Methane Emissions from Major Rice Ecosystems in Asia

International Rice Research Institute

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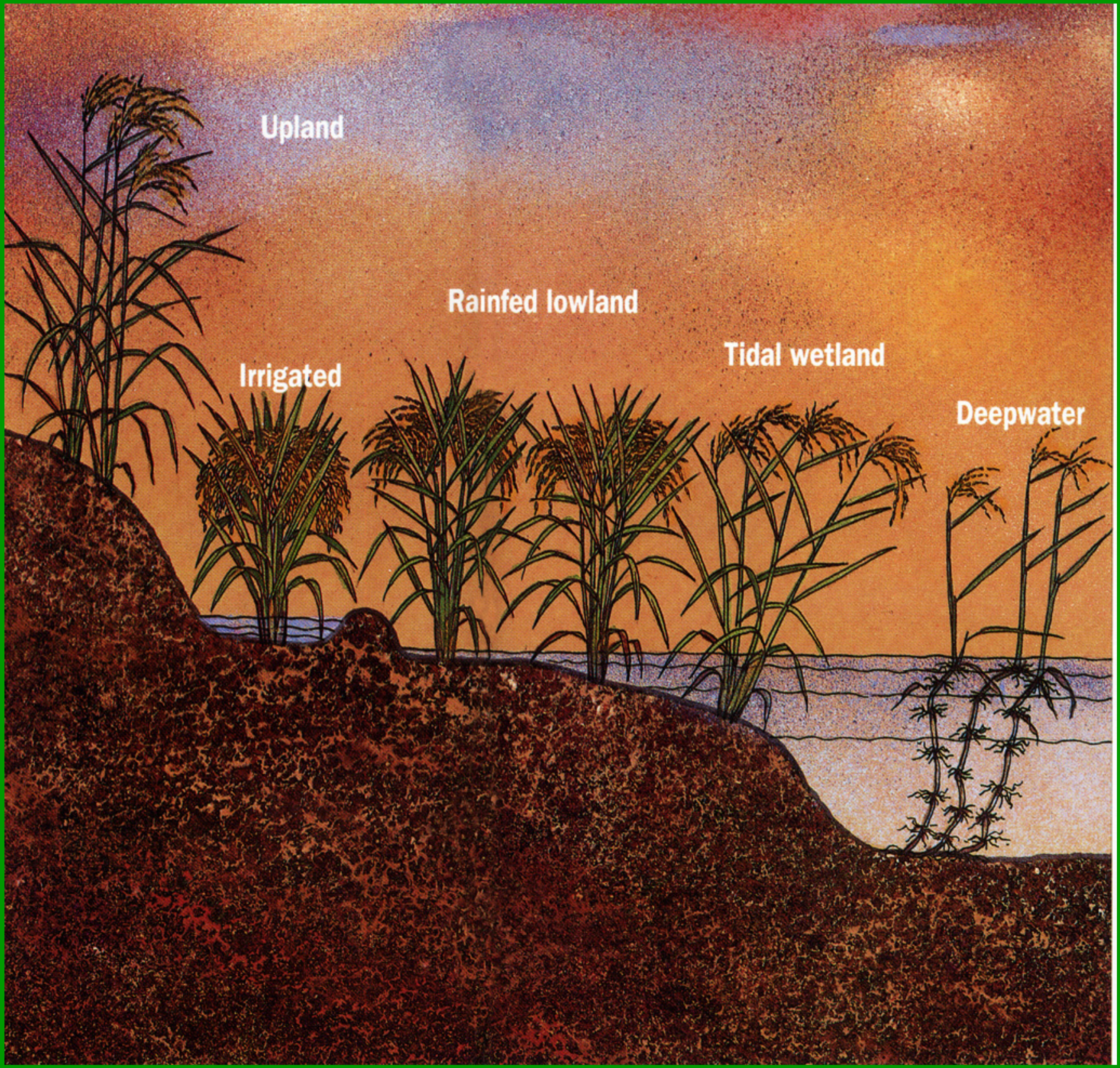
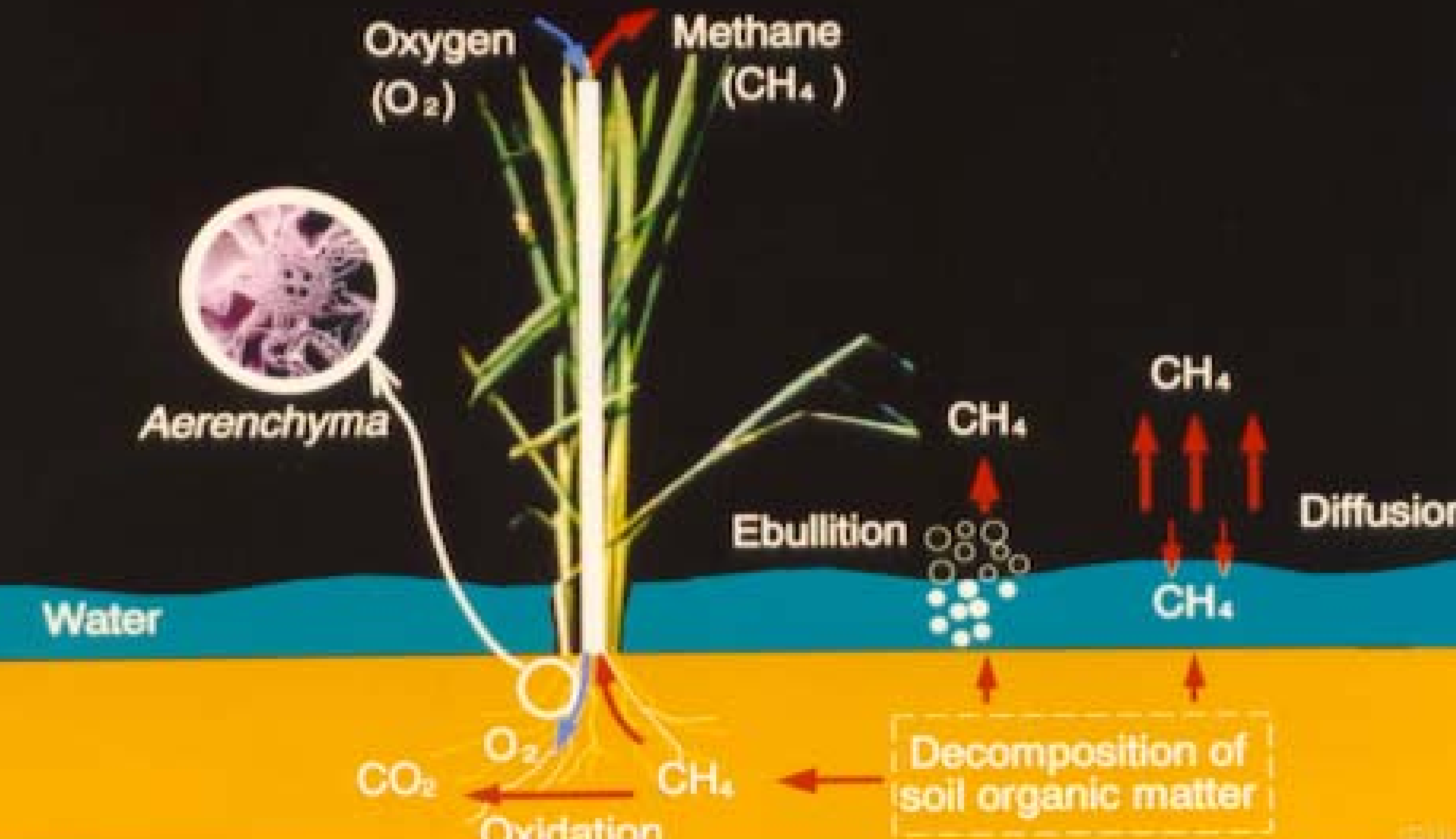
Estimates of sources and sinks of atmospheric methane,
(Tg CH_4 year^{-1})

Sources/sinks	IPCC Emission average
Natural	
Wetlands	115
Termites	20
Oceans, fresh waters	15
Others	15
Anthropogenic	
Fossil fuel (coal, gas prodn/distribn)	100
Cattle	85
Rice paddies	60
Other soils	
Biomass burning	40
Landfills	40
Animal waste	25
Domestic sewage	25
Total identified sources	535
Total sinks	515
Atmospheric increase	37

Rice ecosystems



Methane in a paddy field



The Interregional Research Programme on Methane Emissions from Rice Fields

- International Rice Research Institute, Fraunhofer Institute for Atmospheric Environmental Research, Agricultural Research Institutes of China, India, Indonesia, Philippines and Thailand
- Funded by United Nations Development Program, Global Environmental Facility (UNDP/GEF GLO/91/G31)
- 1993-1999

Stations of the Interregional Program on Methane Emissions

Irrigated rice ecosystem

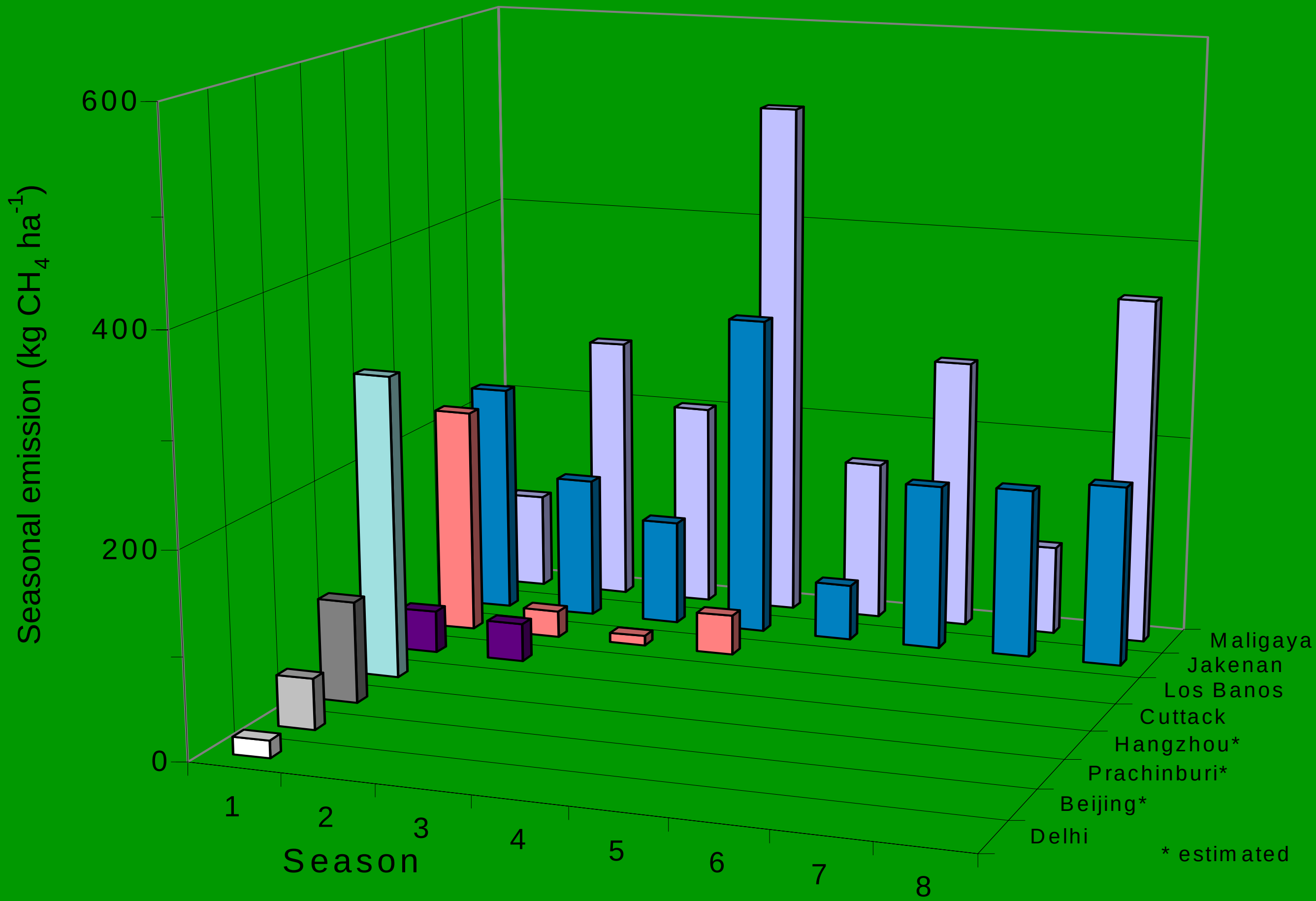
Irrigated rice: heavy water consumer

Methane emissions: field measuring system

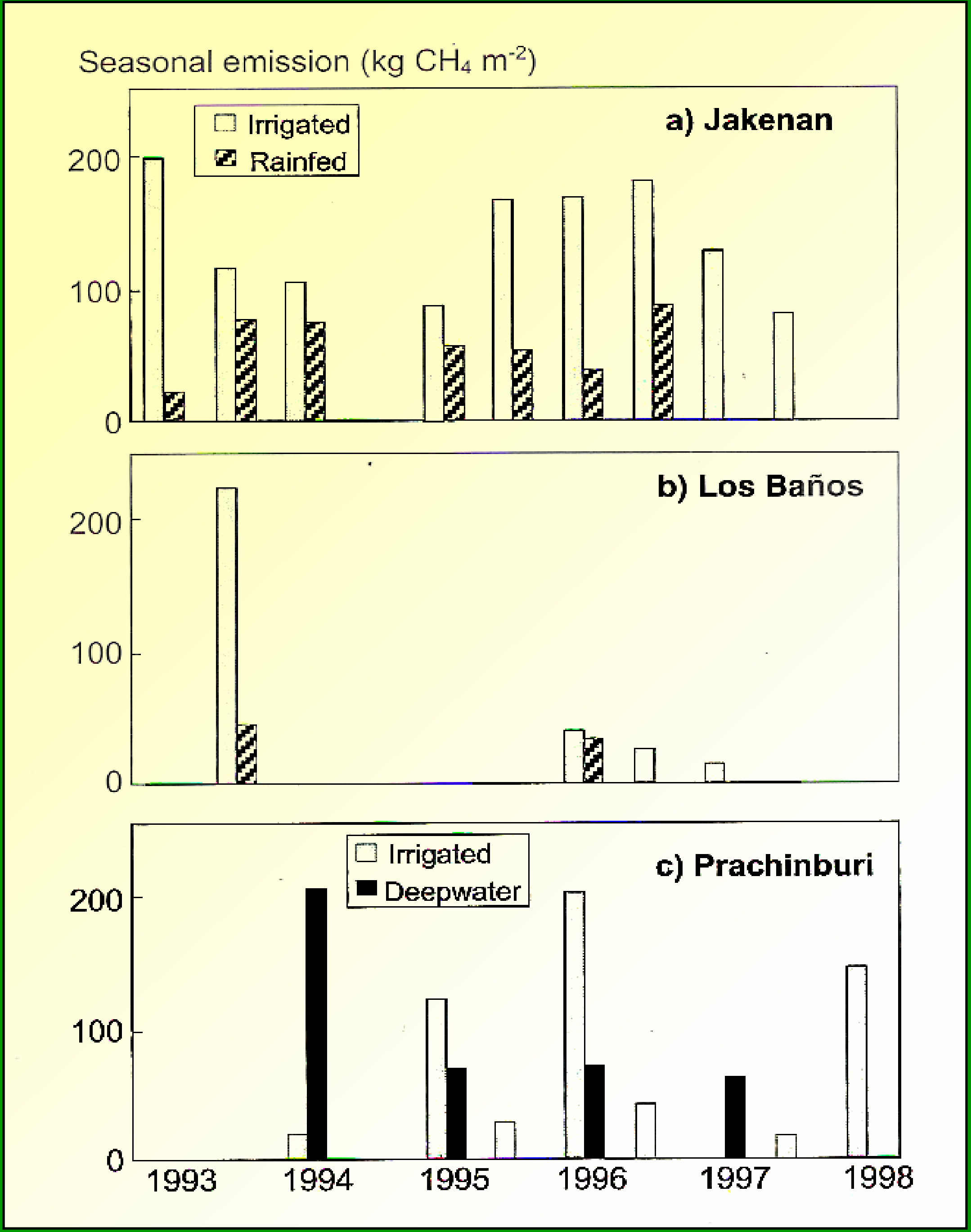
Methane emissions from rice fields: Controlling factors:

- Soil properties
- Temperature
- Cultural practices (water regime/drainage, fertilizer, seeding/transplanting, straw/residue management)
- Rice variety

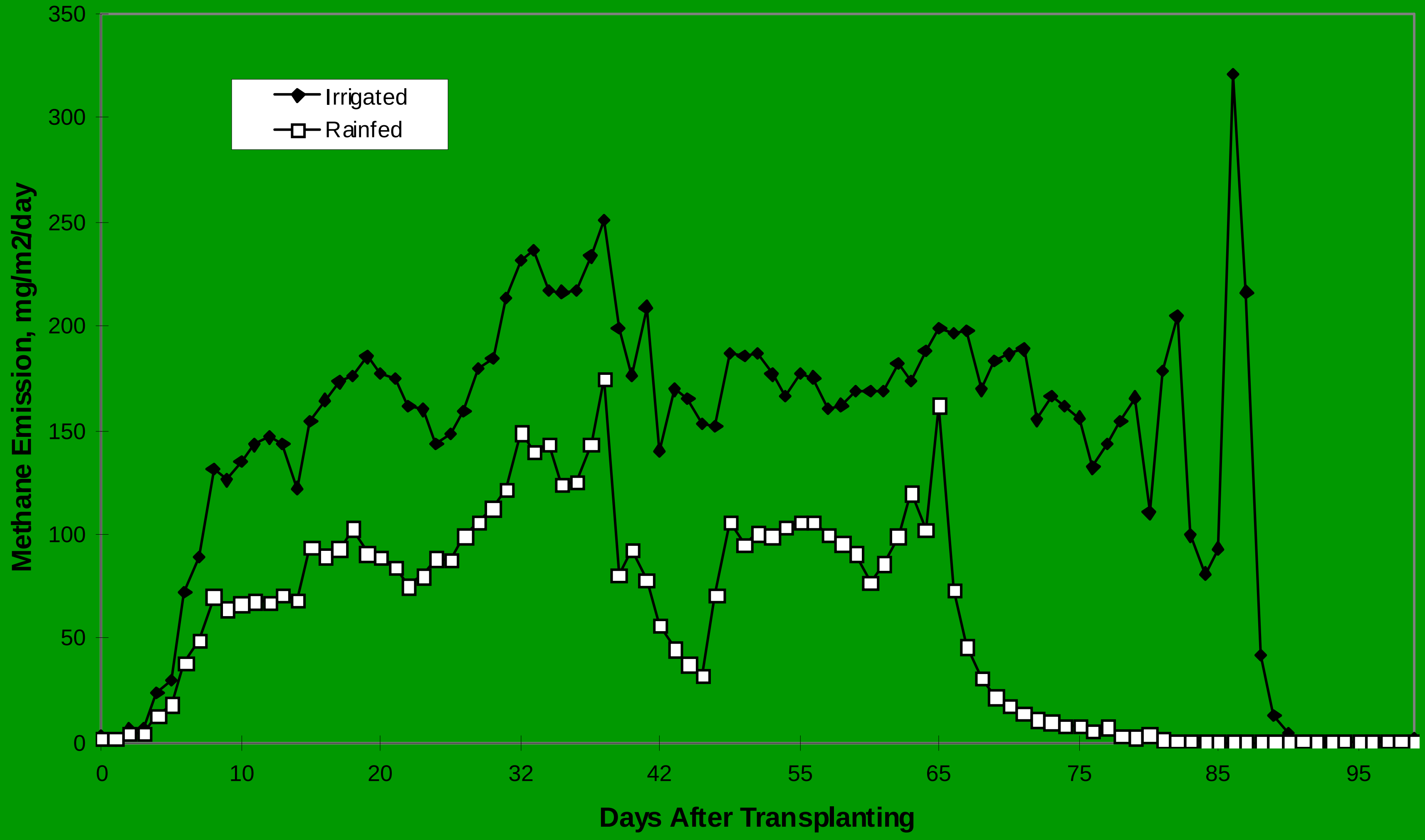
Seasonal CH_4 emissions from reference treatment (continuous flooding, pure mineral fertilizer, cultivar IR72)

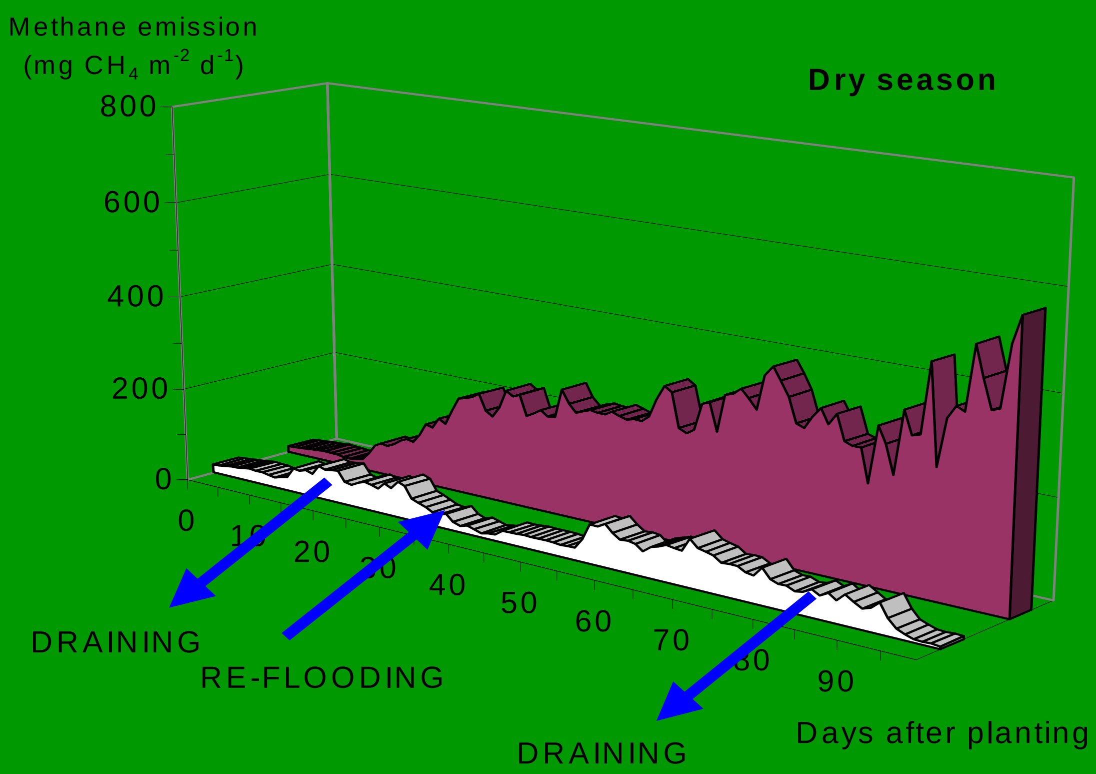


Seasonal CH_4 emissions from irrigated and rainfed rice in Jakenan and Los Baños, and irrigated and deepwater rice in Prachinburi



Effect of water regime on methane emission from ricefield grown to IR72 at Jakenan, Indonesia during the 1994 dry season

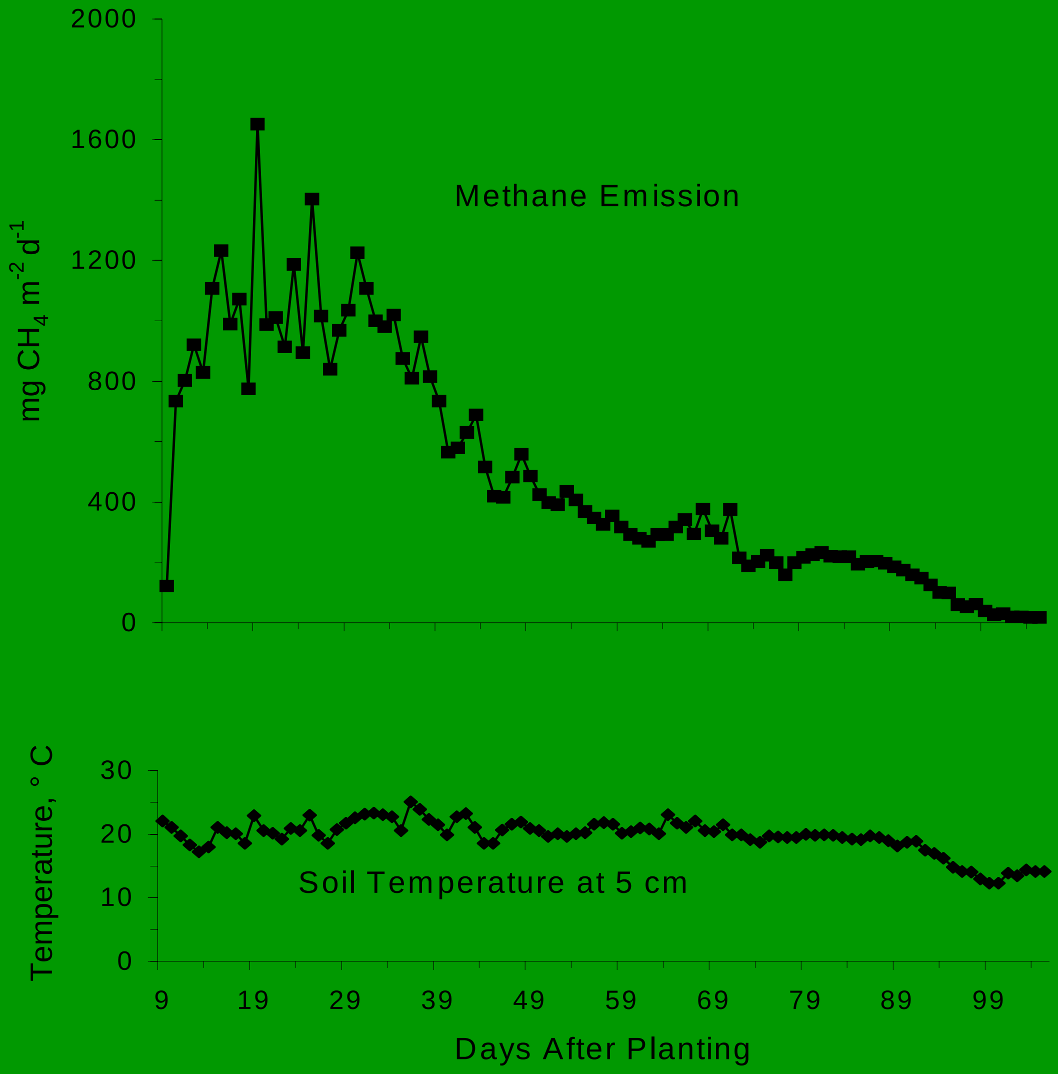




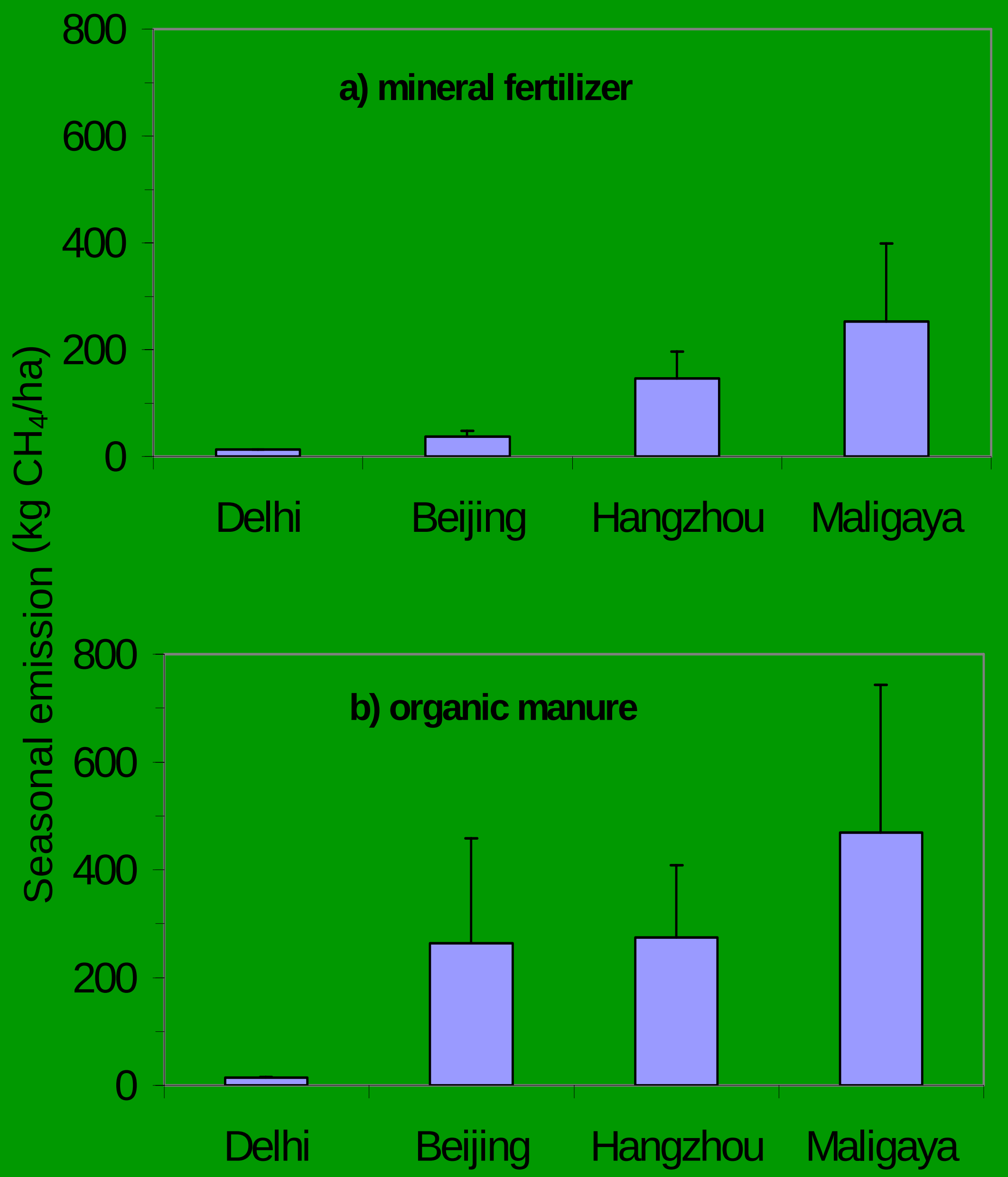
Methane emission rates in rainfed (white) and irrigated (maroon) rice , Los Baños, Philippines

Effect of temperature on methane emission

Beijing, China

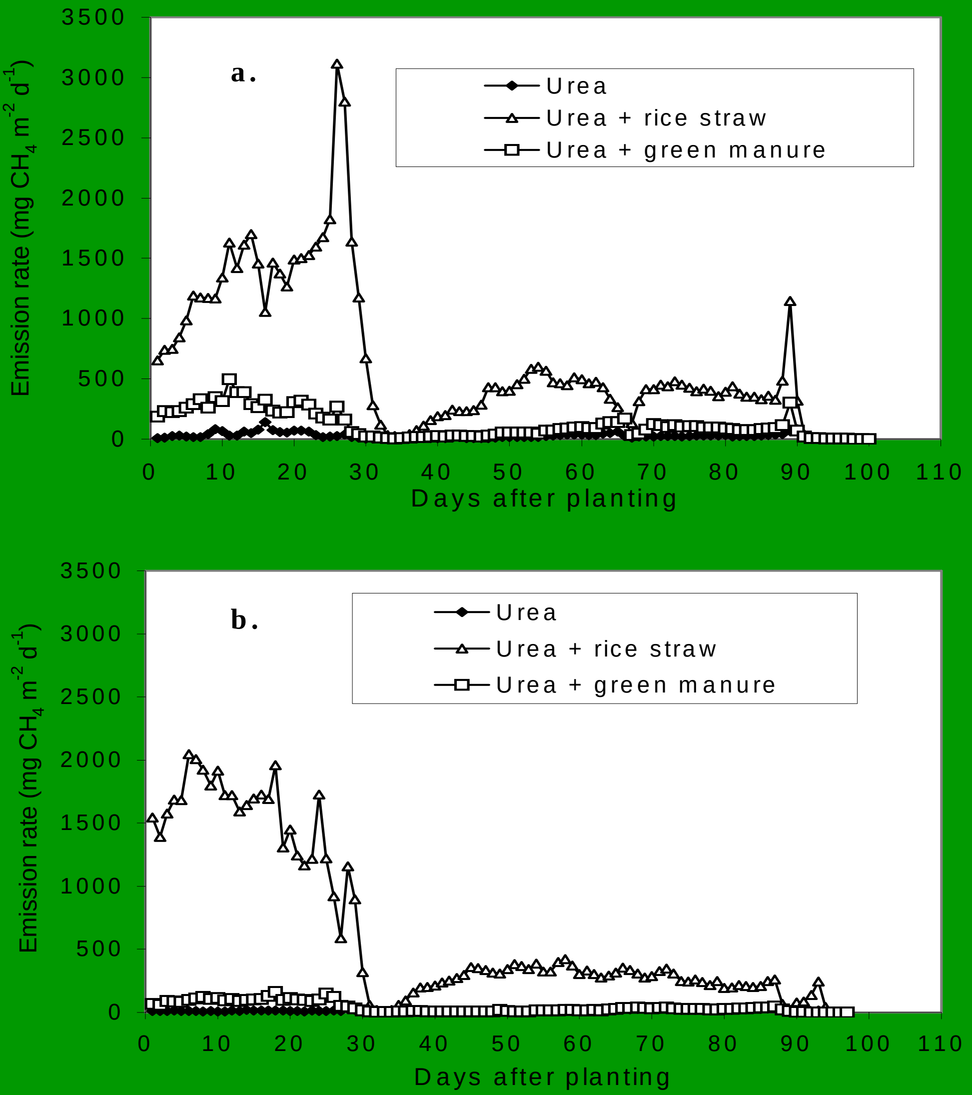


Site-specific CH_4 emissions in response to organic amendments



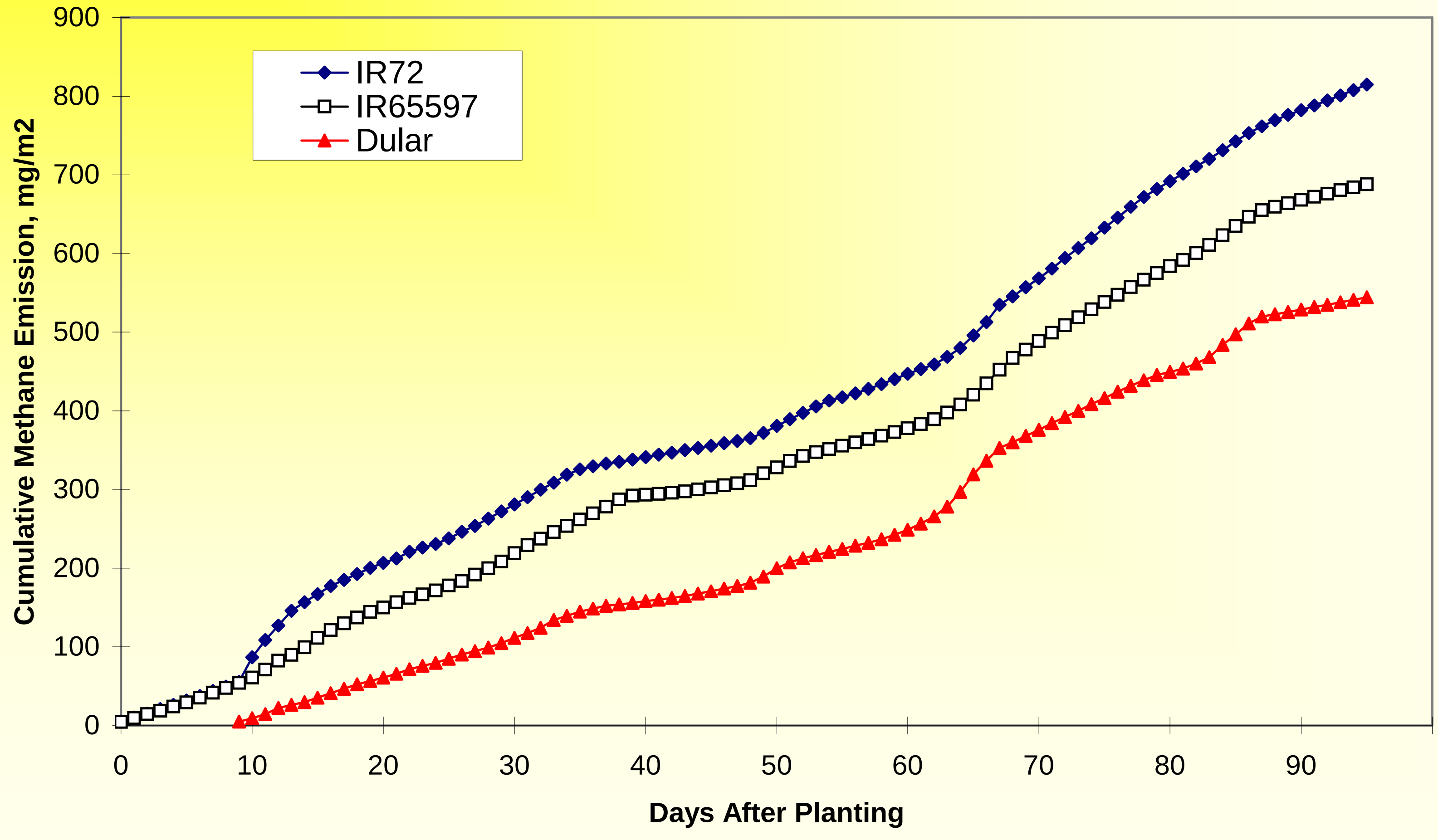
Methane emissions from urea, rice straw and organic manure

Los Baños Philippines



Conventional, improved high yielding, and new plant type

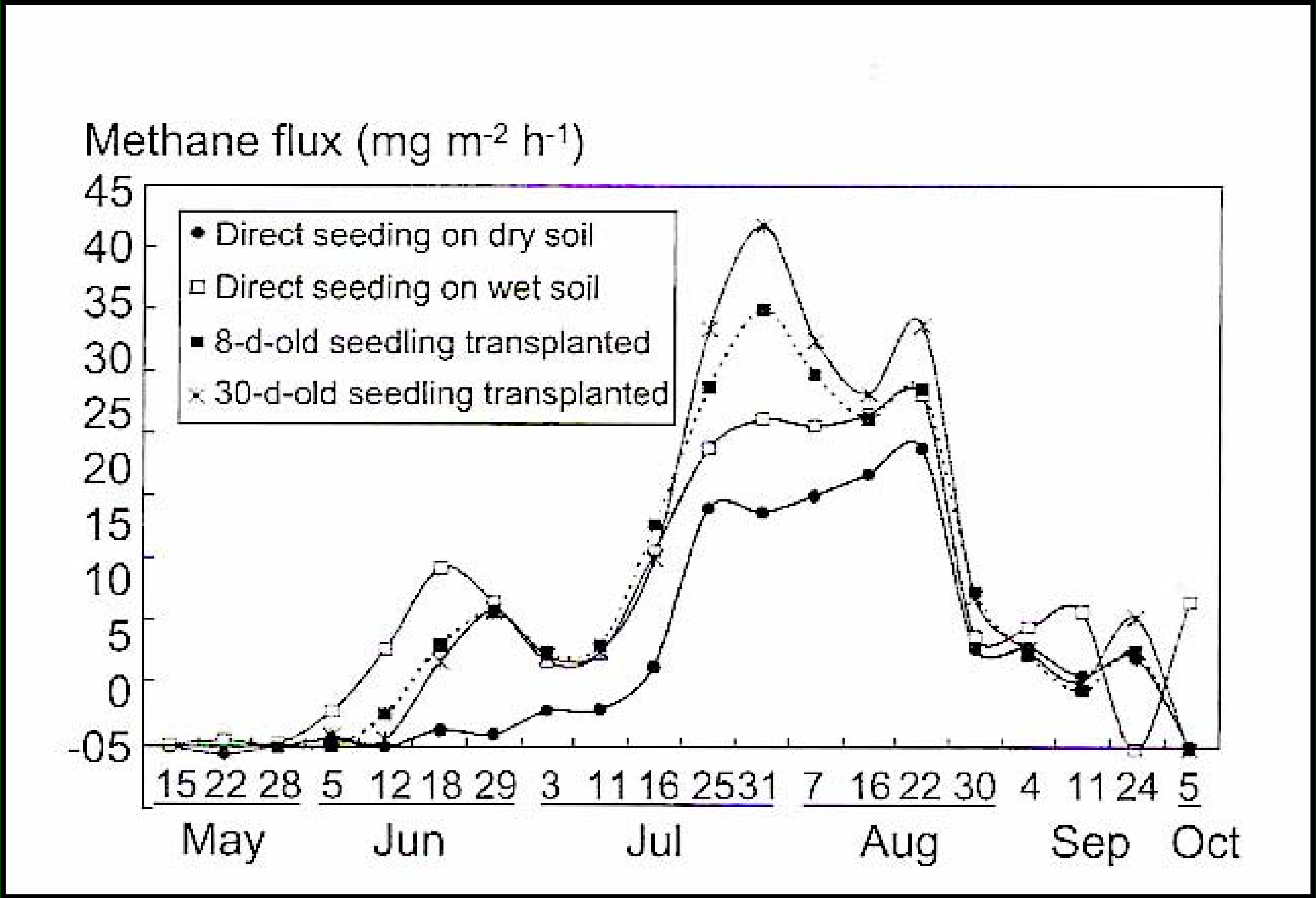
Effect of cultivar, 1995 DS



Transplanting

Direct (wet) seeding

Direct (dry) seeding



Variations in CH_4 emissions as affected by different cultural practices in Southeastern Korea

Harvesting rice

Residue management

- **Eliminate straw burning**
- **Incorporate rice straw**
  - **Maintain soil fertility in the long term**
  - **Sustain increased yield**
  - **Increase in organic C, N, available P, K and Si**
  - **Yield advantage of straw incorporation over straw burning is 0.4 t ha^{-1} $season^{-1}$**

Nutrient content of straw

Element	Content, %
• Nitrogen	0.6
• Phosphorus	0.1
• Sulfur	0.1
• Potassium	1.5
• Silica	5.0
• Carbon	40.0

Burning rice straw in China

Field burning of crop residues

Trace gases emitted

- Methane
- Carbon monoxide
- Non methane volatile organic compound
- Nitrous oxide
- Nitrogen oxides

Alternate residue management

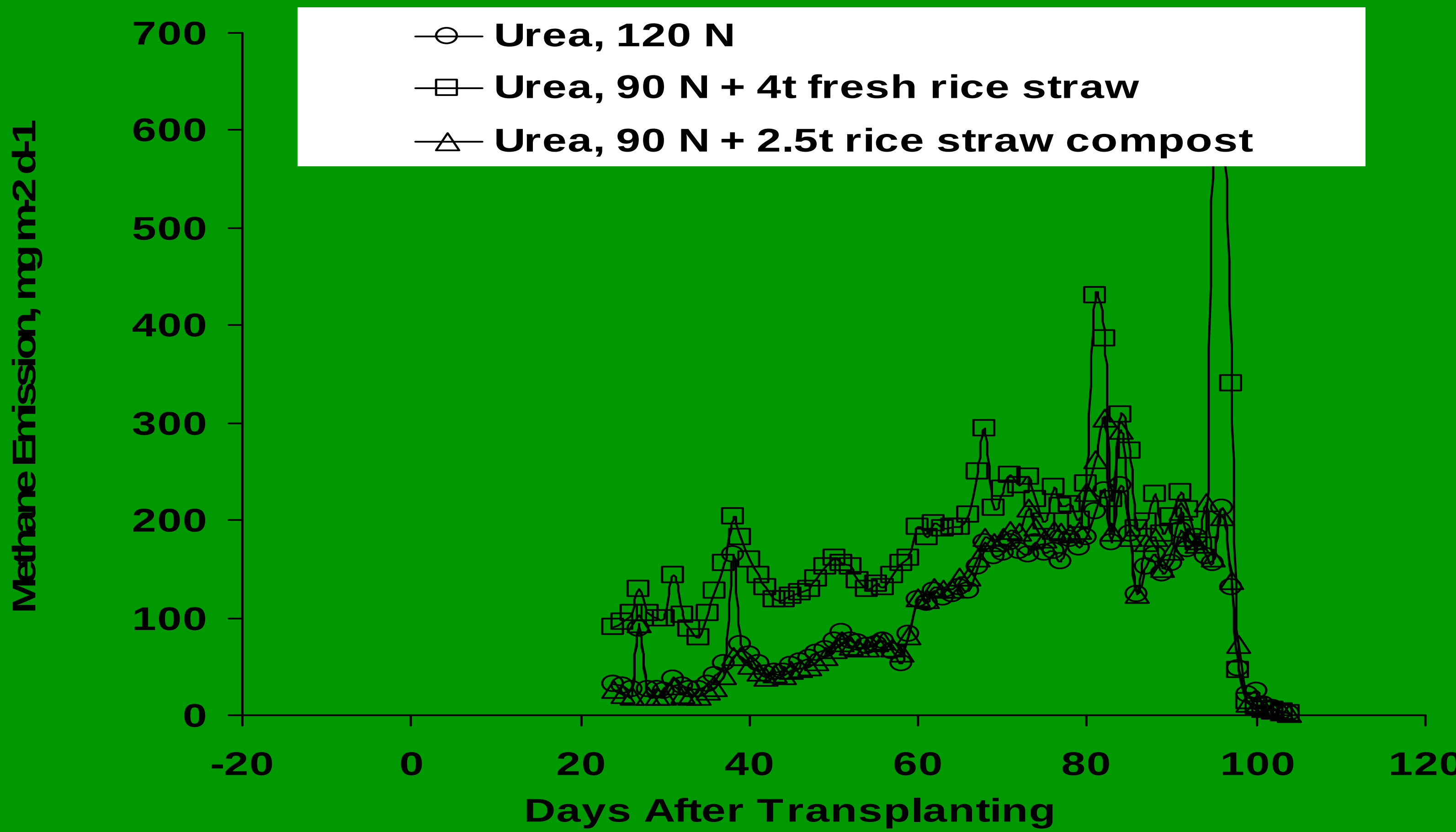
Incorporation into the soil

- rice-rice system: incorporate previous residue soon after harvest
- rice-upland crop: use straw as upland crop mulch

Straw incorporation

Composted rice straw from methane generator

Effect of straw management on methane emission Maligaya, Philippines, 1997



Methane and nitrous oxide emissions

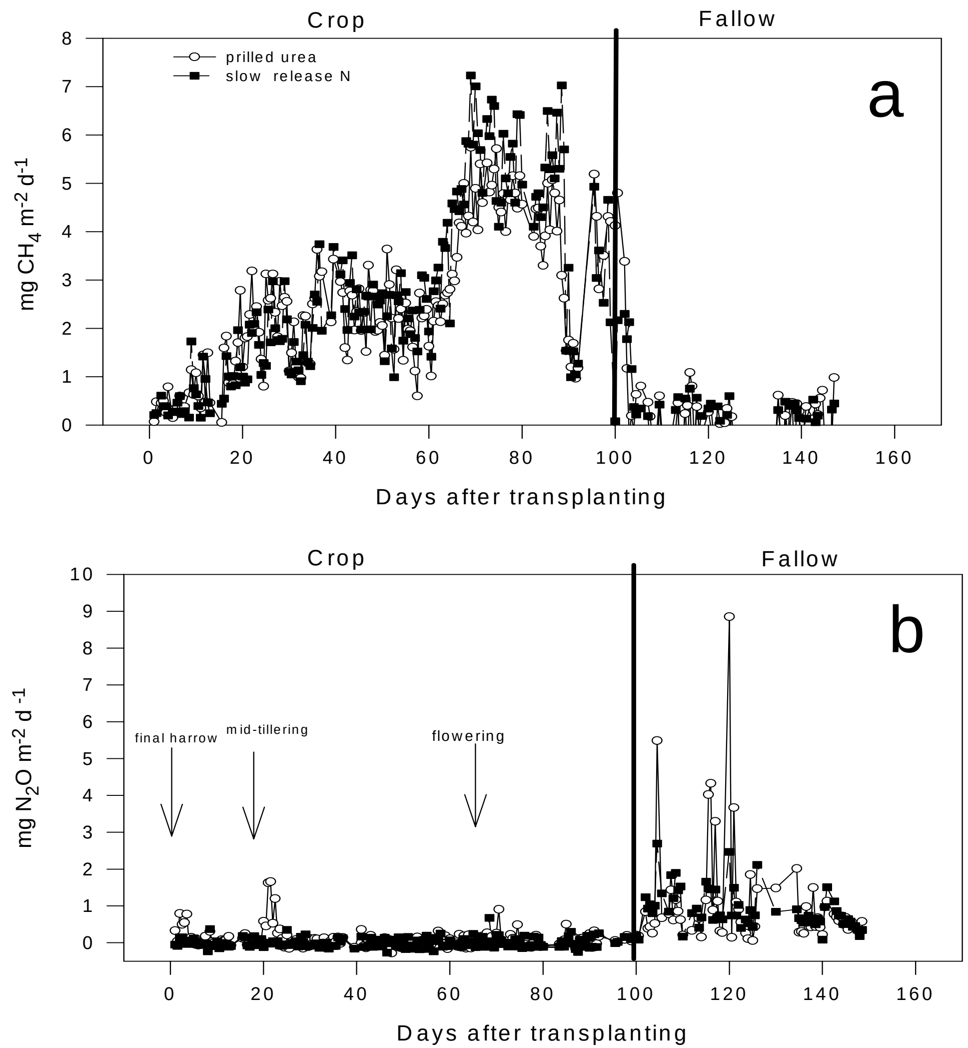


Figure 1a,b. CH_4 and N_2O fluxes during the 1994 wet season (crop and fallow period).

Rice production and methane emissions

Management practices can be modified to reduce emissions without affecting yield

- **Intermittent drainage in irrigated systems reduces emissions and also saves water**
- **Improved crop residue management can reduce emissions**
- **Direct seeding results in less labor and water input and reduce methane emissions**
- **Plants grown under good nutrition exhibit reduced methane emissions**

Rice production area ('000 hectares) in the Philippines by ecosystem (1983-93).

Year	Total	Irrigated	Rainfed
1983	3141	1688	1473
1984	3222	1755	1467
1985	3403	1838	1565
1986	3403	1878	1525
1987	3256	1852	1404
1988	3393	1956	1437
1989	3497	2064	1433
1990	3319	2010	1309
1991	3425	2060	1365
1992	3198	1980	1218
1993	3450	2017	1433
Mean	3337	1916	1421

Source: World Rice Statistics 1993-94, IRRI.

Methane emission factors from rice fields in the Philippines.

Ecosystem	Mean emission (mg/m²/day) from Sites			Emission Factor (kg/ha/day)		% **Decrease** from IPCC
	Los Baños	Maligaya	Mean	**Derived**	IPCC default (T=27 ° C)	
Irrigated	233.1	225.5	229.3	**2.3**	5.9	61
Rainfed	40.3		40.3	**0.4**	3.54	89

Global rice ecosystems, area and methane emissions

Ecosystem	Area (ha x 10^6)	Methane emission (kg ha^{-1})
Irrigated	79	21
Rainfed	36	10
Upland	19	0
Deepwater and tidal wetlands	12	16

Methane emission from rice fields:

Mitigation options in irrigated ecosystem

- Water management
- Management of organic amendments
- Alternate cultural practices
- Rice cultivar selection

Methane emission from rice fields:

Mitigation options in rainfed ecosystem

- Suitable water management
- Management of organic amendment
- Use of nitrification inhibitors

Methane emission from rice fields:

Mitigation options in deepwater ecosystem

- Proper straw management

Acknowledgment

- Mrs. Rhoda Lantin, retired Research Scientist of the International Rice Research Institute provided all the slides, materials and data for this presentation.

THANK YOU!