhouse Gas Emission Study

December 13-14, 2006

Tsukuba, Japan

An International Research Project

MAGES

Monsoon Asia Agricultural Greenhouse Gas Emission Studies

Targets

- More accurate regional estimation of Agricultural GHG emissions
- Provide feasible mitigation options and their potentials
- Assess the influences of changing GHG emissions due to changes of management on regional land ecosystems and the atmosphere

Plans in 2007

- MAGES web-site will be open soon.
- MAGES Research Plan will be completed by summer.
- Selected papers in 2006 Workshop will be published as a special section of Soil Sci. Plant Nutr.
- Next Workshop will be held in late 2007 or 2008.