Third World Lecture 1983
Agricultural Progress—Key to Third World Prosperity

Address delivered by Dr M S Swaminathan, Director-General of the International Rice Research Institute, when receiving the Third World Prize for 1982 on behalf of the Institute. The Prize was presented to Dr Swaminathan by the Prime Minister of the People's Republic of China, H E Zhao Ziyang, at the innaugural session of the South-South Conference on Strategies of Development, Negotiations and Cooperation, in Beijing on 4 April 1983

On behalf of the Board of Trustees and staff of the International Rice Research Institute may I express our sincere gratitude to the Third World Foundation for Social and Economic Studies. You have recognised the role of agricultural science as a catalyst for agrarian prosperity through the selection of IRRI for the 1982 Third World Prize. We accept the Third World Award on behalf of the global family of farm scientists.

Agriculture began in what is now called the Third World. The ancestral homes of the world's most important crops are in Third World countries: rice, wheat, maize, potato, cassava, sweet potato, sugarcane, soybean, pulses, numerous vegetables, most fruit trees, cotton and other fibres, many forage grasses and legumes, and numerous forest trees including most hardwood species.

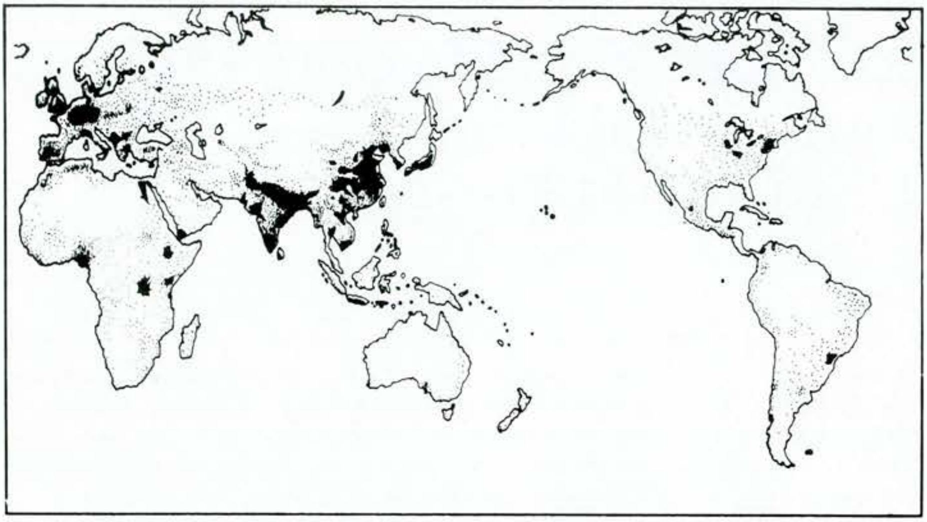
This is not surprising because agriculture revolves around the harvest of solar energy, and abundant, year-round sunshine is the Third World's greatest asset.

Culture was cradled by the prehistoric shift from food-gathering to food-growing in the Third World. Domestication of crop plants and farm animals and the development of water conservation and irrigation systems led to the civilisations of the Nile Valley, Mesopotamia, the Indus Valley, the Andean highlands and Central America, and, of course, China. No wonder the Chinese peasants are known as 'farmers of 50 centuries.' Their development of efficient methods of restoring soil fertility has enabled them to continuously and intensively harvest crops from limited land for more than 7,000 years.

Thus, the world's most experienced farmers are found in the Third World.

Asia is today the home of more than half of the world's people. But some 500 million Asians live in absolute poverty and go to bed hungry each night. About 10 million or more children die every year from causes associated with hunger and malnutrition.

We thus live in an unequal and paradoxical world. It is an irony that 'God



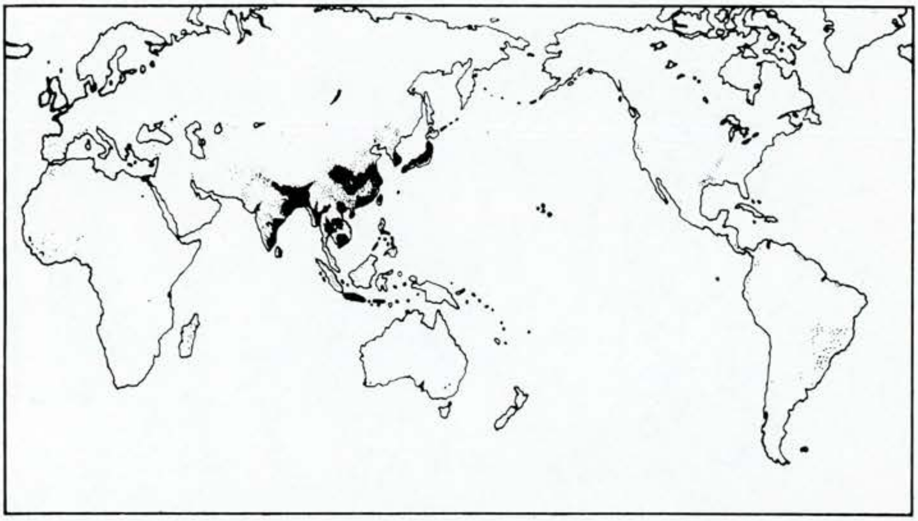
Rice means life itself to the world's most densely populated countries. About 55 per cent of the world's people live in Asia.

continues to be bread' (to quote Mahatma Gandhi) to children, women, and men in many parts of the 'South', while the prayer 'God give us today our daily bread...' has lost historical relevance in many countries of the 'North'. On one hand, mountains of grain are rising in highly developed countries. Some governments are giving farmers incentives to leave land fallow. On the other hand, many Third World countries lead a 'ship to mouth' existence because they are increasingly dependent on grain imports. It is a paradox that many Third World countries—who must balance their food budgets by accepting free grain or purchasing it on concessional or commercial terms—are the countries with the largest reservoirs of untapped agricultural resources.

Why should an abundance of natural resources coexist with low farm productivity and consequent hunger? Can't we take steps to convert the natural blessings of the Third World—its basic life support systems of land, water, sunshine, flora and fauna—into wealth that is vital to its people? Why are many developing countries still giving low priority to agriculture?

In response to this paradox, the Rockefeller and Ford Foundations, in cooperation with the Republic of the Philippines, established the International Rice Research Institute in 1960 on the beautiful campus of the University of the Philippines at Los Baños. IRRI's objective is to increase the production of rice and of food from rice-based farming systems through applied agricultural science.

The choice of rice as the focus of an international research initiative and the choice of the Philippines as its location were appropriate. More than 95 per cent of the world's rice area is in the Third World. For more than 1.5 billion low-income people in Asia, and hundreds of millions in Africa and Latin America, rice is the



Ninety-two per cent of the world's rice is grown and consumed in Asia.

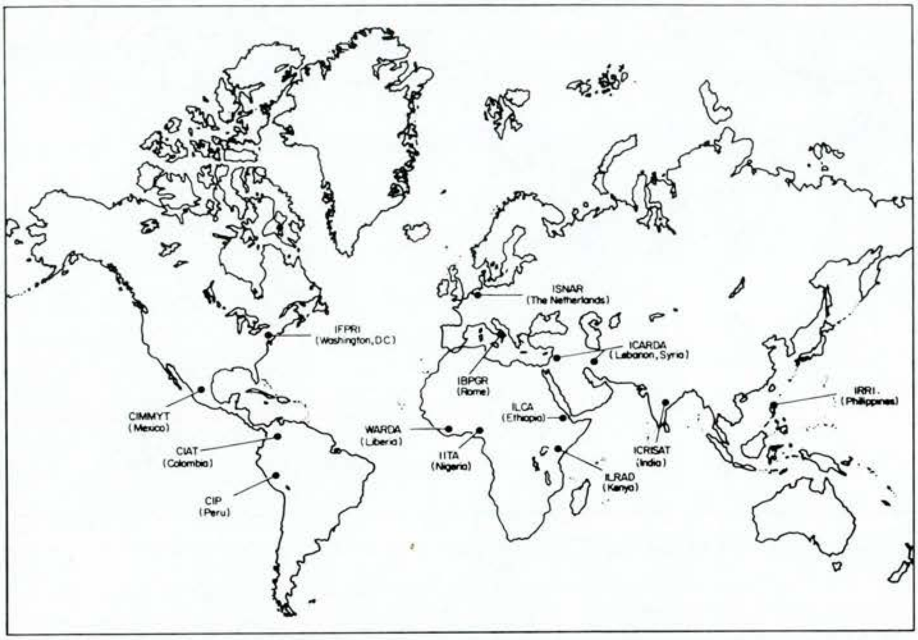
major source of calories and protein. Rice comprises a third of the area planted to cereals in developing countries. In 36 countries where more than 100,000 hectares are planted to rice, the annual per capita income is less than US$300. They are the lowest income group in the world.

The history of IRRI—appropriately titled *An adventure in applied science*—was recently written by its first director, Dr R F Chandler Jr. Therefore, I shall not give you detailed background on the Institute and its accomplishments. I am content to say that IRRI was blessed with the able guidance of scientists of eminence and vision such as late Dr Sterling Wortman of the Rockefeller Foundation; the earlier directors, Dr Chandler and Dr Nyle C Brady; and of Boards of Trustees formerly headed by the late Dr George Harrar and by Dr Forrest F Hill, and now, Dr Clarence C Gray III. Above all, the staff of the Institute, drawn from more than 20 countries, has worked with single-minded devotion to achieve a scientific elimination of barriers to high and stable yields.

IRRI's success is due to the cooperation of national governments in many developing nations. Not only did the Philippine Government provide the land for IRRI's research centre and experiment farms, it also allowed freedom for IRRI scientists to travel to observe rice problems first hand, and freedom for rice workers everywhere to come to the Philippines to participate in IRRI training programmes.

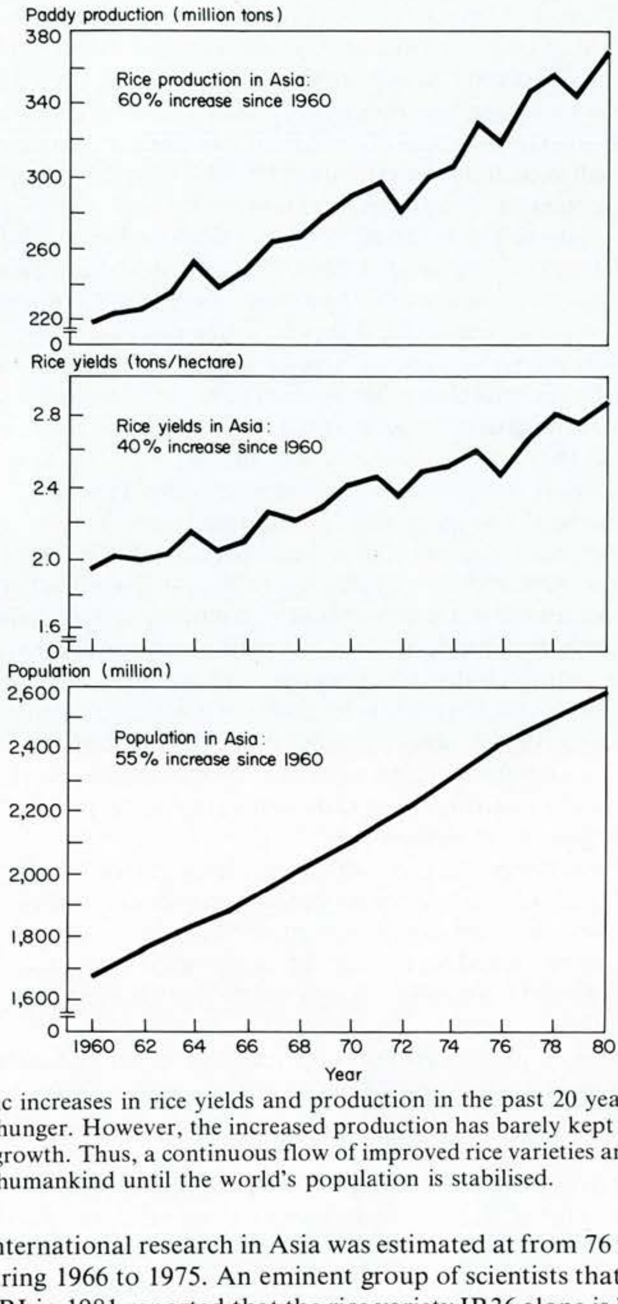
The neighbouring University of the Philippines at Los Baños awarded affiliate graduate faculty status to IRRI scientists, which gave scholars an opportunity to study for advanced degrees at UPLB and conduct their thesis research at IRRI.

Without such international cooperation, IRRI could have become another



IRRI was the first of the International Agricultural Research Centres. Today a network of 13 Centres is supported through the Consultative Group on International Agricultural Research (CGIAR), an international consortium of 36 government and private agencies dedicated to the support and improvement of agricultural research in the Third World. Employed within this far-flung network are about 7,000 persons, which include more than 600 senior scientists from 40 nations. CIAT = Centro Internacional de Agricultura Tropical, Apartado Aereo 6713, Cali, Colombia; CIMMYT = Centro Internacional de Mejoramiento de Maiz y Trigo, Londres 40, Mexico 6, D. F., Mexico; CIP = Centro Internacional de la Papa, Apartado 5969, Lima, Peru; IBPGR = International Board for Plant Genetic Resources, Food and Agriculture Organisation of the United Nations, Via delle Terme de Caracalla, 00100 Rome, Italy; ICARDA = International Centre for Agricultural Research in the Dry Areas, P.O. Box 114/5055, Beirut, Lebanon; ICRISAT = International Crops Research Institute for the Semi-Arid Tropics, Patancheru P.O. Andhra Pradesh 502324, India; IFPRI = International Food Policy Research Institute, 1776 Massachusetts Avenue, N.W., Washington, D.C. 20036, USA; IITA = International Institute of Tropial Agriculture, P.O. Box 5320, Ibadan, Nigeria; ILCA = International Livestock Centre for Africa, P.O. Box 5689, Addis Ababa, Ethiopia; ILRAD = International Laboratory for Research on Animal Diseases, P.O. Box 30709, Nairobi, Kenya; IRRI = International Rice Research Institute, P.O. Box 933, Manila, Philippines; ISNAR = International Service for National Agricultural Research, P.O. Box 93375, 2509 AJ The Hague, The Netherlands; WARDA = West Africa Rice Development Association, E.J. Roye Memorial Building, P.O. Box 1019, Monrovia, Liberia.

'ivory tower'. Instead IRRI became the hub of an international endeavour to assure food security in countries where rice is the staple. The research investment grew rapidly in both national and international research systems in Asia. The



The dramatic increases in rice yields and production in the past 20 years have averted widespread hunger. However, the increased production has barely kept ahead of Asia's population growth. Thus, a continuous flow of improved rice varieties and technology is essential to humankind until the world's population is stabilised.

return on international research in Asia was estimated at from 76 to 102 per cent per year during 1966 to 1975. An eminent group of scientists that examined the work of IRRI in 1981 reported that the rice variety IR36 alone is helping to add US$1.5 billion worth of additional income to farmers each year.

In 1971 IRRI, the first of the International Agricultural Research Centres, became part of a global family of IARCs funded through the newly established Consultative Group on International Agricultural Research (CGIAR), jointly sponsored by the Food and Agriculture Organisation of the United Nations, the United Nations Development Programme, and the International Bank for Reconstruction and Development (World Bank). In 1983, 36 countries and donor organisations will contribute an estimated US$164 million to support the core research programmes of 13 International Centres through the CGIAR. Donor members now include Third World countries such as Brazil, India, Mexico, Nigeria, the Philippines, and Saudi Arabia. The crops and livestock on which the International Centres focus provide 75 per cent of the food for the Third World. The 600 senior scientists who work at these Centres are drawn from 40 nations.

In a world beleaguered by negation, despair and conflict, the CGIAR stands out as a meaningful, affirming flame. Mr Warren C Baum, Chairman, CGIAR and Members of this Group deserve our gratitude for nursing this flame which strives to bring cheer and light to homes engulfed by the degrading darkness of hunger.

IRRI today is more than a research institute. It is also a coordinating body for international networks such as the International Rice Testing Programme, through which global teams of capable, highly dedicated scientists and scholars work to improve and stabilise rice yields under diverse, and often harsh, growing conditions. More than 800 rice scientists in 75 countries on five continents work together in experiments and testing programmes catalysed and coordinated by IRRI. The strengths of individual scientists and countries may vary, but the collective strength of this worldwide rice research community is mighty.

We are honoured that the award ceremony for the Third World Prize is being held in the People's Republic of China, the world's oldest and largest producer and consumer of rice. China grows about 35 per cent of the world's rice and almost half of China's total grain production is rice.

Some of the most important scientific ingredients of modern rice technology originated in China. Chinese scientists were among the original IRRI staff. The semidwarfing gene that was essential to the development of high-yielding rice varieties—and most semidwarfs bred by national rice improvement programmes—came from Dee-geo-woo-gen, a short-statured rice variety of Chinese origin.

IRRI is privileged to have strong cooperative links with China through the Chinese Academy of Agricultural Sciences, the Chinese Academy of Agricultural Mechanisation Sciences, Academia Sinica, and other organisations. This award ceremony gives us an opportunity to salute both farmers and scientific colleagues in China for their contributions to raising the yield ceiling in rice.

Farmers are believed to have domesticated semiaquatic rice varieties shortly after the Neo-Thermal Age (12,000 to 14,000 years ago). Some say rice farming began in CHina, others say India or Thailand. Recent archeological findings show that farmers cultivated rice in China and India at least 7,000 years ago. The civilisations that developed around major Asian river systems—the Ganges, Yangtse, Brahmaputra, Irrawaddy, Mekong—thrived on rice culture.

Yet rice yields were almost stagnant for centuries, levelling at a yield plateau of less than 2 tons per hectare—the level that basic soil fertility could sustain because rice needs about 1 kilogram of nitrogen to yield 15 kilogram of grain.

From 1960 to 1980, average rice yields in Asia rose by 40 per cent and production more than 60 per cent, although we must also consider that Asia's population rose 55 per cent in the same 20 years.

How did the farmers of Bangladesh, Burma, China, India, Indonesia, Japan, the Philippines, and other Asian countries raise rice production more in the past 20 years than in the preceding 7,000 years? Five major advances led to the doubling and tripling of rice production:

1. *The modern semidwarf plant type that increases the efficiency of nutrient, water, and sunshine use.* The traditional varieties 'lodged', or fell over when soil fertility exceeded the capacity to produce more than 2 or 3 tons of rice per hectare. Grain rotted in the water or was eaten by rats. Photosynthesis ceased.

   Modern semidwarf rice varieties yield 5 tons or more because their strong stems—inherited from Chinese parents—enable them to stand erect and convert nutrients, water, and sunshine into grain more efficiently. Many of the newer varieties carry built-in genetic resistance to a host of insects and diseases.
2. *Short growth duration and insensitivity to daylength.* Teams of researchers selectively bred these traits into the modern rice varieties to make it possible for farmers to grow two or three crops where they previously grew only one crop, and to grow superior varieties at different latitudes.
3. *Cultivation of F_1 hybrid rice.* China is the world's pioneer in hybrid rice production. China now grows more than 6 million hectares of hybrid rice; yields are about 30 per cent higher than those of ordinary semidwarfs.
4. *Improved irrigation and water management.* Better availability of water gives farmers yet another opportunity to grow two or more crops per year in the same field.

   An old Chinese saying vividly portrays the *green power* of tropical rice land: 'a field can look gold, black, and green on the same day.' The *gold* represents the mature rice crop, which the farmer and his family harvest early in the morning. The same rice field looks *black* around noon because the family has already plowed the field in preparation for the next crop. Late that afternoon the field looks *green* because the farm family has transplanted a new rice crop!

   In the IRRI Rice Garden, a crop is harvested every Monday and another planted every Friday. Good water management and early maturing varieties allow the planting and harvesting to be staggered throughout the year. The system spreads labour, cash inputs, and risk—and enhances both income and food production for the family. And the intensive production more fully exploits human inputs, water, sunshine, and soil.
5. *Introduction of new farm management techniques.* Yields are higher and farm incomes more secure because farmers now have improved implements, mineral fertilisers and better methods to apply them, integrated procedures for pest control, and improved postharvest technology.

Most Asian countries have assisted farmers to derive benefits from these technological advances by introducing yield-oriented production programmes such as Masagana 99 in the Philippines, BIMAS (Mass Guidance Toward Self-Sufficiency in Food Production) in Indonesia, the Whole Township Programme in Burma, and the High-Yielding Varieties and Small Farmers Development Programmes in India.

These factors now enable farmers to exploit the yield potential of management-responsive crop varieties, multiple cropping, and improved preharvest and postharvest operations. Each development can be traced to the application of science to agriculture.

Mr. Lu Shen Rong, an old rice farmer in a production brigade in Lu Jha Chun, Hangzhou Province, recently described the impact that these advances have made in China. Mr. Lu has grown rice for almost 50 years; hence his deep insight was born from vast experience.

I asked Mr Lu, 'What are the most important farm problems today, and in what areas do you feel we should focus the research in future?' The farmer's immediate reply was '*The care of the soil and the health of the plant.*'

I have worked in agricultural research for almost 35 years, but I could not have better summarised the most urgent challenges for the future.

Asia has little unused land, and agricultural land is a shrinking resource as population multiples and urbanisation forces its way into the countryside. Asia's ratio of land to people—0.21 hectares per person—is the lowest in the world. Future increases in agricultural production must come mainly from higher productivity and cropping intensity per unit of land, time, water, energy, and labour. The Food and Agriculture Organisation estimates that rice production must increase by more than 3 per cent per year during the remainder of the 20th century. This will require a continuous improvement in productivity—and it must be done without harming the long-term production potential of the soil. This challenge requires the intensification of research on all aspects of plant and soil care.

The improvement of soil and plant health motivated IRRI and the International Fertiliser Development Centre to organise a network of cooperative experiments under the International Network on Soil Fertility and Fertiliser Evaluation for Rice (INSFFER).

Proper attention to plant health not only prevents crop damage from the unholy triple alliance of insects, diseases, and weeds but also reduces risk and uncertainty in agriculture. Institutes such as IRRI offer unusual opportunities to develop varieties with multiple pest resistance.

In the IRRI Genetic Resource Centre, more than 65,000 varieties of rice are preserved for the use of today's rice scientists and farmers, and for generations yet unborn.

But the IRRI collection probably includes little more than half of the world's genetic variability in rice. With the cooperation of the Chinese Academy of Agricultural Sciences and other national research systems, we propose to develop a global strategy to collect the remaining genetic strains as rapidly as possible. Many irreplaceable rice strains—the fruits of thousands of years of natural and human selection—grow in endangered habitats and face the threat of extinction. Agricultural organisations everywhere must join forces to collect and preserve this invaluable germplasm for posterity.

But preserving the world's rice germplasm is not enough. More important, we must know the diversity of genetic traits these strains possess so that we can put those traits to work for the benefit of rice farmers everywhere.

Through the multidisciplinary Genetic Evaluation and Utilisation (GEU) programme, IRRI and worldwide cooperators carefully test this vast seed collection for the expression of more than 50 inherited characteristics, such as resistance to the diseases and insects that ravage farmers' crops and tie them to costly chemical protection, and tolerance of adverse soils.

Armed with such information, scientists from many countries withdraw parents from the Genetic Resources Laboratory to crossbreed with rices that have still other traits needed by the small-scale farmer. Such a strategy has led to a worldwide genetic pipeline from which flows a stream of high-yielding rice varieties with the built-in ability to tolerate not only pests but also salinity, alkalinity, or other adverse soil conditions; drought; deep water and floods; or cold temperature.

The best rices from all nations are selected under adverse environments through the International Rice Testing Programme—a worldwide cooperative network. The power that such global cooperation gives all scientists is illustrated by the success of IR36, a rice variety now grown on almost 11 million hectares in Asia. IR36 is probably the most widely grown variety—of any food crop—the world has ever known. To develop IR36, IRRI scientists crossed 13 parents, including a wild species, from six countries. Scientists in the Philippines, Indonesia, and India cooperated in the selection of IR36.

When tungro virus disease reached an epidemic level in South Sulawesi, IRRI rushed a set of genetic material to Indonesia. Indonesian scientists planted the rices in 'hot spots' where the disease was rampant. The survivors included the line that became IR36. Another set of materials was sent to Orissa, where Indian scientists selected plants for resistance to gall midge, a serious pest in much of Asia that was not present in the Philippines.

The insect resistance alone of IR36 saves rice farmers in the Third World untold millions per year—money that would otherwise have been spent on petroleum-based insecticides.

One moral stands clear in a world divided by discord and distrust. International cooperation leads to universal prosperity.

We have no time to relax. Eternal vigilance is the price of a stable, prosperous, and productive agriculture. A new biotype of brown planthopper recently attacked IR36 in North Sumatra. Fortunately, Indonesian scientists were prepared and immediately arranged a new 'genetic barrier'. In February 1982 IRRI airlifted more than 20 tons of seeds of a newer variety, IR56—which is resistant to the new biotype—to Indonesia for multiplication and distribution to farmers.

Most experts agree that fighting the famine of jobs is as important as fighting the food famine during the remainder of the 20th century. The nutrition problem in many parts of the Third World can be improved even more by an increase in person-years of employment than by an increase in grain production. Rapid agricultural development is important to generate the employment necessary to purchase food and increase its availability. In fact, rural development in Asia implies largely the development of land- and water-based occupations such as crop and animal husbandry, horticulture, fisheries, and forestry.

Asia is a continent of small-scale farmers; more than 75 per cent of its farmers cultivate less than 2 hectares of land. Earlier I mentioned that recent scientific advances have enhanced the production potential of small farms in the Third World. But we should recognise that although new technologies have in many cases been used economically by all farmers, regardless of their farm size, the technologies themselves are not 'resource neutral'. Farmers need cash inputs to enhance agricultural output. Modernisation of agriculture involves the increased use of purchased inputs and a greater dependence on marketing opportunities. Public policies that simultaneously help small farmers raise production and help poor consumers increase consumption are vital to advancing agricultural well-being in the Third World.

Because of risks, farmers largely base their decisions to adopt new technology on the likely net returns per hectare as well as on security of income. In many South-East Asian countries, an increase of 1 million tons in rice production requires the active participation of about 2 million farming families. Hence, attention to their problems is vital for success in increasing production.

Inadequate attention to small farm management has increased production costs and risk. Agricultural scientists must find more ways to enhance the resource neutrality of technology by substituting nonmonetary or inexpensive inputs for high-cost inputs and minimising yield fluctuations caused by weather aberrations and pest epidemics. New technologies must ensure that labour demand increases faster than its supply and that food supply increases faster than its demand. These objectives require that social, biological and physical scientists work as teams.

New systems of small farm management must marry individual initiative and group endeavour. Japan has pioneered yield increases in agriculture through integrated systems of research, extension, input supply (including credit) and remunerative pricing. In China, a household responsibility system of crop production has been superimposed over social land ownership. This provides a mechanism for blending collective management of farm operations such as irrigation, plant protection, and postharvest operations with individual enterprise and incentive.

In countries where land is individually owned, can social or group management of key farm operations be superimposed on individual initiative and ownership rights? Obviously, farmers have often done this themselves. Agricultural research organisations can help by demonstrating how enlightened self-interest demands that farmers living in a watershed or a village participate in the management of farm operations that elevate and stabilise yield per unit of cash input. In particular, there is immediate need for increasing returns from irrigated agriculture through equitable systems of water distribution and better on-farm management of water. The major irrigation systems of the world are in Asia, but there is considerable scope for improving productivity per unit of water.

Farmers live in a world of action, not of words, so personal experience is the only meaningful source of conviction. Therefore, they must be shown how blending of individual ownership and group action can better serve the interests of the individual and the community in the same manner that China is demonstrating how social ownership and individual initiative can be combined in a meaningful way.

Third World countries should lose no further time in developing strong *national food security systems* with the following major components:

1. Ecological security to protect basic life support systems such as land, water flora, fauna, and the atmosphere;
2. Technological security at both the production and postharvest phases, which can help to promote accelerated growth coupled with production stability;
3. Social security to provide the needed purchasing power to the rural and urban poor through greater opportunities for gainful employment;
4. Water security, both for drinking and irrigation;
5. Nutrition education; and
6. Population stabilisation.

The most precious resources of the Third World are its intelligent and hardworking rural populations and its abundant sunlight. These assets can be purposefully married through a photosynthetic pathway of development that gives greater attention to green plants. Poverty persists when human resources are undervalued and land and other physical and material resources are overvalued. Human resource development holds the key to national prosperity as well as to peace and progress.

IRRI emphasises manpower development through its education and training programme in which about 3,000 rice scientists, extension specialists, and educators from more than 50 countries have participated; 95 per cent have been from the Third World. Sixty per cent remain active in rice research.

During the next few decades rapidly rising income in many developing countries is likely to fuel a tremendous growth in the demand for food, which can only be met by increased food imports.

From 1970 to 1977, 20 developing countries with some 700 million people had an average growth rate of 4 per cent or more in per capita income. Eight of these countries, all major oil-exporters, had an average per capita income growth rate of 5.6 per cent: Algeria, Indonesia, Iran, Iraq, Mexico, Nigeria, Saudi Arabia, and Venezuela. Such income increases sparked an extraordinary rise in the demand for food in those countries, a demand that their still-immature agricultural sectors were unable to meet. Thus, food imports to those countries grew at an unprecedented rate of 19 per cent per year in real terms.

Eleven other rapid-growth countries—Brazil, Hong Kong, the Democratic People's Republic of Korea, the Republic of Korea, Malaysia, the Philippines, Singapore, Syria, Thailand, Tunisia, and Turkey—had an average growth rate of 5.6 per cent in per-capita income during the same period. In those countries, the demand for food rose by more than 5 per cent per year.

Some of the countries with rapid growth of income may well be able to achieve the high rates of growth in domestic food production needed to satiate demand. But research carried out by the International Food Policy Research Institute indicates that developing countries with the fastest growth rates in food staple production from 1961 to 1976 collectively more than doubled their net food imports during the same period. From 1961 to 1976 the average growth rate for basic food staple production in those countries was 3.9 per cent—but their increases in food imports meant that their self-sufficiency ratio actually declined by 2 per cent. These data show that while it is possible for developing countries with rapid income growth to achieve impressive increases in basic food production, it is still quite difficult for such production to keep pace with the rate of growth in demand for food caused by increases in population and income.

Stagnation in social and economic evolution has resulted in inadequate progress in achieving self-reliance in food production in many Third World countries. Such stagnation was caused by colonialism before World War II. Population explosion facilitated by advances in preventive and curative medicine after World War II, as well as continued low priority to agricultural and rural development after independence aggravated the problems. Neglect of agriculture also led to the continued nonutilisation or underutilisation of the national blessing of these countries for generating more jobs and income. The economic problems of Third World countries are well articulated, but the potentials for overcoming major problems through a careful blend of brain (technology), brawn (hard and dedicated work), and bank (cash inputs) continue to remain neglected or underestimated. It is in this context that the the role of accelerated agricultural growth as a trigger of Third World prosperity must be appreciated.

Priority to the farm sector does not imply neglect of industry. In fact, there are several major linkages between agriculture and industry. Agriculture supplies the raw materials for employment-intensive industries. Agriculture stimulates and sustains industrial output through rural household demands for consumer goods and services. Agriculture influences industry through government savings and public investment. Agricultural growth requires fertiliser, machinery, tools and energy.

The International Food Policy Research Institute has attempted to quantify the impact of such linkages. Using a macroeconomic model, it has been estimated that from 1961 to 1972, a 1 per cent increase in agriculture in India generated a 0.5

per cent increase in industrial growth. Agriculture increased national income by 0.7 per cent.

Poor people spend most of any additional income on food. In India, studies show that the poor spend 60 per cent of increments to income on grain and almost 80 per cent on total food products. Food and employment are intimately related through the multiplier effects of agricultural growth and development.

Technological change in agriculture can stimulate growth in income and employment in many sectors of the economy. It raises the incomes of farmers, who devote a large share of their additional income to locally produced goods and services. IFPRI research in Malaysia, Bangladesh, and India has shown that from 40 to 80 per cent of increments to farmers' income is spent on such local 'tertiaries' as housing, entertainment, and services. Such tertiaries create more employment.

In a recent study in Malaysia, it was found that each additional dollar of value an irrigation project created in the paddy rice sector indirectly generated an additional $0.83 of value in the non-rice economy. Of this $0.83, about two-thirds was attributable to final household demand linkages and only one-third to increased demands for paddy intermediaries. Thus there are symbiotic linkages in the growth of all the three major factors of an economy—agriculture, industry, and services. Agricultural growth necessitates better rural communication and better communication helps to minimise the gap between the city and the village in technological evolution.

Science and technology are important components of the wall dividing poverty and prosperity. Today there are unusual opportunities for developing countries to improve the quality of life of their people and to reduce drudgery in rural areas, particularly in women-specific occupations, through an integration of traditional and emerging technologies. Recent advances in microelectronics and microprocessors, biotechnology, satellite communication and imagery, and solar and renewable energy technology can be harnessed to upgrade traditional skills and occupations. In the past, industrialisation was synonymous with urbanisation, centralisation, automation, and pollution. Today it is possible to promote in rural areas sophisticated agroindustrial complexes based on decentralised infrastructure and production techniques. That will help marry the techniques of science with the culture and skills of the people. With financial support from the Asian Development Bank, IRRI and the University of the Philippines at Los Baños this year intend to initiate a pioneer project to show how productivity can be maximised and income enhanced through the scientific utilisation of every part of the rice biomass.

History shows us that man causes civilisations to blossom . . . and to decay. Some historic centres of agriculture are useless deserts today. In contrast, some areas that were considered hopeless wastelands in the early 20th century are now fertile farming areas. A proper combination of political will, professionalism, and people's action is essential to harness the power that science gives us for increasing human happiness and welfare.

During the 1980s, the scientists and scholars of IRRI, and of the world's rice research family, will continue their relentless struggle for higher and more stable income for farmers through a multipronged research strategy that consists of:

1. Sustaining and expanding production gains in irrigated areas;
2. Extending frontiers of high-yield technology to areas of moisture stress and/or excess;
3. Increasing productivity in problem-soil areas;
4. Improving the income and employment potential of rice farming systems;
5. Adding a dimension of resource neutrality to scale neutrality in technology development;
6. Improving methods of manpower development, information dissemination, technology transfer;
7. Identifying and helping to remove the constraints responsible for the gap between potential and actual yields at the farm level; and
8. Monitoring the consequences of new technology.

We live in this world as guests of green plants and of the farmers and fishermen who cultivate them and harvest their products. Today an eminent group dedicated to Third World development has recognised the pivotal role of science in agricultural progress by choosing an agricultural research centre for a distinguished award. I assure you, on behalf of my colleagues in national agricultural improvement programmes and at IRRI and other CGIAR institutions, that we shall do everything possible to help farmers—who will in turn help humankind make hunger a problem of the past.