GLOBAL
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# Global

## Research Programme on Methane Emissions from Rice Fields

Project Document

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## Research Programme on Methane Emissions from Rice Fields

Project Document

*This Project Document has been edited to facilitate public dissemination.*
*The original is on file in the GEF Office at UNDP Headquarters in New York.*

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| CGIAR | Consultative Group for International Agricultural Research |
| $CH_4$ | Methane |
| IARC | International Agricultural Research Center |
| IGAC | International Global Atmospheric Chemistry Project |
| IGBP | International Geosphere and Biosphere Programme |
| IRRI | International Rice Research Institute |
| NARS | National Agricultural Research Systems |
| $N_2O$ | Nitrous oxide |
| pH | (Measure of acidity or alkalinity) |
| U.S. EPA | United States Environmental Protection Agency |

UNITED NATIONS DEVELOPMENT PROGRAMME

# GLOBAL ENVIRONMENT FACILITY

Global Project

| | |
|---|---|
| **Title:** | Research Programme on Methane Emissions from Rice Fields |
| **Number:** | GLO/91/G31/A/1G/31 |
| **Duration:** | Five years |
| **Project Site:** | Global |
| **UNDP Sector:** | Agriculture, Forestry and Fisheries |
| **Subsector:** | Crop Production and Protection |
| **Executing Agency:** | UNDP Office for Project Services (OPS) |
| **Estimated Starting Date:** | April 1992 |
| **Government Inputs:** | To be determined by each participating government |
| **UNDP/GEF Inputs:** | US $5 million |

**Brief Description:**

This project is designed to:

- Establish, in collaboration with national programmes in major rice growing countries, reliable data about both the scale of and control mechanisms for methane emissions from major rice ecosystems
- Foster sustainable rice productivity and production by providing methane mitigating technologies that are technically and socioeconomically feasible.

## A. CONTEXT

### 1. Description of subsector

Rice is the world's most important food crop, and the pressure to increase its production is growing. More than 90 percent of the world's rice is grown and consumed in Asia, where more than half the world's population lives. Nearly 80 percent of the world's poor are concentrated in Asia, where the population is growing at a rate of 1.8 percent per year. Between 80 to 100 million more rice consumers must be fed each year. Yet almost no additional land is available for the planting of rice in Asia, and environmentally fragile areas are being pillaged. Landless families are being forced from the countryside into teeming, squalid cities, which in turn sprawl farther onto prime rice land.

In thirty years, the earth will be home to 8 billion people. More than half - 4.3 billion, almost as many as inhabit the earth today - will be rice consumers. Feeding them will require a massive increase in global rice production, from today's 510 million tons to 760 million tons. This 49 percent increase, if it can be achieved, will merely maintain current nutrition levels, which are already inadequate for hundreds of millions of people. Although remarkable gains in rice production in the 1970s were achieved, they were accompanied by increased emissions from rice fields of methane ($CH_4$), a greenhouse gas (GHG) which contributes to global warming. The challenge to rice scientists is to conduct research that will help developing countries to grow more rice on limited land in ways that do not harm the environment, and which benefit both farmers and consumers.

The International Rice Research Institute (IRRI), an autonomous, nonprofit agricultural research and training center in the Philippines, was established in 1960 to help increase food production from rice-based farming systems in developing countries, particularly in Asia. IRRI scientists and management have been involved in farsighted planning to develop a strategy that will ensure enough rice for the world in the 21st century. The Institute's Strategic Plan, "IRRI toward 2000 and Beyond," and its Five-Year Work Plan (1990-1994), which were both approved by the Technical Advisory Council (TAC) of the Consultative Group for International Agricultural Research (CGIAR), focus on how rice science can increase stable, sustainable and equitable rice production.

The Institute is dedicated to discovery and invention, to finding the knowledge and technology needed to enable rice-dependent people everywhere to live, grow, and achieve. The goal is to improve the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes. IRRI generates and disseminates rice related knowledge and technology of short- and long-term environmental, social and economic benefit, which also helps to enhance national rice research systems.

IRRI has a comparative advantage in global rice research, especially for Asia. During its thirty years of existence, IRRI has established excellent scientific credentials on almost all aspects of rice cultivation. IRRI's strong and unbiased research traditions, research consortia, international networks and specific country projects, its communications system involving all rice growing countries, its various degree and non-degree training programmes, and its collaboration with advanced research institutions, provide the quality of infrastructure needed to lead and coordinate this inter-regional project on methane emissions from rice fields.

Knowledge gained in rice genetics will enable scientists to further increase rice productivity, both through breeding even higher yielding rice varieties and through designing more efficient systems of crop management. IRRI research programmes center on the world's major rice ecosystems, as well as on cross-ecosystems work that spans different environments. In each research programme, interdisciplinary scientific teams work to resolve critical, far-ranging rice production problems. Collaboration is an important research strategy. Many problem-focused research projects are carried out in partnership with scientists worldwide, in sophisticated laboratories, and with the participation of in-country research teams.

IRRI identified four important concerns in its recent strategic analysis: sustainability, equity, enhancement of research capability, and innovativeness of approach in dealing with problems. Its new programme structure and workplan, developed in consultation with scientists, policymakers, other research institutions, and development-oriented nongovernmental organizations, reflect these concerns.

## 2. Current research programmes

Current programmes focused on methane research include:

- *IRRI-United States Environmental Protection Agency (U.S. EPA) Global Change Project.* Research on effects of climate change such as increased temperature and carbon dioxide levels on ultra violet-B ray (UV-B) rice, and baseline research on $CH_4$ fluxes from rice fields.

- *Wetland Biogeochemistry Institute, Louisiana State University, United States.* Collaborative studies on the effects of soil redox-pH conditions, and increased carbon dioxide and temperature levels on methane formation. Component of the IRRI-U.S. EPA project.

- *Fraunhofer Gesellschaft for Environmental Atmospheric Science, Germany.* Collaborative studies on methane fluxes from rice fields as affected by water regimes, fertilizer application, and organic amendments. Component of the IRRI-U.S. EPA project.

- *Department of Soil Science and Geology, Agricultural University Wageningen, the Netherlands.* Effect of soil properties on methane fluxes; collaborative thesis research.

Research on the following topics related to rice field $CH_4$ emissions is being conducted:

- Climate change and rice
- Biological nitrogen fixation (BNF), fertilizer efficiency, organic amendments and soil fertility in wetlands rice systems
- Volatilization (ammonia release) and denitrification (nitrous oxide ($N_20$) losses)
- Soil, water and plant relationships, especially processes in the rice rhizosphere
- Photosynthetic aquatic biomass in rice fields and floodwater ecology

- Water use efficiency in irrigated rice systems
- Exchange of rice germplasm.

### 3. Current outreach and training programmes

IRRI's outreach and training activities are designed to share knowledge and strengthen National Agricultural Research Systems (NARS). The Institute's international programmes equip it to:

- House the world's leading rice germplasm collection, and provide services such as evaluation, preservation, and dissemination of rice germplasm

- Gather and disseminate information on rice and rice related science

- Organize conferences to facilitate the exchange of knowledge and direct its application to resolve emerging problems

- Promote the exchange of technologies and their evaluation by national programmes

- Provide short-term and degree training courses in collaboration with universities all over the world

- Extend technical services to strengthen the capacity of different NARS to conduct rice research.

## B. PROJECT JUSTIFICATION

### 1. Problem to be addressed and the present situation

The proposed project addresses the problem of growing emissions of methane from rice fields, and the need for comprehensive reseach that can be used as the basis for policy decisions.

Methane has been identified as an important GHG. It affects tropospheric ozone, hydroxyl radicals and carbon monoxide concentrations, stratospheric chlorine and ozone chemistry, and through its infrared properties, the earth's energy balance. Analysis of gases trapped in polar ice cores has revealed that atmospheric concentrations of methane have more than doubled in the last 200 years. Currently, the atmospheric methane concentration is about 1.7 parts per million by volume (ppmv), increasing by about 1 percent per year. Methane accounted for almost 20 percent of the radiative forcing (increased global warming) added to the atmosphere in the 1980s. Using general circulation models (GCMs) rather than simple energy balance models, the heating effect of trace gases, especially $CH_4$ and $N_2O$, has been found to be higher than previously believed. Trace gases generally increase the temperature, lead to stronger seasonal and latitudinal variations, and produce temperature increases in the tropical upper troposphere. Managing methane emissions offers an opportunity to mitigate global warming since methane has a high warming potential but a relatively short atmospheric lifetime (approximately twelve years), and more than 50 percent of its emissions are of anthropogenic origin.

Seventy to 90 ninety percent of atmospheric methane is derived from modern biogenic sources. Flooded rice fields are an important source of atmospheric $CH_4$ on a global scale. In such fields, methane is produced as a result of the anaerobic decomposition of organic substrates by methanogenic bacteria. It has been estimated that rice fields annually contribute 60 to 170 Tg ($=10^{12}$g) of methane to the atmosphere, which is approximately 25 percent of total annual emissions. These emissions are expected to rise over the next few decades as the production of rice increases.

The increase in rice demand will likely be met by:

- Improving soil and water management, especially by expanding and increasing the efficiency of irrigated systems, which will extend the time that soil is submerged

- Increasing cropping intensity by the number of rice crops grown per area per year

- Increasing inputs and efficiency of chemical and organic fertilizers

- Developing and disseminating new, higher yielding cultivars.

Most of these developments imply optimizing existing practices which will favor $CH_4$ formation and significantly increase methane emissions from flooded rice fields.

Recent efforts of the Intergovernmental Panel on Climate Change have determined that a 10 to 15 percent reduction in global $CH_4$ emissions is required to stabilize its concentrations in the atmosphere. A 20 percent reduction in methane emissions from rice fields will contribute about 30 to 50 percent of the required reduction. While it is not expected that reductions of methane emissions from rice cultivation can be achieved by the year 2000, scientists have determined that a 10 to 30 percent reduction, relative to current levels, is feasible in the long term. This will require a comprehensive research approach to develop the necessary technologies.

Three major processes control methane fluxes in rice fields:

- Methane production in the anaerobic soil
- Methane oxidation in the rice rhizosphere and the floodwater-soil interface
- $CH_4$ transport to the atmosphere.

Methane production is highly influenced by soil temperature; soil redox potential; soil pH; carbon supply to methanogenic bacterial, toxic substances; and competition with sulfate-reducing bacteria. In general, methane emission rates have been found to depend on the type, rate and mode of application of fertilizers. The application of organic fertilizers increases methane emissions; this increase is less marked with composted materials.

Little data is available on $CH_4$ oxidation. Estimates indicate that more than 60 percent of the methane produced during a rice cropping season may be oxidized in the rice rhizosphere or in the aerobic floodwater-soil interface. Up to 90 percent of $CH_4$ is emitted to the atmosphere via the rice plant. Specific tissue (the aerenchyma) supplies the root with oxygen and functions as a chimney for the release of methane. Unvegetated flooded rice fields emit only a small fraction of the methane emitted from planted fields.

Various alternatives have been proposed for mitigating methane emissions. These include soil amendments, water management strategies, and selection of rice cultivar, fertilizer, and the manner of its application. Substantial additional work, especially process-oriented research, is required to identify the most technically and socioeconomically feasible mitigation options that maintain or enhance rice productivity and production in sustainable rice systems. The problem of inreased $N_2O$ emissions in mitigating $CH_4$ emissions also needs attention. Owing to other priorities and the lack of awareness, resources and expertise, NARS of rice growing countries in the developing world have not been able to conduct sufficient and appropriate research on methane emissions from rice fields. In Asia, only China and India have monitored methane emission rates from rice fields.

Over the last decades, IRRI and NARS have made great progress in developing broadly adapted, high yielding, disease resistant, soil-stress tolerant germplasm and related ideotypes in soil, water, fertilizer and pest management, in both cropping as well as farming systems. Since rice plants mediate up to 90 percent of the methane flux to the atmosphere, the development of acceptable high yielding rice cultivars that reduce $CH_4$ emissions is a challenge, but one that would need time. Therefore, it is essential that mitigation technologies are developed interactively with production technologies which are already in the pipeline or being currently designed.

With the support of the U.S. EPA, some baseline research to identify and assess major controlling factors and processes of methane fluxes from rice fields has been started at IRRI, in collaboration with advanced institutions in the United States, Germany and the Netherlands. These research activities focus on the physico-chemical mechanisms governing methane formation, oxidation and emission, and the effects of certain established agricultural practices on $CH_4$ fluxes. Since environmental conditions in the Philippines, the location of IRRI, represent only a small part of the spectrum of rice ecosystems, additional activities must be established at IRRI and in national research systems to represent a wider range of rice ecosystems and sub-ecosystems. Collaboration with NARS is also important since they are the institutions that develop or adapt technology for dissemination at the national level.

The concerns that drive the development of this inter-regional programme are global, with causes and effects that transcend national boundaries and require international cooperation. The human, technical, and financial resources needed to successfully implement the essential research programme and necessary mitigation technologies cannot be met without the involvement of most rice growing countries, as well as of non-rice growing countries that are concerned about methane levels. Reducing methane emissions from rice fields requires concerted response strategies involving both groups in the design and execution of research that should be the basis for recommended policy actions.

## 2. Expected end-of-project situation

By the end of this project, the following results are anticipated:

- National programmes in major rice growing countries in the developing world will have established reliable data on methane fluxes from rice fields in their main rice ecosystems

- National programmes will have explored the effects of current cultivation practices on methane emissions, and will have tested mitigation technologies

- Reliable methane emission rates for major rice ecosystems will be available to asses more accurately global and regional annual fluxes of methane from rice fields

- A minimum set of environmental parameters will allow extrapolation and prediction of the effect of rice technologies on methane fluxes in various rice environments

- IRRI and national programmes will have increased the awareness of decisionmakers, resource managers, extension services, and farmers on causes, extent, and mitigation options concerning methane emissions from rice fields. It is intended that this awareness will lead to concerted response strategies.

## 3. Project strategy

Based on the distribution of harvested rice lands, IRRI has identified NARS representing the major rice ecosystems which can provide the essential infrastructure for the proposed research on methane emissions:

| Rice Ecosystem | Country | No. of key sites |
|---|---|---|
| Irrigated | China | 2 |
| | India | 1 |
| | Philippines | 1 |
| Rainfed lowland | India | 1 |
| | Indonesia | 1 |
| | Philippines (IRRI) | 1 |
| Deepwater/tidal wetland | Thailand | 1 |

The specific location of key research sites will be identified by IRRI and the respective NARS.

The project is divided into four major components:

- Development and standardization of equipment and methodology

- Development of a cadre of experts in collaborating NARS
- Quantification of methane fluxes in major rice ecosystems and diagnosis of mitigation options
- Evaluation of processes that control methane fluxes from rice fields.

IRRI will focus on methodology development, training, and baseline research, while NARS will focus on measurements of methane fluxes in major rice ecosystems and the verification of promising mitigation alternatives.

The direct recipients of the proposed project are the NARS involved in rice improvement. NARS, being responsible for rice improvement in their countries, are in turn responsible to the target beneficiaries (rice farmers and consumers). The project will be coordinated and implemented by IRRI scientists in collaboration with the participating NARS, advanced institutions, and international research programmes.

IRRI will provide the necessary physical facilities for the execution of the project, and coordinate the implementation of project activities by the participating NARS. Other concerned International Agricultural Research Centers (IARCs), or international research programmes like the International Geosphere and Biosphere Programme (IGBP) of the International Union for the Conservation of Nature and Natural Resources (IUCN), will contribute relevant expertise as necessary.

## 4. Target beneficiaries

Rice farmers throughout the developing world will benefit through the acquisition of rice technologies that will at least maintain, if not improve, rice productivity in sustainable and culturally acceptable ways.

The national programmes of developing rice growing countries in Asia, Africa and Latin America will be immediate beneficiaries. NARS in Asia, in particular, where more than 95 percent of rice is grown, will achieve the capacity to significantly contribute to the awareness and mitigation of $CH_4$ emissions from rice lands which add to global warming. Other immediate beneficiaries will be international programmes (such as IGBP) and advanced institutions collaborating in this project or participating in research on global climate change.

## 5. Reasons for assistance from UNDP

This project is within IRRI's Five-Year Work Plan (1990-1994). Funding for this plan is approximately 20 percent less than what is needed and what has been approved. IRRI has initiated research on $CH_4$ at its research center at Los Banos with financial support from the U.S. EPA. Additional external funds are necessary to enhance IRRI's baseline research capability, and to establish within NARS the capacity for research on methane emissions to effectively explore mitigation options in major rice ecosystems.

## 6. Special considerations

As noted above, this project will be supplemented by a research project on $CH_4$ emissions at IRRI, recently started in collaboration with the Wetland Biogeochemistry Institute at Louisiana State University in the United States, and the Fraunhofer Gesellschaft for Environmental Atmospheric Science in Germany.

This proposed research project could become part of the core project of the IGBP/International Global Atmospheric Chemistry Project (IGAC) on trace gas emissions from rice fields. Its objectives and approaches are fully in accord with the IGBP/IGAC project, especially with respect to establishing research activities in the national programmes of rice growing countries.

## 7. Coordination arrangements

Research coordination at IRRI

IRRI has adapted a matrix management structure to coordinate its research programme under the Deputy Director General for Research. The newly established research programmes serving the main rice ecosystems are positioned to plan, monitor, evaluate, and revise activities, and to set priorities for management and services. Five ecosystem research programmes drive the matrix. They are the irrigated rice, rainfed lowland rice, upland rice, deepwater and tidal wetlands rice, and the cross-ecosystems research programmes.

The newly structured discipline-based divisions (formed by merging research departments) permit more meaningful research as well as leadership. Interactive management within the matrix structure enables programme leaders and division heads to meet the objectives of the ecosystem-specific programmes with appropriate disciplinary balance in the research projects. IRRI, therefore, can focus sharply on critical rice science issues and respond quickly to emerging scientific opportunities.

Budgeting is project-based. Within research programmes, forty-nine projects have been established; in international programmes, there are seventeen projects. Each project team uses a zero-based budgeting system to estimate the resources needed (personnel time, general operating costs and equipment) to carry out the work planned. Programme leaders and the heads of divisions/centers balance these estimates against resources. Programme leaders and the Institute's management then adjust all budgets against the Institute's overall resources.

International programme coordination at IRRI

International programmes are coordinated at IRRI by the Deputy Director General for International Programmes. The programmes are carried out by center staff who coordinate with the research programmes or form part of the research teams. This encourages partnerships between scientists in the national rice research systems via research consortia, relevant networks, and country programmes.

## 8. Counterpart support capacity

Cooperative research programmes with NARS are developed by direct interaction between the responsible scientists at IRRI and the national institutions concerned, and are regularly reviewed in planning meetings convened jointly by IRRI and NARS.

Links with international organizations

The IARCs (supported by the Consultative Group for International Agricultural Research (CGIAR)) and other international centers with regional responsibilities for rice, will provide experience and knowledge generated by their respective programmes; and the national programmes will be encouraged to exchange promising technology. Close links will be encouraged between the three IARCs that share a rice mandate - the International Institute of Tropical Agriculture (IITA) in Nigeria, the Centro Internacional de Agricultura Tropica (CIAT) in Colombia, and the West Africa Rice Development Association (WARDA) in Cote d'Ivoire. In addition, IRRI will strengthen its links with IGBP and IGAC on issues related to methane emissions.

Links with national organizations

The implementation of the project will benefit from the links already established with the various national centers, particularly those collaborating in IRRI's networks and research consortia. The various NARS institutions and IARCs that will collaborate in the project are:

| | |
|---|---|
| China: | China National Rice Research Institute, Hangzhou |
| | National Environmental Protection Agency of China, Beijing |
| India: | Indian Council for Agricultural Research (ICAR), New Delhi |
| Indonesia: | Agency for Agricultural Research and Development (AARD), Bogor |
| | Sukamandi Research Institute for Food Crops (SURIF), Sukamandi, Subang |
| Philippines: | PhilRice, Maligaya, Munoz, Nueva Ecija |
| Thailand: | Pathus Thani Rice Research Center, Thanyaburi, Pathum Thani |
| | Prachinburi Rice Research Center, Bansang, Prachinburi. |

Detailed agreements and arrangements with collaborating countries are still to be finalized.

Links with institutes in developed countries

This project is related to a number of research exercises being conducted on methane emissions from rice fields in the United States, Japan and Italy. In some cases, the main research group is directly involved with other IRRI projects. In other cases, information is being shared with other research groups. The Fraunhofer Gesellschaft for Environmental Atmospheric Science in Germany will collaborate directly in the project.

## C. DEVELOPMENT OBJECTIVE

To establish, in collaboration with national programmes in major rice growing countries, reliable data about the scale of and control mechanisms for methane emissions from major rice ecosystems, and to foster sustainable rice productivity and production by providing methane mitigating technologies that are technically and socioeconomically feasible.

## D. IMMEDIATE OBJECTIVES, OUTPUTS, AND ACTIVITIES

IMMEDIATE OBJECTIVE 1

Develop and standardize measurement systems that:

- Are suitable for reliable methane flux measurements in different rice ecosystems
- Allow simultaneous semicontinuous flux measurements of at least three to four treatments and at least three replicates
- Are stable and reliable under tropical conditions
- Can be operated by scientific support staff.

Standardized measurement systems will facilitate the pooling, analysis, comparison of and access to measurement data from the different sites and seasons. Standardized measurement systems will also make for efficient logistics and training for operations and maintenance.

Reliable and accurate measurements of the high diel and seasonal variation of methane fluxes require a high frequency of measurements throughout the twenty-fourth day and the entire season. Three to four treatments per season are necessary to provide adequate data on major factors influencing methane fluxes within the timeframe of the project. At least three replicates are needed for statistical analyses of experimental data.

At present only automatic closed static chamber systems, similar to the one developed by the Fraunhofer Gesellschaft for Environmental Atmospheric Science and successfully tested in China, fulfill the requirements at a reasonable cost.

**Output 1.1**

Standardized methane flux measurement systems for irrigated, rainfed, tidal wetlands and deepwater rice ecosystems.

Activities for Output 1.1

1.1.1 Design measurement systems.

Responsible Parties: Project team, IRRI and Fraunhofer Gesellschaft for Environmental Atmospheric Science.

1.1.2 Design measurement systems.

Responsible Party: Fraunhofer Gesellschaft for Environmental Atmospheric Science.

1.1.3 Install and test measurement systems at experimental sites.

Responsible Parties: Fraunhofer Gesellschaft for Environmental Atmospheric Science, IRRI and project teams at experimental sites.

IMMEDIATE OBJECTIVE 2

Upgrade strength of participating NARS in measurement and analysis of methane fluxes and techniques of essential soil and water measurements.

Develop a cadre of experts in participating NARS to implement the proposed experiments at selected key sites of national programmes.

**Output 2.1**

Training of NARS scientists in participating countries in essential measurements, and in the analysis of methane flux and its physico-chemistry.

Activity for Output 2.1

2.1.1 Provide four weeks of on-the-job training at IRRI in operation and maintenance of the measurement system, and in analyses of the rice-soil-floodwater-plant system.

Responsible Parties: IRRI and Fraunhofer Gesellschaft for Environmental Atmospheric Science.

**Output 2.2**

Annual training and planning workshops, including visits to experimental sites. The initial workshop will be held at IRRI, and the following ones in the participating countries.

Activity for Output 2.2

2.2.1 Plan and review experiments annually, including field visits to measurement sites.

Responsible Parties: Project team and other invited scientists.

**Output 2.3**

The strengthening of NARS through visits and consultation by IRRI and other scientists.

Activity for Output 2.3

2.3.1 Invite project team and other scientists to visit collaborating countries annually in order to interact with scientists in location-specific planning, the inspection of experiments, and consultation with decisionmakers.

Responsible Parties: Coordinating IRRI scientists.

IMMEDIATE OBJECTIVE 3

Determine the effects of current and advanced cultivation technologies on methane fluxes in representative rice fields of major rice ecosystems. These experiments will provide more reliable estimates of regional and global methane fluxes from rice fields and so help to identify the most promising mitigation options.

**Output 3.1**

Identification of key research sites for methane flux measurements.

Activity for Output 3.1

3.1.1 Identify key research sites for major rice ecosystems in collaborating countries.

Responsible Parties: IRRI and NARS.

**Output 3.2**

Setting up of measurement systems at key sites.

Activity for Output 3.2

3.2.1 Set up measurement systems at key sites for major rice ecosystems in collaborating countries.

Responsible Parties: IRRI and Fraunhofer Gesellschaft for Environmental Atmospheric Science.

**Output 3.3**

Determine the effects of current and advanced cultivation technologies on seasonal methane fluxes of rice fields in major rice ecosystems.

Activities for Output 3.3

3.3.1 Measure the effects of soil properties, land preparation, rice cultivars, fertilizer application, water regimes, and organic amendments such as permanent flooding, interseasonal drying, and intermittent drainage on methane flux in *irrigated* rice fields.

Responsible Parties: IRRI, Fraunhofer Gesellschaft for Environmental Atmospheric Science, and NARS in China, India and the Philippines.

3.3.2 Measure the effects of soil properties, land preparation, rice cultivars, fertilizer application, water regimes, and organic amendments such as permanent flooding, interseasonal drying, and intermittent drainage on methane flux in *rainfed* rice fields.

Responsible Parties: IRRI, Fraunhofer Gesellschaft for Environmental Atmospheric Science, and NARS in India and Indonesia.

3.3.3 Measure the effects of water depth, rice cultivars, tidal rice, and salinity and acidity on methane flux in *deepwater* rice fields.

Responsible Parties: IRRI, Fraunhofer Gesellschaft for Environmental Atmospheric Science, and NARS in Thailand.

Activities 3.1.1 - 3.1.3 may be modified according to knowledge gained and mitigation options arising from research activities in Immediate Objectives 3 - 5.

IMMEDIATE OBJECTIVE 4

Evaluate processes that control methane formation, oxidation and transport.

Knowledge of processes that control methane fluxes will improve extrapolation and application of results, and provide a more reliable tool for the timely development of feasible mitigation options. Such knowledge is also essential for process-oriented modeling of methane fluxes.

**Output 4.1**

Knowledge of processes that control methane flux.

Activities for Output 4.1

4.1.1 Identify effects of redox potential (Eh), pH, exchange capacity of soils (EC), sulfate, organic substrates (such as straw, compost, green manures and algae), and temperature on methane formation through incubation studies.

Responsible Parties: IRRI, Fraunhofer Gesellschaft for Environmental Atmospheric Science and collaborating NARS.

4.1.2 Classify soil types according to methane-producing potential through incubation studies.

Responsible Party: IRRI.

4.1.3 Understand oxidation processes and gas transports in the root-soil-plant system and floodwater-soil interface, and determine methane oxidation rates.

Responsible Party: IRRI.

## E. INPUTS

IRRI

IRRI's inputs include research and international programmes staff; laboratory and support facilities; and administrative and logistical support to conduct the research and training programmes.

Countries

Scientists from collaborating NARS will participate in IRRI's training programmes, meetings, and collaborative research projects.

UNDP

UNDP will provide US $5 million to support the programme. Budget allocations for five years beginning in 1992 are attached.

## F. RISKS

Given IRRI's strong links with NARS and their history of successful collaboration, no risks are anticipated.

## G. PRIOR OBLIGATIONS AND PREREQUISITES

IRRI has well-established research and training facilities at its headquarters in Los Banos, the Philippines, to carry out the activities described in this project. IRRI is recognized worldwide as a center of excellence in rice research, and holds the world's most extensive collection of rice germplasm as well as rice literature. It also has highly skilled internationally and nationally recruited staff in research, training and administration to undertake the proposed activities. In addition, IRRI has extensive links with NARS, and its outreach offices in India, Indonesia and Thailand can facilitate the collaborative research where needed. The selected NARS have skilled research staff and adequate research facilities to execute the proposed activities in collaboration with IRRI.

## H. PROJECT REVIEW, REPORTING AND EVALUATION

The following arrangements are in place to ensure the timely and thorough monitoring and evaluation of progress of IRRI's research and international programmes:

- The Programme Committee of the IRRI Board of Trustees reviews research policy and programmes biannually. In addition, teams from ecosystem-based research programmes and projects also meet at least twice a year to review progress.

- IRRI's programme leaders and project coordinators monitor research progress and budget expenditures regularly with concerned scientists. These leaders and coordinators report directly to the Deputy Director General for Research.

- IRRI publishes yearly programme reports which highlight its research and international programmes. In addition, scientists report significant findings through international journals and meetings.

- In-house reviews of selected topics are mandated by IRRI's Board of Trustees each year. Such reviews are generally made by external review panels comprising scientists recognized worldwide in the relevant fields.

- At five-year intervals, the Technical Advisory Council of the CGIAR also arranges comprehensive external programme and management reviews of each IARC, including IRRI, on behalf of donors.

- It is expected that this entire project will be reviewed halfway and at its conclusion.

- Progress of work on the proposed project will be reported annually to UNDP.

## I. LEGAL ASPECTS

IRRI is an autonomous, nonprofit organization, governed by a Board of Trustees.

## J. WORKPLAN

The duration of this project will be five years.

| | YEAR 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Immediate Objective 1** (Develop measurement systems for methane fluxes in different rice ecosystems) | | | | | |
| Output 1.1 | | | | | |
| Research Activity 1 | x | | | | |
| Research Activity 2 | x | | | | |
| Research Activity 3 | x | x | | | |
| **Immediate Objective 2** (Upgrade research strength of collaborating NARS) | | | | | |
| Output 2.1 | | | | | |
| Research Activity 1 | x | | | | |
| Output 2.2 | | | | | |
| Research Activity 1 | x | x | x | x | x |
| Output 2.3 | | | | | |
| Research Activity 1 | x | x | x | x | x |
| **Immediate Objective 3** (Determine methane flux in major rice ecosystems) | | | | | |
| Output 3.1 | | | | | |
| Research Activity 1 | x | | | | |
| Output 3.2 | | | | | |
| Research Activity 1 | x | x | | | |
| Output 3.3 | | | | | |
| Research Activity 1 | x | x | x | x | x |
| Research Activity 2 | | x | x | x | x |
| Research Activity 3 | | x | x | x | x |
| **Immediate Objective 4** (Determine processes that control methane flux) | | | | | |
| Output 4.1 | | | | | |
| Research Activity 1 | x | x | x | x | x |
| Research Activity 2 | x | x | x | x | x |
| Research Activity 3 | x | x | x | x | x |
| Research Activity 4 | x | x | x | x | x |

Budget (in US$)

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total | |
|---|---|---|---|---|---|---|---|
| 1. Salaries and Benefits | | | | | | | |
| a. Senior Staff (1) | | | | | | | |
| b. Junior Staff | | | | | | | |
| Research Assistants (3) | | | | | | | |
| Field Assistant (1) | | | | | | | |
| Laboratory Assistant (1) | | | | | | | |
| Laborers (2) | | | | | | | |
| c. Junior Staff at Country Sites (7) | | | | | | | |
| Research Assistants (2) | | | | | | | |
| Laborers (2) | 217,200 | 196,600 | 210,300 | 225,000 | 257,600 | 1,106,700 | |
| d. Hourly Help and Overtime | | 6,000 | 6,400 | 6,900 | 7,400 | 7,900 | 34,600 |
| Sub-total | 223,200 | 203,000 | 217,200 | 232,400 | 265,500 | 1,141,300 | |
| 2. General Operating Costs | 321,600 | 213,000 | 227,900 | 243,500 | 261,900 | 1,267,900 | |
| 3. Equipment/Capital | | | | | | | |
| a. Measurement System (8) | 1,280,000 | 20,000 | 20,000 | 20,000 | 20,000 | 1,360,000 | |
| b. Soil Water Kit (8) | 80,000 | 7,000 | 7,000 | 7,000 | 7,000 | 108,000 | |
| Sub-total | 1,360,000 | 27,000 | 27,000 | 27,000 | 27,000 | 1,468,000 | |
| 4. Training | 40,600 | ______ | ______ | ______ | ______ | 40,600 | |
| 5. Workshops | 57,000 | 61,000 | 65,300 | 69,900 | 74,800 | 328,000 | |
| 6. Consultancy/Inspection | 17,800 | 19,000 | 20,300 | 21,700 | 23,200 | 102,000 | |
| 7. Central Services* | 303,000 | 78,500 | 83,600 | 89,200 | 97,900 | 652,200 | |
| TOTAL | 2,323,200 | 601,500 | 641,300 | 683,700 | 750,800 | 5,000,000 | |

* OPS 6%, IRRI 9%

23-Dec-91/jra/29.1223meth

## PROJECT BUDGET COVERING GEF CONTRIBUTION
(in US Dollars)

COUNTRY: Global
PROJECT NUMBER: GLO/91/G31/A/1G/31
PROJECT TITLE: An Interregional Research Programme on Methane Emission from Rice Fields

| Budget Line | | Total | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| 20 | SUBCONTRACT | | | | | | |
| 2100 | IRRI | 4,700,000 | 2,263,200 | 541,500 | 581,300 | 623,700 | 690,300 |
| 2900 | Components Total | 4,700,000 | 2,263,200 | 541,500 | 581,300 | 623,700 | 690,300 |
| 99 | PROJECT TOTAL | 4,700,000* | 2,263,200 | 541,500 | 581,300 | 623,700 | 690,300 |

* This amount excludes Executing Agency's overhead costs of 6% which is $300,000.