PN-ABG-769

IRRI RESEARCH PAPER SERIES
Number 141 April 1990

Myanmar's Experience in Rice Improvement, 1830-1985

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MYANMAR'S EXPERIENCE IN RICE IMPROVEMENT, 1830-1985

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ABSTRACT

Rice production is dependent on many complex factors both within and outside the control of a government. Production stability, profitability, sustainability, and equity are important issues in any rice production program.

Myanmar experienced 3 distinct periods of rice production growth during the last 150 yr under 3 administrations. The first period of growth, between 1885 and 1910, was brought about by a rapid expansion of rice area, while the second took place between 1955 and 1965 by bringing back into production riceland abandoned during World War II. The third period of growth, 1975-85, was generated by applying new technology in more favorable environments.

The Whole Township Rice Production Program, a new extension approach, provided the main thrust for the third growth period. The program expanded rapidly with substitution of high-yielding rice varieties (HYVs) for local varieties, coupled with increased use of chemical fertilizers. A multivariate regression analysis was made on data collected during the program years. A linear multivariate response function was estimated to account for the sources of increased yield. Eleven variables were found to contribute significantly to yield.

The economic returns to the new technology were reasonably attractive in almost all rice environments, with better returns in more favorable ones.

The third growth period has leveled off due to the leveling off of the area planted to HYVs and to the static consumption of fertilizers. Analysis suggests that a new technology development and transfer system will be necessary to raise production.

The area with immediate growth potential, about 50% of the total rice area, has already been exploited, and it will be necessary to extend new technologies to areas with future growth potential, estimated at about 40% of the total rice area, which are mostly in the hands of resource-poor farmers.

A thorough understanding of the future growth potential areas as well as of the farmers who live there is most important in designing approaches appropriate to these areas. The concept of farmer participatory research and extension, which is to blend the institutionalized knowledge system with that of the indigenous people, should permit a technology to evolve that is truly appropriate to the area and to the people, ensuring production stability, profitability, sustainability, and equity.

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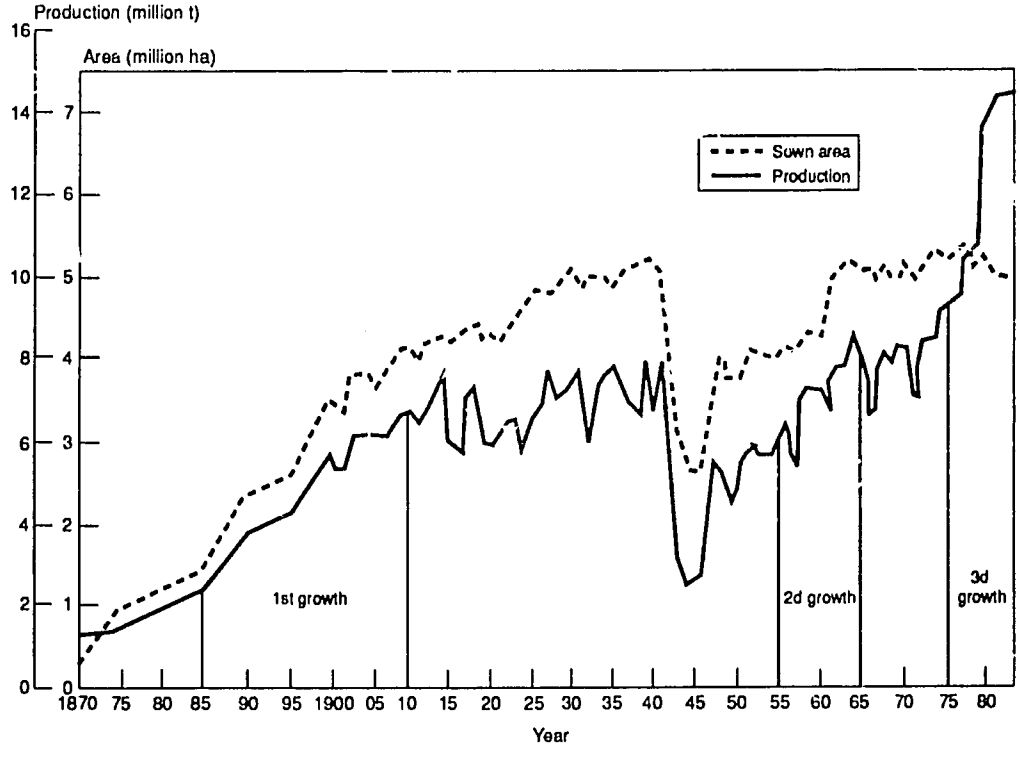
MYANMAR'S EXPERIENCE IN RICE IMPROVEMENT, 1830-1985

Myanmar (formerly Burma) is an agricultural country with more than 10 million ha of cultivated land planted to some 60 crops. In 1983, the agricultural sector contributed 50% of the country's gross domestic product (GDP) and 47% of its export earnings (Hill and Jayasuriya 1986). In earlier days, the agricultural sector provided an even larger share of GDP and exports. Myanmar's economy is clearly dependent on agriculture. Crop production is the major agricultural activity, and it is largely dependent on weather. Presently, rice occupies nearly 50% of the crop area and dominates the agricultural sector, thereby controlling the national economy. Rice is the staple food of the population, and rice shortages cause the prices of many other commodities to rise, creating market instabilities. Nearly 70% of the population rely directly or indirectly on the rice industry. Rice is thus inextricably interwoven into the economic and social fabric of Myanmar life.

The pattern of rice production over the last 150 yr has been variable, with both rising and stagnant periods (Fig. 1). Successive governments have differed in their objectives and strategies, contributing to the fluctuation. The most important factor influencing rice production is the weather. Land tenure, credit availability, procurement, processing, transportation, marketing, and support services also have a direct influence on rice production. Manipulation of these factors in the direction of governmental objectives largely defines the pattern of rice production.

Myanmar passed through three types of government from 1830 to 1985: The British annexed the country in three stages— the Arakan and Tenasserim coastal strips in 1826, Pegu and Martaban in 1852, and the rest in 1885—and established a colonial government. An independent Burmese Government took over in 1948. And in 1962, the government of the Socialist Republic of the Union of Burma assumed control. The three governments all emphasized rice production and introduced various programs to increase output.

Data on rice production alone do not reveal the full influence of rice on the population. Production stability, profitability, sustainability, and equity need to be studied to examine the impact of rice on the social and economic conditions of the country under the three administrations. Production stability here relates to spatial and temporal vari-



1. Trends in rice area and production, Myanmar, 1870-1985. Sources: Cheng 1968; Department of Settlement and Land Records 1941-54; Grant 1939; Ministry of Planning and Finance 1984, 1987; Revolutionary Government of the Union of Burma 1966, 1973, 1978.

ability in both production and profit. Profitability means profit obtained from the increased yield after accounting for the cost of additional inputs. Sustainability is the long-term maintenance of production and profit levels. Equity refers to the distribution of the benefits that result from production. Production changes caused by technology or other means are accompanied by these important elements.

AREA, YIELD, AND PRODUCTION

In the past, rice was cultivated in all parts of the country, irrespective of its agroecological suitability, mainly for domestic consumption. Before the arrival of the British, the Burmese Kings adopted a restrictive commercial policy, prohibiting the export of many products, including rice (Cheng 1968). This restriction on the rice exports discouraged the peasants from growing more than was required for their own consumption. After the British arrived, the rice trade was developed by introducing various measures to encourage the expansion of rice-growing areas. But rapid rice production growth took place only after the second annexation, when the Irrawaddy Delta was put under rice cultivation (Adas 1974).

This deltaic area offered a favorable rice environment in terms of both weather and soils. The British Government lifted the ban on rice exports and provided assistance to commercial firms to promote them. It made the country a safe and profitable place for foreign investment. It introduced a land tenure system that gave pioneer farmers a permanent and inheritable title to land, which could be sold, mortgaged, or transferred. The land tenure system also exempted land tax payments on newly cleared land for 12 yr (Binns 1948, Cheng 1968). These measures, along with an immigration program to attract people from Upper Burma and India with reduced fares, resulted in a great number of people moving to the delta. These governmental actions greatly accelerated the expansion of the rice area in the delta, especially when such actions gained momentum in the last two decades of the 19th century. In spite of wild animals and snakes on the newly cleared land, compounded by malaria and dysentery, the rice area expanded rapidly because of the British Government incentives and the hard work, abilities, and determination of the farmers.

The earliest available records show that the rice area was 27,000 ha in 1830, and reached 1.2 million ha in 1880, an increase of more than 1 million ha in a span of only 50 yr. Another 1 million ha was added between 1880 and 1890. The same magnitude of rice area expansion continued in the last decade of the 19th century to reach 3.5 million ha by 1900. These expansions occurred mainly in the Irrawaddy Delta (Grant 1939).

As the available land became limited, the rate of area expansion slowed. The area reached 5 million ha in 1930, after which it stabilized until 1985. But nearly one-half of the rice area was abandoned during World War II. The prewar level of 5 million ha was regained only in 1963. Now, the rice area of the country is steady at around 5 million ha, with slight variations in some years due to weather abnormalities.

The regional rice yield has varied greatly since rice was sown throughout the country, irrespective of agroecological suitability. The yield was estimated by the Settlement and Land Records Department at 1.7 t/ha at the beginning of this century, with a tendency to decrease in subsequent years. The estimates of yield ranged from 1.0 to 1.8 t/ha in Upper Burma, 1.2 to 1.5 t/ha in the coastal area, and 1.4 to 1.9 t/ha in the delta. The yield fell to as low as 1.0 t/ha during World War II but rose to the prewar level of 1.7 t/ha in 1958. This low national average remained stationary until 1975, after which it increased rapidly to 3.0 t/ha due to the widespread adoption of modern high-yielding varieties (HYVs) along with appropriate agronomic practices. The yield stabilized at around 3.0 t/ha after 1982 (Grant 1939, Ministry of Planning and Finance 1987).

Total rice production during the period under study rose from only 44,000 t in [illegible] 0 to 7 million t at the outbreak of World War II to 14 million t in 1985 (Grant 1939, Ministry of Planning and Finance 1987). Total rough rice production is a function of harvested area (generally 95% of the sown area) and of yield. Rice production increases in the earlier period were thus due to horizontal growth through expansion in area, while increases after 1975 were due to vertical growth through higher yields.

SUPPORT SERVICES

Agricultural research and extension, and the availability of credit constituted the major support services that directly influenced rice production. The contribution of research and extension to rice production in the earlier period was minimal; production gains were secured by the expansion of area, mainly manipulated by governmental encouragement through trade. The Agricultural Department, responsible for research and extension, was part of the Department of Settlement and Land Records during the 19th century. It became a separate department only at the beginning of this century, but no significant contribution could be made due to a shortage of skilled manpower and lack of encouragement by the government. Research activities were restricted to a few experimental stations, while the extension section adopted the demonstration as its main approach. But, in the later period when the government placed greater emphasis on vertical growth, research and extension became the most important support services. The manpower resources of the Agricultural Department, later renamed the Agriculture Corporation, were greatly increased, along with improved technical capabilities, when many staff returned from studies abroad.

In 1967, the Agricultural Department introduced rice variety IR8 and tested it in many areas of the country. IR8 outyielded the local varieties by three to five times. Although the yield was very attractive, farmers did not adopt the variety due to its poor eating quality. But the IR8 trials had far-reaching consequences; the planners and administrators witnessed them with great satisfaction. Researchers and extension workers, convinced of the high-yielding potential of the

dwarf, stiff-straw rice variety released by IRRI, gained confidence in their work. Farmers also took keen interest in the results of the trials. Public recognition that higher crop production was possible through the application of science to agriculture enhanced the role of officials of the Agricultural Department. The Department's researchers renewed their efforts, resulting in the release of the first local HYV rice, Shwe-wa-htun. The new variety, developed by subjecting IR5 to gamma rays, became popular among the farmers, especially in the delta. It covered nearly 1 million ha in 1985. Another variety, Mashuri, introduced from Malaysia and reselected at the experimental stations, was released in 1976 and soon covered nearly 0.5 million ha, mainly in Upper Burma.

In 1977, a farmer named U Thein Aung introduced another HYV called Shwe-ta-soke, which has enjoyed wide acceptance in the delta area, eventually covering 0.5 million ha. U Thein Aung had observed new plants that possessed desirable characteristics growing in his own fields planted to a local variety. Knowing the requirements of plant characteristics for the general growing conditions of the delta and the resource base of the majority of the farmers, he was able to recognize the improved plant. He developed his HYV through single-plant selection. The yield of Shwe-ta-soke was comparable to that of other HYVs, and the grain quality was acceptable to the general population. In 1985, the rice area planted to HYVs amounted to 2.5 million ha or 50% of the total area. Shwe-wa-htun, Mashuri, and Shwe-ta-soke covered 80% of this area. The remaining 20% was planted to other new HYVs developed through both local and international research (Khin Win, in press).

HYV rices and chemical fertilizers entered Myanmar agriculture simultaneously in a complementary manner. The new varieties could not exhibit their high-yielding potential unless a reasonable amount of fertilizer was applied. Conversely, acceptance of fertilizers owed much to the HYV rices. Despite low fertilizer prices and sufficient credit facilities to encourage fertilizer use in earlier years, fertilizers were not really popular before the advent of HYVs. The widespread adoption of new varieties quickly pushed fertilizer use upward. The annual consumption of fertilizers for rice rose from 6,000 t in 1960 to 300,000 t in 1985 (Ministry of Planning and Finance 1987). The demand for fertilizer exceeded the supply. Use of fertilizers in a particular year would depend on the expansion of the HYV area, availability of fertilizer stock at the distribution points, available cash in the farmers' hands, production of local fertilizer factories, amount of fertilizer imports, and activities of the extension service.

The extension approach followed the demonstration technique of previous times. A new variety or a new technology was demonstrated on a carefully selected small plot. Farmers readily admitted that the yield of the plot was much higher than that of the surrounding plots, but they entertained doubts about the availability of the inputs and the profitability of the technology. Neglect of farmers' perceptions, compounded by the extension workers' lack of seriousness, often reduced the effectiveness of the demonstration approach. The effectiveness of the agricultural extension service through demonstration fell short of the needs demanded by the situation. A new extension approach was needed for rapidly expanding HYVs and greater use of fertilizers. In 1977, the Agriculture Corporation introduced the Selective Concentrative Strategy. The new approach was also called the Whole Township Rice Production Program (WTRPP). The WTRPP had five components: proven new technology, governmental support and leadership, selectivity and concentration, mass participation, and competition (Khin Win et al 1981).

Available research results in the form of HYVs, responses of rice to fertilizers, plant protection practices, optimum plant population densities, and other technological components were brought together to form a package of technology. This package was put into practice by the farmers with a dynamic governmental support system. Localities having the optimum conditions for rice production and varieties suitable for the locality were selected. Agriculture Corporation officials were also selected from both the research and the extension sections. Young, active, innovative persons who were good team workers and had the right attitude toward the farmers' life were selected for the chosen townships. Concentration meant the preferential allocation of resources and inputs for the selected area. This component radically changed the existing practice of equally allocating limited resources to every township. The new technology demanded more labor, especially for transplanting and harvesting. The higher labor requirement was met by voluntary exchange of labor and organizing nonfarmers through mass participation. The strategy also made the farmers compete among themselves in transplanting, harvesting, and yield to encourage them to exert their capabilities to the fullest extent.

Preprogram activities were initiated in 1975 and 1976, in a village covering 1,886 ha involving 506 farmers, to serve as practical training for 41 extension workers. The activities also intended to test the farmers' attitude toward technological change and be a guide to the kind of components a larger project would require. The preprogram activities were also a good test of the coordination needed for research and extension workers to become a harmonious team.

The success and experience gained during the 2 yr of preprogram activities encouraged the Agriculture Corporation to launch a full-scale program in 2 townships, 1 in Upper Burma and 1 in Lower Burma, in 1977. The program covered 90,000 ha, and the results proved successful in raising the yield from 2.4 to 3.1 t/ha in the former township, and from 2.0 to 2.8 t/ha in the latter. The program was extended in 1978 to 23 townships with an area of 850,000 ha. The average yield increased from 2.1 to 2.8 t/ha in the program area. Analysis of the results showed that 40% of the yield increases were due to varietal change and fertilizer application, 18% to correct seedling age, 24% to row transplanting, and 1% to plant protection (Khin Win et al 1981). Since 1978, the program has

Table 1 Townships in the Whole Township Rice Production Program, by year and by environment, 1977-85 (Agriculture Corporation, various years).

Crop year	Townships (no.) in given environment					
	Delta zone	Coastal zone	Dry zone		Northeastern zone	Total
			Irrigated	Rainfed		
1977-78	1	-	1	-	-	2
1978-79	11	1	4	6	1	23
1979-80	20	5	7	7	4	43
1980-81	40	10	7	8	7	72
1981-82	43	12	7	8	8	78
1982-83	44	12	7	10	9	82
1983-84	44	12	7	10	9	82
1984-85	44	12	7	10	9	82
1985-86	44	12	7	10	9	82

Table 2. Changes in rice varieties and yields, by environment, 1975-85 (Agriculture Corporation, various years).

Environment	Area (million ha) under given variety type[a]				Yield (t/ha)	
	1975		1985		1975	1985
	HYV	LV	HYV	LV		
Delta zone	0.3	2.4	1.7	1.0	1.9	3.4
Coastal zone	0.0	0.7	0.3	0.4	1.6	2.7
Dry zone	0.1	0.7	0.5	0.3	1.8	2.7
Northeastern zone	-	0.7	0.2	0.5	1.3	2.2
Total or average	0.4	4.5	2.7	2.2	1.8	3.1

[a] HYV = high-yielding variety, LV = local variety.

been extended to many townships. The activities and successes of the program in the major rice environments are summarized in Tables 1-3.

There are four main rice environments: delta zone, coastal zone, dry zone, and northeastern zone. The delta zone had the largest sown area, about 55% of the total rice area, and the highest potential in terms of productivity and production. The other zones each had about 15% of the total riceland. The coastal zone was self-sufficient in rice, while the dry zone and the northeastern zone were and still are rice-deficient. Potential for increased productivity existed in the irrigated portion of the dry zone. Some area expansion was possible in the other zones, although there were some limitations: deepwater and saline conditions in the coastal zone, and scanty rainfall, poor soil, and cold temperatures in the other zones.

The delta zone had the most townships, followed by the dry zone (both irrigated and rainfed), the coastal zone, and the northeastern zone (Table 1). Because the initial program townships were selected by considering suitability and productivity, as more townships joined the program greater variability was introduced.

In general, the higher the varietal changes from local varieties (LVs) to HYVs, the higher was the increase in yield in almost all the environments (Table 2). The slight discrepancy in the dry zone as compared with the other zones is due to the insufficiency of rainfall there.

Table 3. Average national and program township yields and rice production, 1977-85 (Ministry of Planning and Finance 1984, 1987).

Crop year	Average yield (t/ha)		Production (million t)	
	National	Program townships	National	Program townships
1977-78	1.9	2.9	9.3	0.3
1978-79	2.1	2.9	10.4	2.3
1979-80	2.4	3.1	10.3	3.7
1980-81	2.8	3.4	13.1	7.4
1981-82	2.9	3.5	13.9	8.5
1982-83	3.2	3.6	14.2	8.9
1983-84	3.1	3.5	14.3	8.7
1984-85	3.1	3.6	14.3	8.6
1985-86	3.1	3.5	14.3	8.6

As expected, yields in the program townships exceeded the national average. But the difference became less with time; evidently some dilution effect occurred as the program expanded and became the victim of its own success. This situation is illustrated in Table 3.

Regression analysis of the data collected during the program years permitted analysis of the changes in rice yield. A linear multivariate response function was estimated to account for the sources of contribution to the yield. The variables included in the regression analysis were:

Variable	*Symbol*
Area (%) sown with HYVs	X_1
Row-transplanted area (%)	X_2
Area (%) sown with 25- to 30-d-old seedlings	X_3
Area (%) sown at 20- x 15-cm spacing	X_3'[a]
Area (%) intercultivated and weeded	X_4
Area (%) under water management	X_5
Manure applied (t/ha)	X_6
Urea applied (kg/ha)	X_7
Triple superphosphate applied (kg/ha)	X_7'[b]
Muriate of potash applied (kg/ha)	X_7''[b]
Pest-protected area (%)	X_8
Pest-infested area (%)	X_9
Total labor use (d)/10 ha	X_{10}
Area (ha)/extension worker	X_{11}
Production camps (no.) in the township	X_{12}
Staff (no.) trained during the year	X_{13}
Farmers' training (high level)	X_{14}
Farmers' training (medium level)	X_{15}
Voluntary labor (high level)	X_{16}
Voluntary labor (medium level)	X_{17}
Rice environment (delta zone)	X_{18}
Rice environment (coastal zone)	X_{19}
Rice environment (irrigated zone)	X_{20}
Rice environment (dry zone)	X_{21}
Rainfall relative to normal	X_{22}
Program life (yr)	X_{23}
Rice yield (kg/ha)	Y

[a]Correlations of X_2 and X_3 with X_3' are high. X_2 and X_3 were thus taken into the model as explanatory variables for X_3'.
[b]Correlation coefficients between X_7, X_7', and X_7'' are high. X_7 was chosen as the main variable to represent all fertilizer variables.

Yield in kilograms per hectare was used as the dependent variable, while the factors listed as X_1 to X_{23} were hypothesized to affect yield. A stepwise regression procedure was used so that each equation was estimated with progressively larger subsets of the independent variables that best explained the yield based on the *F*-test of statistical significance of the coefficient of determination. Of the variables analyzed, 11 were statistically significant (Table 4).

With these 11 variables, yield changes resulting from the applied technology were calculated following the method used by Herdt and Mandac (1979) (Table 5).

Further analysis of the variables for the rice environments indicated differential effects due to these variables. However, two variables—HYVs with fertilizers, and program life—were found to be the major contributory variables in all environments except the dry zone rainfed environment. The significance of the program life variable means that the experience gained during the program years was quite instrumental in affecting yield. This demonstrates the importance of good management and motivation of all involved in the program for effective technology transfer.

Table 4. Regression equations calculated from data obtained from program townships.

Independent variable	Symbol	Coefficient[a]
Area (%) sown with HYVs	X_1	9.33***
Area (%) sown with 25- to 30-d-old seedlings	X_3	3.16**
Pest-protected area (%)	X_8	2.09**
Total labor use (d)/10 ha	X_{10}	0.61**
Production camps (no.) in townships	X_{12}	28.38**
Farmers' training (high level)	X_{14}	196.12**
Farmers' training (medium level)	X_{15}	134.35*
Rice environment (delta zone)	X_{18}	594.55***
Rice environment (coastal zone)	X_{19}	601.78***
Rainfall relative to normal	X_{22}	612.27***
Program life (yr)	X_{23}	259.84***
Constant (kg/ha)		179.71
R^2 value		0.73
Standard error		358.39

[a] *** = significant at the 0.1% level, ** = 1% level, * = 5% level.

Table 5. Yield increase contributions for the significant variables excluding rice-growing environment.

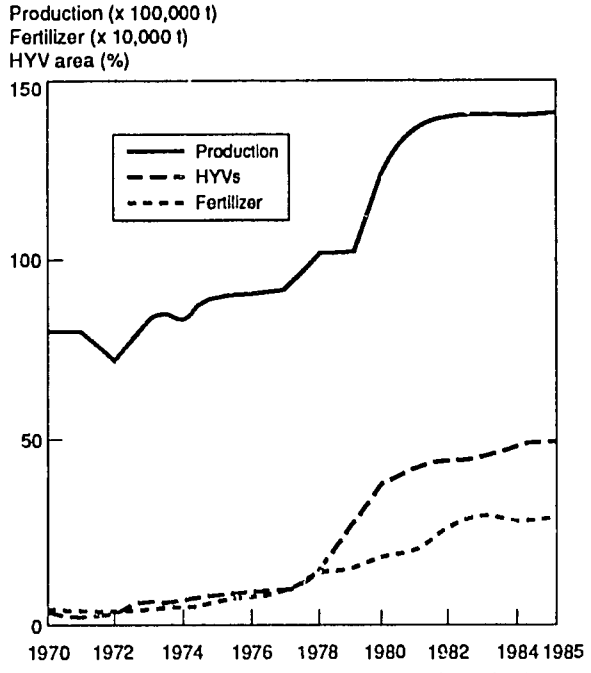
Variable	Symbol	Increase due to the program	
		kg/ha	%
Area (%) sown with HYVs	X_1	260	36
Area (%) sown with 25- to 30-d-old seedlings	X_3	39	5
Pest-protected area (%)	X_8	20	3
Total labor use (d) /10 ha	X_{10}	73	10
Production camps (no.) in townships	X_{12}	45	6
Farmers' training (high level)	X_{14}	20	3
Farmers' training (medium level)	X_{15}	20	3
Rainfall relative to normal	X_{22}	37	5
Program life (yr)	X_{23}	281	39
Yield increase explained by the model		775	109
Actual yield increase		719	100

Thus, the most important and basic elements in the process of technological change were the use of HYVs together with appropriate agronomic practices, and experience with the program. The results reported earlier by Khin Win (1981) on the importance of HYVs and fertilizers for increased yield are further confirmed by these results.

The area planted to HYVs and the use of chemical fertilizers gradually flattened off (Fig. 2).

The leveling off of rice production is related to the leveling off of the area planted to HYVs and to the static consumption of fertilizers. This indicates that further yield increases would need new HYVs and agronomic techniques. This should define the area of research aimed at increased rice production.

Besides research and extension, agricultural credit formed an important support service that had great influence on rice production. When the delta zone was being developed, the pioneer settlers had a great need for credit. They required



2. Changes in rice production in relation to HYV and fertilizer use, 1970-85 (Agriculture Corporation, various years).

cattle, implements, seed, and other utilities to clear the land, in addition to the daily family needs before the first crop of rice could be harvested. The government provided credit, but it was not widely used despite low interest rates. The unpopularity stemmed from the facts that many forms had to be filled out, frequent attendance was required at the Township Officer's office, and there were many complicated procedures. Furthermore, a definite date of repayment was fixed. In contrast, private moneylenders offered easy credit, although they charged higher interest rates. Of the estimated annual requirement of 200 million rupees, the government credit amounted to only 2 million rupees. Among the private moneylenders, Indians, known as Chittyers, supplied more than two-thirds of the total credit requirement, amounting to 160 million rupees every year (Cheng 1968).

From 1948 to 1962, credit remained a problem. The government's share increased to 50 million kyats (a kyat had the same monetary value as a rupee), but private moneylenders still supplied three quarters of the yearly requirement. In 1975-85, the need for credit was felt even more strongly as the country launched the WTRPP in the face of rising costs of all necessary inputs. During this period, the lending agency, the lending amounts, and the lending procedures all changed. The government issuance of agricultural credit for rice production amounted to more than 1,000 million kyats, which was considered adequate. Credit availability in adequate amounts influenced the decisions of farmers to adopt modern practices (Khin Win, in press).

CONSUMPTION AND EXPORT

Rice production in the country is meant primarily for national consumption, but the available surplus is for export. The surplus has varied with production changes and with increasing internal consumption by the ever-increasing population. Although production in the country as a whole exceeded consumption during 1962-87, four divisions and five states (in the dry zone and in the northeastern zone) were deficient in rice, leaving three divisions and two states (in the delta zone and in the coastal zone) as rice-surplus areas. Even in these surplus divisions and states, only three divisions—Irrawaddy, Pegu, and Rangoon, all in the delta zone—could be considered rice-surplus areas. The surplus rice of the delta had to be distributed to the remaining areas deficient in rice. Thus, the delta zone can be considered the area of prime importance in rice production for the whole country.

Rice serves as the staple food for all of the population, and it will continue to be the dominant staple in the future. Myanmar has one of the world's highest levels of per capita rice consumption, approximately 200 kg/capita per yr (Barker and Herdt 1985). It can be safely assumed that the population will continue to consume at this rate even when other cereals become increasingly available.

Myanmar had the largest share of the international rice market, amounting to 3 million t/yr, before World War II. It exported 60-70% of its production to European markets in the early part of this century. The export market then shifted to India and Sri Lanka. Immediately after the war, earnings from rice exports exceeded those of the prewar period, although the volume fell short of the prewar level. Exports ranged from 1 to 2 million t during this period, representing only 40% of production because of higher internal consumption due to the increasing population. Rice exports began to decline in the late 1960s and early 1970s, reaching as low as 0.25 million t; but they rose to nearly 1 million t in the late 1970s and early 1980s, when rice production increased dramatically under the WTRPP. Presently, the outlook for rice exports appears dim, since the international market absorbs only 3% of world production. But the international rice market can be expected to expand because of greater demand by rice-eating countries as populations increase. Rice will remain a major staple food for a large segment of the world population.

STABILITY, PROFITABILITY, SUSTAINABILITY AND EQUITY

Production stability in earlier days depended only on the weather, particularly the behavior of the monsoon. But as the new technology was applied for higher production, the weather factor was compounded by the availability of inputs like new varieties and fertilizers. In addition, changing prices of rice and inputs began to cause changes in profitability. Sustainability of long-term production growth relied on year-to-year production stability. To maintain a high growth rate posed many problems. Linked to the stability and sustainability of production was equity. In earlier days, rice production growth had been achieved by area expansion. There existed no landlord and no tenants. Any farmer who was able to clear land owned it. But with time the land titles were acquired by

moneylenders because the farmers were unable to repay their debts in the stipulated time. The distribution of earnings followed the pattern of ownership.

The worldwide economic depression of the 1930s struck the country in full force, bringing down the price of rice. The market slump led to financial difficulties, especially when moneylenders pressed for repayment of loans. Confiscation of land by moneylenders led to social unrest. Very few farmers now owned the land they had cleared. The classes of landlords and tenants appeared in society, leading to very inequitable distribution of the benefits of production. A farmer growing rice spent 84% of the output as paid-out costs: land rent took 40%, and the remaining amount was taken by high-interest rates, leaving only 16% as the farmer's share. Net income amounted to only 247 kg/ha, or 21 rupees/ha at the prevailing average market price of rice (Grant 1939). This economic situation occurred mainly in the delta zone. The consequence was frustration for the masses, particularly the farmers.

Rice production growth in the late 1970s and early 1980s was brought about by applying scientific technology to agriculture. The new technology that raised production demanded more expenditures, but it also offered proportionately higher profits. The average production increase, and the additional costs in the various rice-growing environments—from the data of the WTRPP—are summarized in Table 6.

The economic returns to the new technology were reasonably attractive everywhere except in the dry zone rainfed environment, even at the current prices for rice and inputs. The price of rice did not reflect the cost of production, nor the international rice market price. At the same time, inputs were very much subsidized and did not reflect actual costs. Thus, the profits and the benefit-cost ratios changed with the changing prices of rice and inputs. Net income under optimal conditions when family labor was not included in the production cost was 660 kg/ha or 377 kyats/ha at the prevailing prices of rice and inputs (Agriculture Corporation, various years; Jayasuriya 1984). During this period, farmers were required to pay only 30% of their output as paid-out costs, enabling them to retain 70%. There was no land rent, but the farmers complained of the slow increase in rice prices in relation to changes in the prices of other crops.

The country thus witnessed three distinct periods of rice production growth during the last 100 yr, the causes and effects of which were different. The first growth, which occurred between 1885 and 1910, was brought about by the rapid expansion of rice area in the delta zone, while the second growth, between 1955 and 1965, resulted from bringing back into production the riceland abandoned during World War II. Unlike the previous events, the third growth period, 1975-85, was generated by applying new technology in more favorable environments. These differences in the cause of rice production growth created differential impacts on the population.

The third production growth trend has leveled off, requiring another force to push it upward again. Will the existing technology and extension strategy be able to push up growth, or will new technology and a new approach be needed? Analysis suggests that a new technology development and transfer system will be necessary to raise production with acceptable sustainability and equity.

IMPLICATION FOR FUTURE GROWTH

The area covered by HYVs in Myanmar leveled off after attaining 53%. Likewise, fertilizer use slowed after reaching 300,000 t annually, pointing out that the timely availability of this input in sufficient amounts became limiting with the existing infrastructure and institutional conditions of the country. Rice variety and fertilizer use constitute the major components of the new technology, and other improvements need to be made to push production upward. The selective concentrative strategy has already exploited the areas with immediate growth potential, and it will be necessary to extend to areas with future growth potential. The slowing down in the adoption of HYVs after attaining 53% might be taken as an indicator that 50% of the rice-growing area belongs to the immediate growth potential area, while the remaining 50% might represent the future growth potential area. It is also possible that about 10% of the future growth potential area consists of low growth potential areas where the topography is too rough, the soils too poor, or the water too scanty or too deep to encourage rice cultivation that is economically feasible or even technologically possible.

An approach for the future should pay special attention to the 40% future growth potential area while making every effort to maintain the gain made in the immediate growth potential area. A new strategy of technology development and

Table 6. Economic returns to additional costs due to new technology in various rice-growing environments.

Environment	Production increase		Production cost (kyats/ha)		Net benefit (kyats)	Benefit-cost ratio
	t/ha	kyats/ha	Total cost (before program)	Additional cost		
Delta zone	1.3	552	783	273	279	2.0
Coastal zone	1.3	569	755	290	279	2.0
Dry zone	1.2	513	1003	239	274	2.2
Rainfed	1.2	254	785	240	14	1.1
Northeastern zone	0.9	397	1050	228	169	1.7

transfer appropriate to future growth potential areas will create another wave of rice production growth.

It is thus necessary to identify the land termed here the future growth potential area. Many scientists may consider this area unfavorable. In Myanmar, especially in the delta zone, there are some areas reserved for high-quality rice with superior cooking and eating characteristics, which cannot be replaced by the present HYVs. It will be necessary to identify areas of low productivity in both favorable and unfavorable environments and to study closely the situation of the farmers in these areas. Most of the farmers in these areas are resource-poor. It is necessary to identify the causes of their poverty and the other conditions that perpetuate the situation. A thorough understanding of the area as well as of the farmers is most important in designing an approach appropriate to this 40% future growth potential area.

The farmers have learned their agronomic practices through the day-to-day activities of cultivation over a long period of time and have passed their knowledge on generation to generation. Their knowledge of the situation differs greatly from the institutionalized knowledge of researchers and extension workers; farmers' knowledge is often assumed to be inferior, and it has never been taken into account. For the future growth of rice production in Myanmar, the knowledge and experience of the farmers must be considered to help formulate new technologies. The concept of farmer participation should provide the main thrust for the evolution of a technology truly appropriate to the area and to the people.

The solution to the problems of the future growth potential area cannot be found in a single discipline or in a single individual. Well-coordinated teamwork should form the basis of the approach. Researchers, who tend to be individualistic and independent, must be motivated to interact among themselves. Farmers, who are usually reluctant to participate due to their feeling of social inferiority, must be encouraged to be actively involved in the program. Experience has shown that once the sincerity of the researchers and the objectives of a program are accepted, farmers' participation is enthusiastic. But proper and sincere encouragement is needed. Once the farmers accept that the objective is to secure a better livelihood for them from their only profession, agriculture, by putting science into practice, with a minimum of risk to them, the adoption of new technology will be rapid. People are always receptive to technology that will increase their income and improve their livelihood while keeping the risk within a reasonable limit.

Experience has shown that agricultural research can transform the economy of a country and thus can be a worthwhile investment. So far, the new technology has benefited the resource-rich farmers or the not-so-poor farmers whose rice-growing conditions resemble closely the conditions where the technology was developed. Resource-poor farmers have missed the opportunities offered by the new technology. The need for including the rural poor as target beneficiaries has never been disputed, but the method of accomplishing it poses more problems. The farmer participatory research and extension method will hopefully develop technology appropriate to resource-poor farmers, with direct applicability encompassing stability, profitability, sustainability, and equity.

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The International Rice Research Institute
P.O.Box 933, 1099 Manila, Philippines

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