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PROGRAMME PLANNING

COUNTRY AND INTERCOUNTRY PROGRAMMES AND PROJECTS

Assistance for a global project

Global Research Programme to Develop Sustainable Rice Production Systems that Minimize the Need for Pesticides, Herbicides and Synthetic Nitrogen Fertilizers - International Rice Research Institute (IRRI) - GLO/91/001

Recommendation of the Administrator

Estimated UNDP contribution:	$8,300,000
Duration:	Five years
Executing agency:	World Bank

I. BACKGROUND

1. In 30 years, the earth may have a population of 8 billion people. More than half, 4.3 billion, 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. That 49 per cent increase, if it can be achieved, will merely maintain current nutrition levels which are even now inadequate for hundreds of millions of people. There is an urgent need, therefore, to conduct research that will help developing countries grow more rice on limited land in ways that do not harm the environment and that benefit both farmers and consumers. Half of the world's 144 million hectares of rice-growing land are irrigated and produce nearly

75 per cent of the world's harvest. However, the remarkable production record of irrigated rice ecosystems may not continue to ensure global rice security in the future. The gap between farm yields and those of experimental stations is closing. Farm yields have increased steadily, but the maximum possible yield potential of research stations has not.

2. Rice production systems are a major user of synthetic inputs such as pesticides and fertilizers. Although it is generally accepted that the green revolution in rice has relied on the availability and use of fertilizers and pesticides, only recently has there been concern about these high input levels. The 1985 pesticide market for 15 selected developing countries was estimated at $2.53 billion, of which insecticides constituted the largest group (76.7 per cent), followed by herbicides (13.9 per cent) and fungicides (9.0 per cent). The main crops receiving most of the insecticides were rice, cotton and vegetables. In China, many rice crops receive between five and six applications per season. In India, 17 per cent of the pesticides consumed are used on rice. Rice is the largest user of pesticides and accounts for 53 per cent of the total. Evidence from several countries is accumulating in regard to the deleterious effects of pesticides and synthetic chemical fertilizers on the rice biosphere, on water quality in agricultural and non-agricultural areas and on human health. Data from the Philippines show a direct relationship between increased pesticide use on rice farms and higher mortality rates. Unfortunately, although Asian countries are using increasing amounts of pesticides, the data do not show a corresponding trend towards reduced annual crop losses attributable to pests, or a reduced frequency of severe pest outbreaks or disease epidemics. The losses caused by rice pests (insects, diseases, nematodes, rodents, weeds) are estimated to average 30 to 40 per cent each year despite control measures. Pests are major causes of unstable rice production from year to year and notable outbreaks of brown planthopper, tungro and stemborers have recently occurred in India, Indonesia, Malaysia, the Philippines and Thailand.

3. The practice of Integrated Pest Management (IPM) has been advocated as a response to pesticide-related problems. It provides environment-friendly tools for maintaining, and in some cases increasing, crop production and profitability. IPM is an ecological approach to pest management which strives to reduce the level of economic damage by pests in an integrated manner, and takes into account the agro-ecosystem in which the target crop is grown. Emphasis is given to non-chemical means of pest control such as varietal resistance and biological, cultural and mechanical control. Pesticides are used as the last resort and only when their application can be rationalized on criteria based on environmental safety, economic benefit and social acceptability. The benefits of IPM have been successfully demonstrated in a number of rice-growing countries and include sustainable increases in crop production, lower production costs, reduced government expenditure for pesticide subsidies, reduced health hazards and less environmental pollution. By eliminating subsidies and embracing IPM, the Indonesian Government, for example, is saving roughly $100 million a year, and has reduced rice pesticide usage by over 30 per cent.

4. Weeds are a major problem in all rice production systems. Total direct losses from weeds are estimated to be 10 per cent annually. Herbicides are widely used by farmers because they are labour-saving and often provide effective weed control. However, growing concern over widespread use of herbicides is based on uncertain applicator safety, environmental contamination and increasing numbers of herbicide tolerant weeds. Biological control of weeds is the deliberate use of natural enemies to suppress the growth or reduce the population of a weed species. The use of plant pathogens to control weeds in rice fields without harming the crop or the environment has not been studied extensively.

5. Host plant resistance to the major pests, encapsulated in seeds, is an attractive strategy for pest control. Experience shows, however, that pest populations co-evolve with their rice hosts, and that durable resistance has yet to be achieved. There are also key rice pests for which no good source of plant resistance is known. Thus, pesticides remain a guarantor of yield in the eyes of farmers in many countries. Conservation of the capacity of rice plant genes that confer resistance to specific pests is a critical issue. The usefulness of a known resistance gene may be prolonged through an appropriate strategy that utilizes several techniques to reduce the rate of pest evolution; this includes cultural control and matching novel rice varieties with specific resistances to environments known to favour particular pests. Recent developments in plant research may assist in this effort to increase the longevity of host plant resistance to a particular pest. These developments are in biotechnology, population genetics and pest ecology. For example, biotechnology has produced tools such as the procedure restriction fragment length polymorphism (RFLP) which allow a faster and more accurate characterization of the rice pest population and rice plant resistance. Thus, the pest population against which advanced breeding material is tested can be more accurately matched with the pest population in regions where the variety is eventually planted. This procedure can now be done expeditiously with geostatistical techniques such as geographic information systems (GIS). Complex forms of genetic resistance can now be manipulated by breeders using molecular markers linked to rice genes of interest.

6. The scarcity of soil nitrogen content is an important constraint on rice production. Synthetic nitrogen fertilizer is a major input to rice production around the world, and farmers have become increasingly dependent on off-farm supplies. Unfortunately, many resource poor farmers use little or no nitrogen fertilizer owing to its unavailability, or to lack of cash or credit or poor yield responses caused by adverse growing conditions. Furthermore, more than half the nitrogen fertilizer applied is lost from the system (through denitrification, ammonia volatilization, leaching and runoff). This inefficiency represents a serious expense to the farmer and can lead to extensive environmental pollution. In addition, it may be an important source of nitrous oxide, a gas linked to the greenhouse effect and the destruction of the stratospheric ozone layer. Furthermore, imports of nitrogen fertilizer use scarce foreign exchange. Thus, exploitation of alternative sources of nitrogen through natural processes (biological nitrogen fixation (BNF)) is important in achieving sustainability and reducing the cost of production.

7. Since 1975, UNDP has been financing the International Network for Genetic Evaluation of Rice (INGER), a large international rice testing and evaluation network. This network is the primary global vehicle for the collaborative testing and evaluation of rice. As a direct result of this collaborative network, at least 160 rice varieties originating from 17 countries, the International Rice Research Institute (IRRI) and other international centres have been released to farmers in 37 countries. Furthermore, over 500 scientists from more than 30 countries have received research training in the improvement of rice varieties. It is now important to intensify efforts to evaluate present germ-plasm collections and to identify those that can be used in breeding programmes to help reduce synthetic chemical inputs in rice ecosystems without sacrificing yield.

8. The Institute IRRI, an autonomous, non-profit agricultural research and training centre, was established in 1960. It is now a member of the Consultative Group on International Agricultural Research (CGIAR). The principal objectives of IRRI include: (a) research on rice, including all phases of rice production, management, distribution and utilization; (b) distribution of improved plant materials to national, regional and international rice research centres; (c) education of promising young scientists from rice-growing areas of the world; (d) operation of an international rice seed bank containing a global collection of rice germ-plasm; and (e) conferences and seminars for discussing rice research problems and for developing global research strategies.

II. THE PROJECT

9. The research to be undertaken in the present project will address three sets of environmentally related problems in rice production: (a) the heavy use of pesticides resulting in pest resurgence, health risks for farm families and workers, contaminated water sources and other adverse effects on the environment and wildlife; (b) the increasing dependency on synthetic nitrogen fertilizer which is costly to the farmer, depletes limited foreign exchange, contaminates surface and groundwater and poses a health hazard; and (c) the international exchange and evaluation of elite rice germ-plasm that is less dependent on synthetic pesticides, herbicides and synthetic nitrogen fertilizers. These research activities will help rice-producing countries to resist the tendency towards increased use of synthetic agricultural chemicals in the future, and reduce their current usage by substituting alternative strategies.

10. Heavy pesticide usage will be addressed by the development of technology to reduce pesticides through: (a) Identification and characterization of new sources of durable plant resistance to key pests (including features of plant morphology that support the growth and multiplication of natural enemies of rice pests) using RFLPs, isozymes and other advanced techniques; (b) incorporation of durable plant resistance and features of plant morphology into improved germ-plasm; (c) development of rice planting strategies based on knowledge of pest population biology to enhance the effectiveness and durability of pest resistance genes; (d) development of novel biological control methods for weeds and selected insects; and (e) development of improved pesticide reduction techniques, including pheromones, cultural practices and biocontrol agents for integrated pest management programmes.

11. Long-term nitrogen balance experiments in Japan, the Philippines and Thailand have shown that soil nitrogen content is maintained through biological nitrogen fixation (BNF) by associative and free-living micro-organisms. Recent research evidence also suggests that there are genotypic differences in the ability of rice crops to support BNF; the project will therefore attempt to develop genotypes with the ability to support high BNF. Such genotypes, when available, may considerably reduce synthetic fertilizer nitrogen requirements and associated losses and pollution while contributing to sustainable rice production.

12. The project will support research trials in the INGER programme concerned with the evaluation and exchange of rice germ-plasm that are less dependent on synthetic nitrogen fertilizers and pesticides. The ultimate goal of this international research collaborative network is to synthesize new plant types that will be less dependent on chemical fertilizers, more efficient in the utilization of nitrogen, less susceptible to insects and diseases and amenable to direct seeding. National rice improvement programmes would benefit through their participation in INGER. IRRI co-ordinates the INGER network because of: (a) its excellent seed multiplication and processing facilities; (b) its effective quarantine arrangements with the host country; and (c) its international rice germ-plasm bank and modern rice improvement programme.

13. The ultimate beneficiaries of this research project will be the general public, which will profit from an assured supply of rice at a reasonable price and from reductions in the levels of chemicals in the environment. Reducing the use of synthetic chemicals and nitrogen fertilizers will have a beneficial effect on the environment (both locally and globally), reduce the cost of off-farm inputs and contribute to the development of sustainable rice production systems for specific agro-ecological zones. Furthermore, national rice research systems will be strengthened through the training component of the project. The genetic materials, methodologies and systems developed through the project will assist national rice research scientists throughout the world as they develop new pest-resistant varieties and cropping systems less dependent on synthetic chemicals. All technologies, information and improved rice germ-plasm will be shared through INGER which includes scientists from all the major rice-growing countries in Asia (18 countries), Africa (12 countries), and Latin America (16 countries). IRRI will consider the important role of gender-related issues in rice production during execution of the project. It has helped to establish a successful women in rice farming systems programme and will use this programme and other activities to incorporate gender issues into research and resulting technology.

14. The Administrator intends to entrust the execution of this project to the World Bank, with the understanding that the United Nations Development Programme (UNDP), as a co-sponsor of CGIAR, will advise on certain technical and policy issues arising during its implementation. The project addresses issues that are central to the UNDP fifth cycle and is designed to ensure that these issues are fully represented in the CGIAR programme on rice. UNDP also expects that the information and experience gained from the project activities will be valuable to UNDP in programming future projects and programmes in related areas. A concerted effort will be made to link the training and research activities with field work at the country and intercountry levels, and special efforts will be made to obtain the

assistance of FAO in these activities. UNDP, in consultation with the World Bank, will subsequently evaluate the accomplishments of the project based on reviews by independent consultants.

15. The proposed UNDP contribution is $8,300,000, of which $8 million will be for subcontracts. Direct costs will account for the remaining $300,000. The expenditures under the project will be contained within the indicative planning figure (IPF) for global projects established by the Governing Council of UNDP for the fourth and fifth cycles.

III. RECOMMENDATION OF THE ADMINISTRATOR

16. The Administrator recommends that the Governing Council approve this project.
