Nomination of the

INTERNATIONAL RICE RESEARCH INSTITUTE

for the

1983 NOBEL PEACE PRIZE

for its

Contributions to Peace and Stability in Asia

Through the Alleviation of Hunger

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I. History and early work.

Rice provides more than half of the daily food intake of one out of every three people on earth. Rice is the lifeblood of Asia, where more than half of mankind lives. In the rural areas, rice provides not only food but also a large proportion of the jobs and income for hundreds of millions.

The International Rice Research Institute (IRRI) was established by the Ford and Rockefeller Foundations in cooperation with the Philippine Government in 1960 with the objective of increasing the yields and production of rice, and of food from rice-based farming systems in Asia, Africa, and Latin America. In 20 years IRRI has established a worldwide reputation not only for the excellence and relevance of its scientific work but also for its contributions to the alleviation of world hunger.

IRRI's research program began in 1962. Five years later, IRRI released IR8, the improved semidwarf "miracle" variety that triggered the Green Revolution in rice.

Today, newer IRRI varieties or their progeny are planted on more than 30% of the riceland in the tropics. The improved rice varieties have served as a window into the new world of high yield and improved income awaiting rice farmers of the tropics. Millions of farmers who previously grew a single crop of rice with yields of 1 or 2 tons per hectare (t/ha) now grow two or even three crops with yields of 5 or 6 t/ha.

IRRI grew out of the perceived need for a research center devoted exclusively to increasing rice production, not only to cope with the steadily widening gap between demand and supply but also to alleviate the plight of hundreds of millions of subsistence rice farmers and their families. Most rice farmers are poor, with small land holdings. Literacy levels are low and access to improved technology and production capital is limited.

When IRRI was established, an important decision was made -- that IRRI's program would be problem-oriented, stressing a multidisciplinary and international team approach to the solution of rice-growing problems. That decision influenced the choice of IRRI staff members and established the nature of the research and training programs.

IRRI is truly international; it is administered by a Board of Trustees composed of 15 members from Australia, Bangladesh, China, Egypt, India, Indonesia, Korea, the

Netherlands, Philippines, United Kingdom, United States, and West Germany. Japan

IRRI's senior scientific staff and participants in its education and training programs are even more international. For example, the 55 senior staff at IRRI come from 18 countries. The 194 trainees and scholars now at IRRI are from 23 countries; 95% of them are from developing nations.

IRRI's record of solid success encouraged the establishment of a worldwide system of 13 International Agricultural Research Centers (IARCs), each applying its talents and resources to the alleviation of global and regional agricultural problems.

The crops and livestock on which the IARCs focus provide 75% of the food for developing countries.

The impact of IRRI rices and of the wheat varieties developed by the International Maize and Wheat Improvement Center (CIMMYT) in Mexico led to the 1971 birth of the Consultative Group on International Agricultural Research (CGIAR) under the joint sponsorship of the Food and Agriculture Organization, the United Nations Development Programme, and the World Bank. The CGIAR is a consortium of donor countries (mostly developed but including several from the Third World), development banks, foundations, and agencies that accept a commitment to international agricultural research. Today, 36 contributing members of the CGIAR support the 13 IARCs.

II. The impact of IRRI on rice production: Views of an eminent group of external experts.

The research progress and contributions of all IARCs are reviewed in depth every 5 years by an independent panel of experts formed by the Technical Advisory Committee (TAC) of the CGIAR. From 4 to 23 January 1982 an external panel headed by Dr. A. Blumenschein of Brazil reviewed IRRI -- its programs and activities, and more important, its accomplishments and impact on rice production. The following extracts from the panel report illustrate the significance of IRRI's recent work:

> "IRRI has had a great impact on rice production in many different ways. There are various yardsticks by which this can be measured.
>
> (i) The advancement of science has been considerable with respect to rice genetics, rice physiology, rice soil science, and other fields of science. It is measured in the impressive series of publications and their widespread distribution and use.
>
> (ii) Rice production in several countries has been significantly improved as a result of the new technology. The Philippines has become a net rice exporter. Indonesia will reach self-sufficiency in rice within a few years....

(iii) <u>In economic terms</u> investments in IRRI of about 20 million dollars per year generate an added value of about 1.5 billion dollars per year of increased rice production. This fact indicates that this investment in rice research was appropriate.

(iv) <u>The social impact</u> of IRRI is difficult to measure; the following points have been noticeable in some countries at least:

- small farmers are now using high-yielding varieties
- reduction of off-farm employment
- increase in hired labour on farms
- increase in job opportunities in the villages
- reduction of drudgery
- improvement of living conditions (housing, health, education).

(v) <u>Training.</u> IRRI is one of the largest international agricultural training institutions with a large number of individuals from many countries participating in a wide range of training programmes.

(vi) <u>National programmes.</u> IRRI has strengthened national programmes by training and consulting, and by gradually proceeding from cooperative to collaborative projects.

These results would not have obtained without the active participation of collaborating countries. Initiative is gradually shifting from IRRI to authorities in collaborating countries, a very positive change.

...The impact of IR36 alone would more than justify the investment in IRRI since its establishment 20 years ago.

III. Farmer adoption of modern rice varieties and their impact on production.

The term "modern variety" (MV) refers to the improved rice cultivars developed by IRRI -- and by national rice programs using IRRI varieties as parental material -- since 1960. Most are semidwarfs (about 100 cm tall) but some are of intermediate plant height (120-130 cm).

Through years of research and experimentation, three distinct sets of characteristics have been progressively incorporated into the MVs.

- A high efficiency in the conversion of nutrients (either present in soils or applied through fertilizers) to grain, and nonsensitivity to photoperiod, or day length. These characteristics conferred to IR8 and to subsequent IRRI varieties the potential for high yields and the capacity to grow well in a wide range of latitudes.

- the built-in genetic capacity to resist important insect pests and diseases without chemical protection. Pesticides were necessary to control insect attacks on the early MVs, but most improved rices grown today are resistant to the major rice pests.
- shorter growth duration. Traditional rices matured in 5 or 6 months. IR8 matured in 4 months. MVs grown today mature in a little more than 3 months.

  Early maturing MVs use less water, are exposed to field hazards for a shorter time, often have higher protein content, and perhaps most important, can be planted and harvested early enough for farmers to grow another crop during the monsoon season, thereby making double cropping possible for millions of rice farmers.

Each new characteristic broadened the appeal of MVs to farmers.

By 1979, farmers in 11 of the world's most densely populated nations planted MVs on about 40% of the rice area (Table 1).

Changes in rice production in Indonesia and the Philippines illustrate the extent of spread of the MVs and IRRI's role in their farmer adoption.

Indonesia. Cooperation between IRRI and the Central Research Institute for Food Crops (CRIFC, previously the Central Research Institute for Agriculture) began in 1966. Initially, MVs from IRRI were introduced and evaluated in CRIFC experiment stations. In 1967 two improved IRRI varieties were released: IR5, (called PB-5 in Indonesia) and IR8 (PB-8). These and subsequent MVs were developed and tested by IRRI and Indonesian plant scientists and promoted through the Indonesian rice production intensification program (Bimas Gotong Royong). By 1971-72, the MVs had spread to about 20% of Indonesia's rice area.

But the early MVs were susceptible to insect attack, and intensified cropping provided an environment in which the brown planthopper, a rice pest that has existed in Asia for centuries, became a serious threat.

IRRI scientists identified traditional rice varieties with resistance to the brown planthopper, incorporated the resistance genes into a new series of high-yielding MVs, and evaluated the new varieties at research stations and on farmers' fields in many different countries.

IR26 (PB-26), released in 1975, was the first variety with brown planthopper resistance released in Indonesia.

In 1977, a new brown planthopper biotype -- which rendered IR26 susceptible -- was discovered in Indonesia. Later that year a new variety, IR36 (PB-36), which was resistant to the new biotype as well as other pests, was introduced. IR36 has maintained its resistance to both hopper biotypes through 1982.

The area planted to these high-yielding, resistant MVs in Indonesia increased steadily until by 1980, MVs were grown on almost 60% of Indonesia's total rice area (Table 2), with IR36 by far the most popular.

The MVs have spearheaded a dramatic increase in Indonesian rice production -- an increase that has exceeded population growth. The per-capita availability of rice in Indonesia has increased by almost 50% since 1968 (Figure 1).

Philippines. In July 1966, IRRI released 50 tons of IR8 seed to Philippine agricultural agencies for distribution to farmers, and another 5 tons directly to 2,400 farmers who personally requested the seeds. The adoption of MVs and improved production practices was more rapid in the Philippines than in any other country (Table 3) -- partly because IRRI technology can be utilized there immediately. Farmers adopted MVs in both the more favorable rainfed areas and on irrigated lands; in 1979/80, 89% of the irrigated, and 77% of the rainfed wetland rice areas in the Philippines were planted to MVs. As a result of the new technology, the Philippines has exported rice regularly since 1979.

IV. Benefits to small-scale farmers.

Information on the distribution of rice farms by size, combined with the data in Tables 2 and 3, provides *prima* *facie* evidence of the adoption of the MVs by small farmers. In Indonesia, 66% of all rice is grown on farms less than 2 ha in size. In the Philippines, 65% of the rice is grown on farms of less than 5 ha.

Thus in 1980, when 75% of the rice area in Indonesia and the Philippines was planted to MVs, small farmers, however defined, were growing much of it.

India's National Council of Applied Economic Research has gathered more direct evidence on the use of the seed-fertilizer technology by farmers with different sizes of land holdings. Data from a study of 25,000 farmers show that in most states the proportion of farm area planted to MVs with less than 1 ha or 1 to 2 ha of land is similar to the proportion planted to MVs by farmers with 2 to 4 ha, 4 to 10 ha, or more than 10 ha (Table 4). Similarly, the use of fertilizer, the key input, did not vary substantially by farm size. In fact, the data suggest that small farmers often apply somewhat higher fertilizer rates than larger farmers.

A comparison of labor use with the new rice varieties and the old (Table 5) shows that when the MVs are grown, farmers use more labor/ha per crop than when they grow older varieties.

Thus, although examples can be found in which less labor is used on MVs, the opposite is generally true: the new rice varieties have increased the opportunity for productive employment in developing countries of Asia.

Some critics have stated that the MVs "require" greater fertilizer and pesticide inputs, so that small farmers with scarce access to credit are put at a disadvantage, or required to borrow at high rates of interest.

In fact, the MVs respond much better to chemical inputs than the traditional varieties -- but even without the inputs the MVs yield as well as, or better than, traditional rices. The opportunity to profit substantially through input purchase gives both the small and the large farmer a real incentive to produce more rice. If the availability of credit, markets, and inputs is properly managed, the small farmer benefits greatly. This has been substantiated in many surveys. In Laguna, Philippines, for example, the increased income allowed farmers with 1 to 2 ha of irrigated riceland to employ more labor; to send their children to school; and also enabled their wives to spend more time in the home.

Inevitably, the farmer with a larger area of good soils and an assured water supply is likely to be more successful than a smaller farmer in a less-advantaged area. Nevertheless much can and has been done to improve the rices available to the small and less-advantaged farmers. Perhaps more important, a foundation of knowledge and an assembly line of genes for resistance to adverse conditions have been built, from which improvements to the lot of the small farmer can continue.

V. IRRI and the disadvantaged farmer.

The conservation of the world's rice genetic resources for posterity offers hope for the disadvantaged farmers in areas where adverse environmental conditions have limited the spread of the new rice technology. More than 70,000 strains of rice, mostly traditional varieties that have adapted over centuries to resist pests, drought, adverse soils, or deep water, have been collected and safely stored for future use in the IRRI Gene Bank.

The rice collection is a mine of valuable genes for use today and tomorrow. Scientists use varieties from the Gene Bank as parents -- genetic building blocks -- in crossbreeding programs to develop newer and better varieties for farmers.

Through an interdisciplinary Genetic Evaluation and Utilization Program, IRRI tests the varieties in the Gene Bank for resistance to insects and diseases, and for other desirable characters. For example, screening varieties for resistance to salinity, alkalinity, and acidity has enabled the breeding of varieties tolerant to such adverse soil factors. Land is the most precious resource for agriculture, particularly in Asia where unused land that can be farmed is scarce. Hence the development of varieties that yield well in somewhat hostile soils opens a new life to farmers now struggling to grow rice in such areas. At least 86.5 million ha of saline, alkaline, acid-sulfate, and peat soils can ultimately benefit from such research efforts.

Some have argued that the MVs are only adapted to well-irrigated areas, and because only a third of tropical rice is irrigated, nothing has been done for most rice farmers. In fact IRRI has crossbred traditional rices that have with the ability to survive moisture stress with modern varieties. New progeny varieties have some drought resistance, perform well in rainfed areas, and have been adopted by rainfed farmers. IR42 is a newer IRRI variety whose outstanding ability to perform well in adverse conditions (Table 6) has made it widely grown by rainfed farmers.

For flood-prone areas where water normally reaches 50 cm to 1 m deep -- too deep for semidwarf varieties -- the architecture of the MVs has been genetically welded to the elongating stem of traditional deepwater varieties. Thus rices with yield potential of more than 4 t/ha are now available to those farmers, whose traditional varieties often yielded less than 1 t/ha.

Many of the habitats from which the traditional rices were collected have since undergone disruption. Without IRRI's efforts, the seeds of traditional varieties of those regions would have been lost to mankind forever. For instance, valuable local varieties disappeared during the turmoil in Kampuchea. Fortunately, IRRI had preserved their seeds in the Gene Bank and in 1982 returned seeds to Kampuchea for multiplication and distribution to farmers.

VI. Strengthening of national research capabilities -- educational and training opportunities at IRRI.

IRRI recognizes that properly trained and highly motivated research and extension workers in the national rice improvement programs are essential for long-term continuation of the dramatic increases in rice yields and production. The details of the educational and training opportunities that IRRI offers are outlined in the publication The Training Programs.

The vast majority of participants in IRRI educational programs are from the Third World (Table 7). The alumni of IRRI's educational and training programs hold responsible positions in their home countries; many now lead their own national rice research and development programs. Table 8 gives examples of IRRI alumni who hold leadership positions in Indonesia. Furthermore, the national scientists, on their return to their home countries, become active participants in international research networks catalyzed by IRRI.

VII. Extension education and technology transfer.

IRRI works closely with national agricultural agencies through a network of collaborative trials, monitoring tours, and other joint activities. The following networks are now in operation:

- International Rice Testing Program

- o International Rice Agro-Economic Research Network
- o Asian Cropping Systems Network
- o International Farm Machinery Development Network
- o International Network on Soil Fertility and Fertilizer Evaluation for Rice.

About a third of IRRI's senior staff live and work under cooperative agreements in developing countries outside of the Philippines.

IRRI believes that results not disseminated among its clients (i.e. rice scientists, development administrators, and farmers) are equivalent to work not done. Hence, IRRI has a dynamic publication and information dissemination program. IRRI has published about 85 major books on rice. (Table 9). IRRI distributes about 90,000 copies of major titles per year. The three periodicals published by IRRI include the International Rice Research Newsletter in which rice workers around the world summarize their research. About 225,000 individual periodicals per year are distributed through a computerized mailing system to 13,000 individuals and libraries; 80% are in the Third World. IRRI has developed 70 self-study audiovisual modules (slide sets, tapes, booklets) on rice research methods and production. In some countries such as China and Vietnam, where the lack of English skills is a problem, the audiovisual sets have an additional use -- as training aids in English courses for agricultural workers.

IRRI increasingly designs publications in a manner that facilitates easy and inexpensive translation and copublication in languages other than English. One such book, A Farmer's Primer on Growing Rice, has been translated into 23 languages by national agencies. Field Problems of Tropical Rice, a handbook to help rice workers identify specific diseases, insects, and nutrient deficiencies, has been copublished in 12 languages. IRRI does not ask for fees or royalties for copublication of its materials in developing nations.

To ensure that full details of its own research results are available to all rice scientists in developing countries, a detailed Annual Report and a condensed, interpretive Research Highlights are published yearly. To increase the accessibility of all rice literature, IRRI publishes an annual International Bibliography of Rice Research which is also distributed free to libraries and at low cost to individuals in the Third World.

IRRI has established a Technology Transfer Committee to further strengthen the symbiotic and feedback relationships between the laboratory and the field workers.

VIII. IRRI's catalytic role in achieving growth with stability in rice production.

The widespread acceptance of IR36 is sufficient to indicate the pivotal role IRRI plays in fostering growth with stability of production.

IR36 is probably the most widely grown variety -- of any food crop -- the world has ever known. Farmers now plant IR36 on more than 11 million hectares annually in Asia. And for good reason. IR36 has eliminated many of the risks a farmer takes each time a seed is planted.

IR36 is the progeny of 13 parents from 6 nations -- India, Indonesia, China, Vietnam, Philippines, and the USA -- that were crossbred and tested by IRRI's interdisciplinary GEU team of plant breeders, entomologists, pathologists, agronomists, and soil chemists.

Scientists in national programs field-tested and selected the semidwarf variety in irrigated and rainfed wetlands and in drylands across Asia.

IR36 matures early and has genetic resistance to nine insects and diseases and to several problem soils. To farmers who grow rainfed rice, IR36 brings the chance to grow a crop in the short period when good rains are certain. When rains fail for short periods, IR36 withstands the moisture stress and bounces back when rains return. Its high yields in both irrigated and rainfed fields made IR36 a mainstay in making the Philippines a rice exporter in 1979.

The United Nations and other concerned agencies sent 1,000 tons of IR36 seed to Kampuchea and Laos to stave the threat of famine in 1980-81. Sixty percent of the rice planted in southern Vietnam is IR36, and India, Malaysia, Bangladesh, Sri Lanka harvest millions of tons annually.

IR36 is being tested in Africa -- Malagasy, Mozambique, Zambia -- and in China, the world's largest producer and consumer of rice.

The development of new varieties such as IR36 has been accompanied by substantial progress in new cropping practices. Farmers in many rainfed areas -- Philippines, Sri Lanka, India, Indonesia -- now grow two rice crops where previously they grew only one. Such farmers dry-seed their first crop, which gets off to a rapid start with the early rains. An early-maturing rice crop is ready for harvest in a little more than 3 months and a second crop is transplanted while there is sufficient water to complete its growth. Under favorable conditions, farmers can get their second rice crop off the fields in time use the residual moisture to grow beans, maize, or other dryland crops.

IX. IRRI and world peace and stability.

On a conservative estimate, the work of IRRI contributes at least an extra 40 million tons of rice annually to world production -- 4 times the current world trade in rice. The increased rice and wheat production stimulated by IRRI feed some 200 million people.

Without the additional rice, the world would face major food shortages today. The major cities would probably have been affected most, because of their dependence on the surplus rice from the irrigated areas where the MVs have contributed most.

The shortages would have been reflected in the price of rice -- and as prices increased, so would social disruption.

But that didn't happen. Higher productivity per unit of land and time provided the additional rice. The real consumer price of rice has decreased over the past 20 years in most Asian countries.

Without the new varieties, Asia's only alternative to rice shortages would have been to bring more land into production. The scope for this is extremely limited in land-scarce Asian countries.

For example, had there been no yield increases per hectare since 1966, India would need to farm about 15 million hectares more to grow the quantity of rice it now produces. Similarly, greater productivity has saved the Philippines more than 3.2 million hectares of land.

Above all, IRRI recognizes that small farm agriculture should promote not only higher and more stable yields but also more income and employment. The increase in prosperity in the countryside stimulated by the new technology has undoubtedly helped arrest the flow of people to the large cities. Secondary industries that support agriculture in the country stimulate other facilities, and schools and hospitals are built, reducing the pressures on the large urban conglomerates.

IRRI promotes the development of small rural industries to construct simple machines and implements for the farmer with less than 5 ha of land, who remains ignored by the larger mechanical engineering industry. The purpose and philosophy of IRRI's agricultural engineering program is to diversify -- not displace -- employment opportunities, thereby increasing household income. Not only do the machines provide an alternative to the continuing drudgery of much farm labor, their local manufacture and service also brings job opportunities to rural areas.

IRRI is particularly concerned with safeguarding the interests and welfare of rural women who do much of the transplanting, weeding, and other rice production operations. Hence, IRRI encourages the analysis of the impact of new technologies on reduction of drudgery and employment generation in women-specific occupations. IRRI will sponsor an international conference on "Women in Rice Farming Systems" in September 1983.

IRRI and the University of the Philippines at Los Baños are initiating a demonstration program on the theme "Prosperity through Rice Farming." This program will show, on the principle that seeing is believing, methods to maximize rice production per unit of land, water, time, and energy and to optimize income through the utilization of byproducts from every part of the rice biomass -- straw, bran, and hull -- as well as the grain.

But IRRI's work is far from complete. Although average rice yields in Asia have risen 40% and production, more than 60% since 1960, Asia's population has risen 55% in the same 20 years. So rice improvement is never ending. A continuous flow of improved rice varieties and technology is essential to stave off widespread hunger and unrest until the world's population is stabilized.

IRRI and world peace.

Food is the first among the needs of man. Thus the Roman philosopher Seneca said "A hungry people listens not to reason nor cares for justice, nor is bent by any prayers." It is in this context that the contributions of the International Rice Research Institute to increasing and stabilizing the production of rice and crops grown with it in the world's most densely populated countries are of such great significance to sociopolitical stability in Asia, and to world peace.

IRRI scientists have worked hard to improve the prosperity of the rural areas through a 5-pronged research strategy:

1. To elevate and stabilize rice production in irrigated areas by developing appropriate technology to assure farmers of high yields and high stability;
2. To extend the frontiers of adaptation of improved technologies to areas where environmental and ecological handicaps such as drought and flood have limited their spread;
3. To improve the productivity of soils affected by constraints such as salinity, alkalinity, and acidity and to optimize the benefits from all available soil resources;

4. To increase the employment opportunities to farming families dependent on rice-based farming systems through a beneficial combination of two of the Third World's major assets -- abundant sunlight most of the year and a vast and hard-working human population.
5. To improve the resource neutrality of new technology by finding less-expensive substitutes for costly inputs, thereby making the technology relevant to all farmers regardless of their capacity to purchase inputs and take risks. IR36 is an excellent example. Its broad spectrum of resistance to important insects and diseases has eliminated the need for pesticide application for most farmers who grow the immensely popular variety. Similarly the introduction of Azolla and other biological fertilizers and the improvement of the rice plant's efficiency of mineral fertilizer use help reduce the purchase of large quantities of fertilizer.

Above all, IRRI is helping to conserve for posterity the genetic fruits of thousands of years of natural and human selection by collecting and storing the traditional strains of rice that are threatened with extinction.

The contributions of the international rice improvement family, catalyzed by IRRI, stand as proof that men and women of many nations can work through the bond of science as a family, irrespective of race, color, religion, or political ideology. By strengthening such cooperative bonds, humankind can achieve freedom from hunger -- a freedom that is so vital for enduring peace and human happiness.

The award of the 1983 Nobel Peace Prize to the International Rice Research Institute will therefore carry a timely message of hope to a world increasingly obsessed with conflict and discord.

Table 1. Rice area planted and rice area in modern varieties in 11 countries.[a]

Year	11 countries rice area (000 ha)	MV rice area (000 ha)	% of area in MVs	World rice area (000 ha)
1964/65	71,090	0	0	125,091
1965/66	70,527	42	0	123,751
1966/67	71,677	1,033	1.4	125,212
1967/68	72,293	2,648	3.7	126,934
1968/69	74,072	5,006	6.8	128,247
1969/70	75,860	7,563	10.0	131,599
1970/71	75,552	9,459	12.5	131,097
1971/72	75,556	12,386	16.4	132,011
1972/73	74,220	14,738	19.9	131,464
1973/74	78,148	18,799	24.1	135,770
1974/75	78,186	20,230	25.9	137,824
1975/76	80,876	23,083	28.5	142,677
1976/77	79,637	25,123	31.5	141,506
1977/78	81,685	28,023	34.3	143,661
1978/79	83,283[b]	31,695[b]	38.1	144,947
1979/80	81,904[b]	32,482[b]	39.7	143,066
1980/81	83,337[b]	32,945[b]	39.5	144,479

[a] Bangladesh, Burma, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, South Korea, Sri Lanka, Thailand.

[b] Data for some countries are incomplete. These data assume total and MV areas are the same as the last year for which estimates are available.

Table 2. The spread of modern rice varieties in Indonesia.

Year	Area in rice (000 ha)					% of all rice in MVs
	Modern varieties			Other varieties	All rice	
	Non-resistant	Resistant to biotype 1 bph	Resistant to biotype 1+2 bph[a/]			
1964/65	0	0	0	6,980	6,980	0
1965/66	0	0	0	7,328	7,328	0
1966/67	0	0	0	7,691	7,691	0
1967/68	0	0	0	7,516	7,516	0
1968/69	198.0	0	0	7,823	8,021	2.5
1969/70	831.0	0	0	7,183	8.014	10.4
1970/71	902.6	0	0	7,232	8,135	11.1
1971/72	1,322.9	0	0	7,001	8,324	15.9
1972/73	1,913.8	0	0	5,984	7,898	24.2
1973/74	3,134.5	0	0	5,269	8,404	37.3
1974/75	3,387.4	0	0	5,150	8,537	39.7
1975/76	n.a.	n.a.	0	n.a.	8,489	n.a.
1976/77	2,456.3	1,579.0	13.8	4,320	8,369	48.4
1977/78	1,704.1	1,848.4	901.0	3,907	8,360	53.3
1978/79	1,518.2	1,109.6	2,354.2	3,947	8,929	55.8
1979/80	881.5	525.8	3,958.9	3,484	8,850	60.6
1980/81					9,300	

[a/] Mostly IR36.

Sources: 1972/73 through 1979/80 from Bernsten, Siwi, and Beachell, 1982.
1964/65 through 1971/72 from Dalrymple.
Data on "all rice" from Bureau Pusat Statistik, Indonesia; area in "Other varieties" derived by subtration.

Table 3. The spread of modern rice varieties[a] in the Philippines.

Year	Area (000 ha) Irrigated: Modern varieties	Irrigated: Other varieties	Rainfed: Modern varieties	Rainfed: Other varieties	All rice[b]	% in modern varieties
1964/65	0		0			0
1965/66	0	960.5	0	1,542.9	3,109.2	0
1966/67	52.6	1,303.9	30.0	1,311.3	3,096.1	2.7
1967/68	445.1	863.9	256.4	1,257.6	3,303.7	21.2
1968/69	912.8	570.0	438.9	967.9	3,332.2	40.6
1969/70	826.6	519.1	527.4	828.3	3,113.4	43.5
1970/71	985.0	485.5	580.4	697.0	3,112.6	50.3
1971/72	977.1	354.9	849.7	698.5	3,246.4	56.3
1972/73	872.8	368.1	807.1	629.4	3,111.8	54.0
1973/74	1,194.5	299.2	982.1	551.8	3,436.8	63.3
1974/75	1,108.9	302.8	1,066.1	608.2	3,538.8	61.5
1975/76	1,207.3	287.3	1,092.4	602.3	3,579.3	64.5
1976/77	1,285.5	204.1	1,131.2	526.2	3,547.5	68.1
1977/78	1,334.2	180.7	1,122.6	458.4	3,508.8	70.0
1978/79	1,315.0	157.0	1,196.6	384.0	3,468.9	72.4
1979/80	1,370.0	170.3	1,230.9	366.2	3,503.0	74.2
1980/81						

[a] Includes IR varieties plus those developed by the Philippine Bureau of Plant Industry and the University of the Philippines College of Agriculture.

[b] Difference between total of 4 types and all rice is the area planted to dryland (upland) rice which is entirely in other varieties.

Source: Data obtained directly from the Bureau of Agricultural Economics, Ministry of Agriculture.

Table 4. Proportion of rice area in MVs and fertilizer use by state and farm size, India, 1975-76.

State	% of rice area in MVs (irrigated & unirrigated)		kg/ha (nutrients) per fertilized area	
	Farms below 1 ha	Farms over 10 ha	Farms below 1 ha	Farms over 10 ha
Andhra Pradesh[1/]	34.3	49.1	112	120
Assam[1/]	6.9	11.2	108	8
Bihar[2/]	34.0	29.2	55	31
Gujarat	12.1	2.1	72	44
Harayana	72.5	92.6	91	117
Himachal Pradesh	3.4	-	38	-
Jammu and Kashmir	88.0	-	46	-
Karnataka[1/]	40.5	23.0	194	72
Kerala	48.7	-	100	-
Madhya Pradesh	1.7	1.1	53	17
Maharastra	9.8	-	84	63
Orissa[1/]	28.4	37.9	81	106
Punjab	98.9	100.0	103	115
Rajasthan	-	55.6	143	51
Tamil Nadu[1/]	65.3	19.2	135	108
Uttar Pradesh	35.0	21.1	48	71
West Bengal[1/]	21.3	50.0	100	133

[1/] Average of summer, winter and autumn paddy crops.

[2/] Average of autumn and winder paddy crops.

Source: National Council of Applied Economic Research, Fertilizer Demand Study Interim Report, Vol 2-6, New Delhi, 1978.

Table 5. Labor requirements for rice.

Country	Traditional variety (days/ha)	Modern variety (days/ha)	Change in labor use due to modern variety (%)
Bangladesh	137	194	+42
India (Orissa)	145	169	+17
Indonesia (Central Java)	234	197	-16
(East Java)	253	287	+13
Korea (Hwasunggung)	126	139	+10
Philippines (Laguna)	86	110	+28
Thailand (Suphanburi)	86	120	+40
Sri Lanka (Minipe)	128	171	+33
Nepal (Kosi Zone)	96	126	+30

Sources: Barker, R., and V. Cordova. 1976. Labor utilization in rice production. International Rice Research Institute, Los Baños, Philippines.

Pal, T.K. 1975. Cuttack, Orissa. Pages 133-148 in International Rice Research Institute. Changes in rice farming in selected areas of Asia. Los Baños, Philippines.

Flinn, J.C., B.B. Karki, T. Rawal, P. Masicat, and K. Kalirajan. 1980. Modern rice technology in the Tairai of Kosi Zone, Nepal. IRRI Res. Pap. Ser. 54. 11 p.

Table 6. The resistance of IR42 to pests and other adverse conditions contrasts markedly with that of IR8, released 11 years earlier.[a]

Adverse factor	IR8	IR42
Diseases		
Blast	MR	R
Bacterial blight	S	MR
Grassy stunt	S	R
Tungro	S	R
Ragged stunt	S	R
Insects		
Green leafhopper	R	MR
Brown planthopper	S	R
Stem borer	MS	MR
Nutrient deficiencies		
Nitrogen	MS	R
Phosphorus	MR	MR
Zinc	S	MR
Iron	S	MR
Soil toxicities		
Salinity	MR	MR
Alkalinity	S	MR
Iron toxicity	S	MR
Boron toxicity	MR	MR
Peat soil problems	MS	MR
Drought	S	MR
Submergence	S	MR

[a] R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible.

Table 7. Total number[1/] of IRRI trainees from different countries, 1962-81.

Country	Non degree program	IRRI Training Courses	Degree programs (MS & PhD)	Post-doctoral fellows	Total
ASIA					
Philippines	59	222	145	13	439
Indonesia	41	277	52	1	371
India	26	163	27	56	272
Thailand	39	171	62	4	276
Bangladesh	19	139	73	7	238
Sri Lanka	30	121	32	4	187
Pakistan	18	69	12	4	103
Korea	39	19	18	8	84
Burma	8	76	10	1	95
Japan	38	3	8	17	66
Malaysia	14	55	3	2	74
China					
Mainland	10	48	13	–	71
Taiwan	10	–	29	–	39
Nepal	2	34	12	1	49
Vietnam	11	23	7	2	43
Laos	7	17	–	–	24
Khmer Republic	1	5	–	–	6
Afghanistan	–	1	–	–	1
SUBTOTAL	372	1443	503	120	2438
AFRICA					
Nigeria	3	17	5	2	27
Egypt	6	7	1	–	14
Sierra Leone	3	7	1	–	10
Senegal	4	4	–	–	9
Mali	3	5	–	–	8
Ghana	2	4	1	–	7
Liberia	–	5	1	–	6
Sudan	1	5	–	–	6
Tanzania	1	4	–	–	5
Kenya	1	4	–	–	5
Uganda	–	2	–	–	2
Ivory Coast	1	–	–	–	1
SUBTOTAL	25	64	9	2	100
CENTRAL & SOUTH AMERICA					
Colombia	3	3	6	3	15
Cuba	5	4	–	–	9
Mexico	2	1	3	–	6
Dominican Rep.	–	1	1	–	2
Panama	1	–	1	–	2
Paraguay	–	2	–	–	2
Venezuela	2	–	–	–	2
Brazil	–	1	–	–	1
Costa Rica	1	–	–	–	1
Guyana	–	1	1	–	2
Peru	–	1	–	–	1
Trinidad	–	1	–	–	1
SUBTOTAL	14	14	12	3	44
NORTH AMERICA					
United States	7	12	16	2	37
Canada	–	–	1	–	1
SUBTOTAL	7	12	17	2	38
EUROPE					
Germany	4	–	3	5	12
Netherlands	5	–	2	1	8
France	1	–	–	–	1
Italy	–	–	–	1	1
Switzerland	1	–	–	–	1
United Kingdom	5	–	4	2	11
SUBTOTAL	16	–	9	9	34
OCEANIA					
Fiji	1	7	–	–	8
Australia	1	–	2	–	3
British Solomon Islands	–	2	–	–	2
New Guinea	1	1	–	–	2
SUBTOTAL	3	10	2	–	15
EURASIA					
Iran	5	3	–	–	8
Iraq	1	1	–	–	2
Turkey	–	2	–	–	2
Israel	–	1	–	–	1
SUBTOTAL	6	7	–	–	13
TOTAL	443	1550	552	136	2681

1/ Excludes 2-week Rice Production Training course and other special short-term training programs.

Table 8. Examples of IRRI alumni in leadership positions in Indonesia.[a]

1. Dr. Bernard H. Siwi, Director, Bogor Research Institute for Food Crops (BORIF); Coordinator, National Rice Research Program; Chairman, Genetic Evaluation and Utilization Program of the Central Research Institute for Food Crops (CRIFC)

2. Dr. Ibrahim Manwan, Director, Center for Agricultural Research Planning, Agency for Agricultural Research and Development (AARD)

3. Dr. Surjatna Effendi, Director, Institute for Small Holders Research, Sembawa, South Sumatra

4. Dr. I.N. Oka, Director of Plant Protection, Directorate General for Food Crops

5. Dr. Prabowo Tjitropranoto, Director, National Library for Agricultural Sciences

6. Dr. Sujadi Subijanto, Director, Center for Agricultural Statistics and Data Processing, Agency for Agricultural Research and Development

7. Dr. A. Syarifuddin Karama, Director, Sumatra Agricultural Research Institute for Food Crops (SARIF), CRIFC, Sumatra

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[a] Of the 12 current administrators in the CRIFC, 9 are alumni of IRRI's educational and training programs.

Table 9. Major books published by the International Rice Research Institute, classified by the rice problem areas on which they focus (does not include serials, periodicals, bibliographies, or audiovisual training sets).

Genetic Evaluation & Utilization of Rice

Descriptors for rice *Oryza sativa* L. 1980. 21 p.
Innovative approaches to rice breeding. 1980. 182 p.
Parentage of IRRI crosses IR1-IR30,000
Rice improvement. 1979. 186 p.
Rice improvement in China and other Asian countries. 1980. 307 p.
Rice tissue culture planning conference. 1982. 120 p.

Germplasm Collection and Maintenance

Genetic conservation of rice. 1978. 54 p.
Manual for field collectors of rice. 1972. 32 p.
Manual on genetic conservation of rice germplasm for evaluation and utilization. 1976. 77 p.

Agronomic Characteristics

The morphology and varietal characteristics of the rice plant. 1965. 40 p.
The flowering response of the rice plant to photoperiod. 1976. 75 p.

Grain Quality

Chemical aspects of rice grain quality. 1979. 390 p.

Disease Resistance

Rice blast workshop. 1979. 222 p.
Evolution of the gene rotation concept for rice blast control. 1982. 136 p.

Drought Resistance

Major research in upland rice. 1975. 255 p.
Rainfed lowland rice. 1979. 341 p.
Drought resistance in crops with emphasis on rice. 1982. 416 p.

Deepwater and Flood Tolerance

Deepwater rice. 1977. 239 p.
1978 International deepwater rice workshop. 1979. 300 p.
1981 International deepwater rice workshop. 1982. 520 p.

Temperature Tolerance

Rice cold tolerance workshop. 1979. 139 p.

Control and Management of Rice Pests

Field problems of tropical rice. 1970. 95 p.

Diseases

Handbook of rice diseases in the tropics. 1973. 58 p.
Rice virus diseases. 1972. 142 p.

Insects

Brown planthopper: threat to rice production in Asia. 1979. 369 p.
Insect pests of rice. 1969. 68 p.
Manual for testing insecticides on rice. 1981. 131 p.

Weeds

Major weeds of rice in South and Southeast Asia. 1981. 86 p.

Irrigation Water Management

Irrigation policy and management in Southeast Asia. 1978. 198 p.
Irrigation water management. 1980. 170 p.

Soil and Crop Management for Rice

Blue-green algae and rice. 1980. 112 p.
Nitrogen and rice. 1979. 499 p.
Planting rice. 1974. 9 p.
Production of seedlings. 1972. 24 p.
Rice: soil, water, land. 1978. 185 p.
Soils and rice. 1978. 825 p.
Soil-related constraints to food production in the tropics. 1980. 468 p.

Environment and Its Influence

Agrometeorology of the rice crop. 1980. 254 p.
Climate and rice. 1976. 565 p.
Laboratory manual for physiological studies of rice. 1976. 83 p.

Maps

Map: agroclimatic map of the Philippines
Rice area by type of culture: South, Southeast, and East Asia (3 maps, booklet)
Agroclimatic and dry-season maps of South, Southeast, and East Asia. (5 maps, booklet)
Complete series of agroclimatic and rice area series (8 maps, 2 booklets)

Constraints on Rice Yields

A handbook on the methodology for an integrated experiment-survey on yield constraints. 1978. 60 p.
Constraints to high yields on Asian rice farms: an interim report. 1977. 235 p.
Farm-level constraints to high rice yields in Asia. 1974-77. 1979. 411 p.

Consequences of Rice Technology

Anatomy of a peasant economy. 1978. 149 p.
Changes in rice farming in selected areas of Asia. 1975. 377 p.
Interpretive analysis of selected papers from *Changes in rice farming in selected areas of Asia.* 1978. 166 p.
Economic consequences of the new rice technology. 1978. 402 p.
Landless workers and rice farmers: peasant subclasses under agrarian reform in two Philippine villages. 1982. 237 p.

Cropping Systems

Cropping systems research and development for the Asian rice farmer. 1977. 454 p.
A methodology for on-farm cropping systems research. 1981. 155 p.
Agro-climatic classification for evaluating cropping systems potential in Southeast Asian rice-growing regions. 1974. 17 p.
Report on a workshop on cropping systems research in Asia. 1982. 762 p.
Evaluating technology for new farming systems: case studies from Philippine rice farms. 1982. 119 p.

Machinery Testing and Development

International agricultural machinery workshop. 1978. 203 p.

Statistical Techniques

Statistical procedures for agricultural machinery workshop. 1978. 203 p.
Techniques for field experiments with rice. 1972. 46 p.

Nutrition

Interfaces between agriculture, nutrition, and food science. 1979. 143 p.

Rice Science and Production

A farmer's primer on growing rice. 1979. 221 p. (English).
Fundamentals of rice crop science. 1981. 269 p.
Principles and practices of rice production. 1981. 618 p.
Training manual for rice production. 1976. 140 p.
A continuous rice production system ... the rice garden. 1981. 16 p.

Communication of Information

Communication responsibilities of the international agricultural research centers. 1980. 41 p.

Others

Beyond IR8/IRRI's second decade (a non-technical brochure). 1980. 27 p.
Rice in the tropics: a guide to the development of national programs. 1979. 256 p.
Rice research and production in China: an IRRI team's view. 1978. 119 p.
Rice, science, and man. 1972. 163 p.
Rice research in the 1980s: summary report. 1982. 33 p.
Rice research strategies for the future. 1982. 559 p.
A global experiment in agricultural development. 1982. 24 p.
An adventure in applied research: a history of the International Rice Research Institute. 1982. 236 p.
Report of an exploratory workshop on the role of anthropologists and other social scientists in interdisciplinary teams developing improved food production technology. 1982. 108 p.
Japan's role in tropical rice research. 1982. 46 p.
A plan for IRRI's third decade. 1982. 79 p.

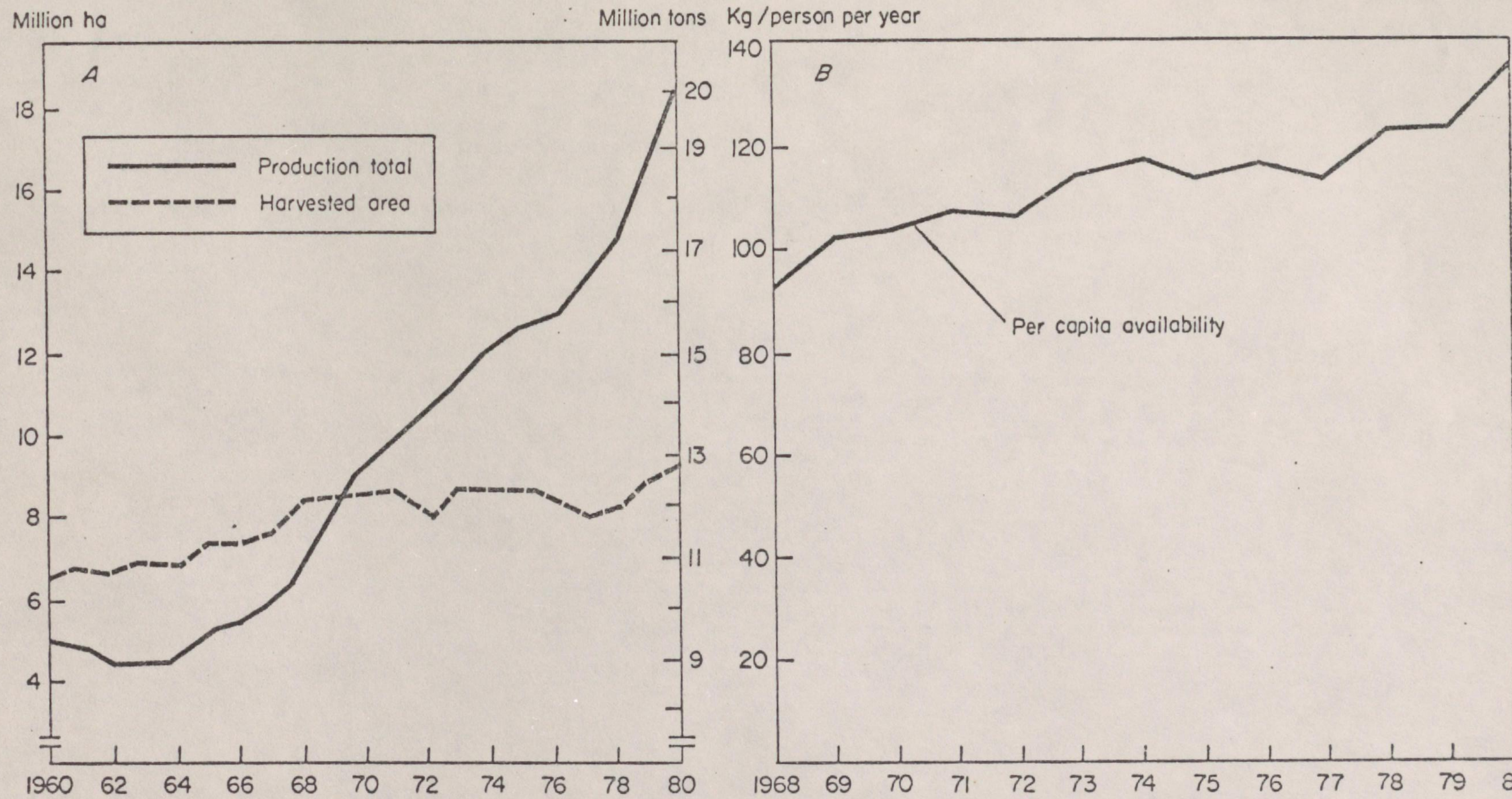

Fig.1 a). Total rice production in Indonesia has risen dramatically since 1960 because of higher yields per hectare made possible by modern rice varieties and technology.

b). The increased production has exceeded Indonesia's population growth. Thus the per capita rice availability has increased by 47% since 1968.

Source: Five years of agricultural research and development for Indonesia, 1981, Agency for Agricultural Research and Development, Ministry of Agriculture, Jakarta, Indonesia.