EFFECTS OF NEW RICE VARIETY UPON THE INCOME OF FARMERS AND THE ECONOMY OF THAILAND, WITH PROJECTIONS TO 1975

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By

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INTRODUCTION

I-A. Importance of Rice to Thailand Economy

Thailand has almost one-fifth of the total land area (61.4½ million rai or 24.56 million acres out of 327.25 million rai) in farms. Of these lands, only 15.5 percent of the total land area or 50 million rai are under cultivation. About 37 million rai or nearly three-fourths of the cultivated area is used for rice, while the remaining one-fourth is devoted to other crops, such as coconuts, para rubber, field crops and fruit trees.[1]

Since rice is the basic food of the Thai people, most of the lowland, which has sufficient water, is planted to rice in order that the yearly supply of rice for home consumption for the grower is assured. It is often difficult to induce farmers to grow other crops unless there is a ready market for them.

Approximately, 84 percent of the total 22.8 million people are engaged in agriculture. About 86 percent of the farmers or 72 percent of the total population are rice farmers.

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[1]Ministry of Agriculture, Agriculture in Thailand, (Ministry of Agriculture, Bangkok, Thailand, September 1961), p. 1.

NOTE: 1 acre = 2.5 rai

More than 80 percent of them own their farms with an average size of 25.6 rai.[2] As a crop, rice occupies the largest area of cultivated land, produces the highest total value among all agricultural crops, provides the best employment opportunity for the majority of the people, supplies more-than-enough staple food for the Kingdom, earns the major share of foreign exchange and yields the most stable revenue for the Government. No one can talk about economic development in Thailand without giving a close look at the current status of this most important crop.

Rice farmers also grow other crops or raise livestock and fish on their farms as minor enterprises. Statistics are not available to show how much income results from these minor crops. One can see that during the past 10 years, 1953-1962, rice occupied, on the average, almost 88 percent of the total flat farmland suitable for rice (Table 1.1).

Approximately 12 percent of this rice farmland was used for other purposes including farmstead, fish pond, cattle grazing, upland crops, oil seeds, garden crops, fiber crops, fruit trees and rubber. Reportedly, the production value of minor crops on the rice farms could safely be estimated at current market prices at about 25 percent of the total production value of rice.[3]

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[2] Ibid., p. 2.

[3] Sawaeng Kulthongkham, Shao-er Ong, Rice Economy of Thailand, (Ministry of Agriculture, Thailand, 1965), p. 11.

Table 1.1: Use of Rice Farmland in Thailand - 1953-1962 (1,000 rai)

Year	Rice Farmland			% of Other Uses to Total
	Total	Rice	Other Uses	
1953	40,594	38,575	2,019	5
1954	41,377	34,732	6,645	13
1955	40,215	36,060	4,155	13
1956	40,968	37,648	3,320	8
1957	41,523	31,717	9,806*	23
1958	41,774	35,987	5,787	14
1959	42,572	37,909	4,663	11
1960	43,236	37,008	6,228	15
1961	43,629	38,619	5,010	11
1962	44,545	41,534	3,071	7

Source: Division of Agricultural Economics, Ministry of Agriculture, Thailand, Agricultural Statistics of Thailand, 1962, pp. 39-40.

NOTE:* The reason for high use is unknown. It might be statistical error or typing error, we do not know.

Some part of these minor crops were grown in rice land during the off-season, thus this added 25 percent is produced by more than the average 12 percent of the land devoted to crops other than rice.

I-B. Brief Historical Review of Varietal Change and Technical Innovation

In 1850, the total area planted to rice was estimated at 5.8 million rai. This area had risen to 8 million rai by 1905, and steadily rose to 34.6 million rai by 1950. On the export side, the average annual export of rice during 1857 to 1859 was 0.594 million tons of rice. After a slow erratic growth up to 1870-1874, the volume rose rapidly to 1.54 million tons in 1930-1934. This three-fold increase over the probable maximum at the time of the Bowring Treaty* took place while the population doubled; this represented

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NOTE:* The Bowring Treaty (1854), the opening of the Suez Canal (1869), the abolition of slavery (1874-1905), and the abolition of the corvee system (1899), all occurring in the second half of the nineteenth century, may be considered as the four major events that directly or indirectly contributed to the revolutionary changes in Thai society in the early modern period. The gaining of freedom of the Thai masses, the free trade opportunity opened to the West and the improved transportation facilities resulted in the tremendous expansion of rice cultivation and phenomenal growth of rice exports.

the major economic change in Thailand since 1855. To be sure, some rice was being exported prior to the Bowring Treaty, but the fact that such exports did exist does not detract from the importance to Thailand of the growth of rice exports since then.[4]

The writer has not been able to identify the variety of rice or changes in varieties in the period 1850-1920. It appears that rice has been cultivated for many years, and that farmer selection had provided a high quality, desirable rice in this earlier period. It is said that Thai rice has long enjoyed a good reputation for its quality throughout the world. This achievement can be attributed to the careful selection and preservation of good quality seed and thorough attention given to its cultivation.

Scientific selection and purification of seeds were commenced by the Government after World War I. As a result, some standard varieties were later established. Among them, and selected from the native varieties, is Pin Kaeow, which was regarded as the most desirable in quality and grain type. It won the first prize at the World Seed and Grain Exhibition

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[4]JamesC. Ingram, Economic Change in Thailand Since 1850 (Stanford: Stanford University Press, 1955), p. 37-40.

held in Regina, Canada in 1933.[5] The present breeding program still emphasizes the high standard of quality and grain size, together with yield and resistance to diseases in making recommendation of a new variety.

The recent development in rice production began in the early 1950's, prior to the establishment of a new Rice Department under the Ministry of Agriculture in 1954. This new Department has the sole purpose of handling rice production, including the technical responsibility of the various phases of rice production such as mechanization, fertilization, pest and disease control, irrigation and breeding.

The Rice Department, among other things, is exploring the application of small, cheap motors to help power farm implements in various phases of rice farming, i.e., pumping of water, plowing, harrowing, harvesting, transporting, threshing, etc. One program, to design useful farm machinery and implements, capable of being sold at a low cost, was completed in a period of three years. After having been tested and proved under actual field conditions, they have been found so satisfactory by farmers that the demand for these

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[5]Agriculture in Thailand, Op. Cit., p. 10-11.

efficient and low cost tractors or power units is so great as to make commercial operation feasible. The government has given the rights to East Asiatic Company Ltd. to produce the "Iron Buffaloes" for further distribution to the farmers.

Fertilization experiments with rice have been conducted during the past thirty years, but were mostly of an exploratory nature. Since 1950, better designed and planned experiments on fertilizers began on a large, nationwide scale and more and more accurate information on application of fertilizers in various parts of the Kingdom is available. Fertilizer field demonstrations have been set up to encourage the farmers to use fertilizers. The average yield increases, grouped by regions, were found to be substantial. Recently, the Thai farmers are using more and more chemical fertilizers leading to a remarkable increase in fertilizer imports by private dealers.

Rice pest and disease control are underway. Presently, most of the control and preventive work is undertaken by the government free of charge. But, with a limited number of trained men and the amount of funds available, only a small fraction of the total area is benefited. In 1962, a United Nation Special Fund project lasting 5 years for a Rice Protection Center was inaugurated and Thailand looks forward to an active and effective rice pest and disease control program

in the future.[6] The plans are accomplished as of 1967, but the evluation results are not available. The government continues to move forward with the encouragement of private enterprise to come in.

The early history since rice crop in Thailand has had to rely on rainfall which is periodic and uncertain. The Thai government realizing this problem has made large investments in developing an irrigation system for the country in the best possible manner. The recently completed Chow Phya River Project will benefit a wide area of the Central Plain Region. This and other projects which will be completed are expected to bring much wealth and prosperity to Thailand in the near future.[7]

I-C: Purpose of the Study

Since 1961, the government of Thailand has been making strong efforts to bring about rapid economic growth in Thailand.[8]

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[6]Ministry of Agriculture, Periodical Report of The Government of Thailand 1960-1962, (Bangkok: Ministry of Agriculture, 1964), p. 21-24.

[7]Agriculture in Thailand, Op. Cit., p. 12-13.

[8]National Economic Development Board, The National Economic Development Plan, 1961-1966, (Bangkok: Government of Thailand, 1964), p. 17.

In as much as the majority of the people are engaged in agriculture, great efforts have been directed to agricultural development, with a view to increasing the income of the Thai farmers. Continued technical advance must be part of this progress. But such developments are mixed blessings, since some farmers and consumers gain while others lose as new techniques are applied.

In this study, we wish to examine the possible impact of a technological change such as IR-8, a new high yielding rice variety, upon various parts of the Thai economy. The projection of production, exports and income changes with a major new variety are done mostly be estimation since data are limited and inaccurate. Thus, this study is more an attempt to apply a method of analysis which could be revised with more realistic data and become a potential guide to policy makers; it is not a prediction.

I-D: Procedure in Making Projection

The projection of output will be based on three different rates of adoption on three different types of farmers, namely, the commercial farms, the intermediate farms and the subsistence farms, varying in the size of their holding. The progressive commercial farmers will adopt sooner and increase their rate of adoption more rapidly up to 90 percent

of the total area holding, as they recognize the net increase in return from the new variety. The intermediate and subsistence farmers will adopt at a slow rate. These rates of adoption are applied annually to 1975 to the rice area cultivated by each type of farmer to obtain a total area sown to the new varieties.

This area in new varieties and with increased fertilizer is multiplied by a yield increase drawn from some experimental data, taking a conservative figure. This procedure provides an aggregate increase in production.

Next, the domestic and foreign market is examined to furnish a basis for a price estimate. Both population increase and income improvement are considered. The analysis is divided into two alternatives. First, Thailand is considered as the primary and major innovator so as to calculate the effects of an unique innovation. Second, other countries of South and Southeast Asia are included so as to identify the effects of a general technological change. As it turns out a surplus situation develops late in the period, so some attention has to be given to possible international export policies, their consequence for prices, and the domestic counterparts to such an international agreement.

The various price changes and the technical changes that accompany the new varieties have effects upon the

costs and returns of the various types of farmers, and these will be identified. Similarly the flows of income change created by the new varieties will have macro-economic effects. We give attention to some of the more important of these effects also, including exchange earnings, the demand for marketing services, the revenue to the Government and the multiplier and economic development effects.

Finally, we examine the per farmer income implication of these changes according to various categories.

II.

ADOPTION OF NEW TECHNOLOGICAL KNOWLEDGE

II-A. Origin of IR-8

The Ford Foundation, which had been operating for some time in India, Burma and Indonesia, among other places, was convinced by experience there that research designed to improve rice production was indispensible to the region. In 1955-1956, the representatives Richard Bradfield of Cornell University and Robert F. Chandler, Jr., of the Ford Foundation staff were assigned to the Far East to make a thorough study of the situation.

After this survey the Ford Foundation expressed a willingness to collaborate with the Rockefeller Foundation in rice variety and production practice research. One outcome was the establishment of the International Rice Research Institute at the site of the College of Agriculture of the University of the Philippines, at Los Banos. The Philippine Government donated the necessary land, the Ford Foundation agreed to supply funds for capital construction, and the Rockefeller Foundation assumed responsibility for operating expenses and for providing key scientists to organize and direct the scientific program under the control of an international board of trustees. The new Institute, now widely known by its initials, IRRI, opened its doors early in 1962.[9]

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[9]Stakman, E. C., et. al., Campaigns Against Hunger. (Massachusetts: The Belknap Press of Harvard University Press, 1967), pp. 290-294.

The staff of IRRI is composed of international scientists from Japan, Taiwan, United States, Australia, Ceylon, India and Philippines. A primary objective of the Institute is to conduct basic and applied research on the rice plant, directed toward improving its productivity and quality.[10] The research was done in various aspects like plant physiology, plant breeding, soil, etc. The rice breeding program shows promise of developing many high-yielding, nitrogen-responding varieties that are short, stiff-strawed and early maturing. One such variety was named IR-8-288-3 in short IR-8.

Since the report cited above was written, this rice IR-8 has been tested under a variety of conditions in S.E. Asia and is considered to have high promise. In fact, by 1968, it had virtually doubled rice production in the Philippines, making that nation self sufficient rather than importers. Other varieties, with similar characteristics, have been and are being developed, and it seems clear that the rice plant can be realized to be better adapted to any particular ecological environment. The various varieties so far developed have characteristics in yield and fertilizer response similar to IR-8.

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[10] Ibid., pp. 294-297.

II-B. Production Per Hectare

The variety, IR-8 to provide high yields, requires greater amounts of imputs especially fertilizer. Weed control also becomes more important. Under favorable conditions, rice production ranges from 6 to 10 tons of rough rice per hectare. The results of experiments in Thailand are not known to the writer, but the experiments conducted at IRRI showed that the yields obtained with 60 kg. of N applied per hectare were 6 to 10 metric tons of rough rice per hectare.[11]

The yield of the old varieties in Thailand, presented in Table II.1, show that in 1955, average yield was 218 kg. per rai and have increased since 1960 from 222 kg. per rai to 257 kg/rai in 1964. This figure is very low when compared with the minimum yield of IR-8 which was 960 kg per rai (6 ton/ha). One can see that with the new variety the yield could increase three or four fold compared with the older existing varieties.

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[11]DeDatta, S. K. et. al. Nitrogen Response and Yield Potential of Some Rice Varietal Types in The Tropics, International Rice Commission Newsletter (Vol. XV, No. 3, September, 1966), p. 20.

Table 2.1. Total Rice Areas and Production in Thailand 1955-1964

Year	Cultivated Area (1,000 rai)	Harvested Area (1,000 rai)	Paddy Production (1,000 tons)	Average Yield (per rai)
1955	36,060	33,598	7,334	218
1956	37,648	36,013	8,297	230
1957	31,717	26,794	5,570	208
1958	35,987	32,306	7,053	218
1959	37,909	32,893	6,770	206
1960	37,008	35,270	7,835	222
1961	38,619	35,349	8,177	231
1962	41,617	38,696	9,279	240
1963	41,277	39,917	10,168	255
1964	40,890	37,367	9,640	257

Source: Ministry of Agriculture, Agricultural Statistics, various issues.

II-C. IR-8 and Other Modern Varieties vs. Traditional Varieties

The modern rice varieties have a characteristic of high response to fertilizer without lodging, resistance to diseases, high yielding and non-photoperiodical. Among these modern varieties, IR-8 is typical. It is the result of crossing Peta and Dgwg. Peta was a tall, vigorous, vegetative variety that usually lodges badly during the rainy season when adequately fertilized. The other parent, Dgwg is a short stiff-strawed indica from Taiwan. The resulting cross had the short, stiff-straw of Dgwg and much of the vigor of Peta, with medium size grain. This variety can absorb up to 150 kg/ha of nitrogen fertilizer without any lodging, is non-photoperiod which can photosynthesize for the productive part in any length of daylight. The cooking quality is not as good as traditional varieties and cannot command high prices in Thailand.

The investigation on the development of improved rice varieties are underway in 18 rice experiment stations in Thailand. The purpose of this research is to find out which new rice varieties contain desirable characteristics. The selection is done by hybridization of modern varieties having different desirable characteristics. There are several hybrid varieties under selection and trial. The

result of well adapted varieties will be submitted to the varietal committee for approval and the successful ones released as recommended varieties.

The traditional varieties are characterized by long straw, soft straw, susceptible to disease and to lodging with a small amount of nitrogen application. They are photo-periodical which require the certain length of daylight to seed, during the short daylight the photosynthesis will produce vegetative parts. The cooking quality of traditional varieties have a high reputation among neighboring countries and are well accepted by the Thai people. The yield of traditional varieties are very low compared with the modern varieties, which can increase production by three to four fold with a reasonable amount of fertilizer.

II-D. Fertilization in Relation to Deep Water and Implication for the New Variety

The government policy is trying to encourage farmers to use more fertilizer in order to increase yield. With the traditional varieties the increased use of fertilizer will not give a good return. As stated before, the plant will produce vegetative parts more rapidly and result in a high percentage of lodging. Also the straw is soft, easily attacked by pests and diseases.

The country may be divided roughly into four main regions, namely, the Northern, the Northeastern, the Central Plain and the Southern. The rice area varies in the different regions. In the Northern region, the rice area contains 6 percent of the total rice acreage of Thailand. In the Northeastern Region, it contains 43 percent of the total acreage. In this region, most of the area is upland with tube well irrigation in some parts. The Central Region, often called the Bangkok Plain, is the "Rice Bowl" of the country. It contains 44 percent of the total acreage. The Southern Region contains 7 percent of the total acreage. Some areas depend upon the monsoon but most of the land in Central and Northern Regions is irrigated by Chao Phya Projects, allowing the farmers to plant rice any time of the year.[12]

Approximately 90 percent of the commercial farms are located in Central Plain, with only 10 percent scattered in other regions. About 40 to 50 percent of the intermediate farms are located in the Central Plain. Most subsistence farms are located in the Northeastern Region.

During the rainy season, heavy rain will fall in September and October. In some parts of the country, the

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[12]Agriculture in Thailand, Op. Cit., pp. 1-4.

rice lands are cultivated under rainfed conditions and physical conditions which do not permit the water to be drained out during the heavy rain. The short stem rice cannot be grown in these areas. This constitutes approximately 24-35 percent of the total rice acreage. The other areas with irrigation, allow the farmers to grow rice all year round and the irrigation canals can drain the water out during heavy rains, maintaining an assured depth of water. The modern varieties including IR-8, IR-5, IR-9, etc., which have short stems can be grown in these areas.

The new varieties and fertilization have to go together. Increased use of fertilizer without adopting a new variety cannot markedly increase yield, or adoption of the new varieties without fertilizer results in the same thing. The Thai Government realizes these problems and is trying to find new varieties which will be suitable for Thailand conditions, with high yielding, non-photoperiod, resistance to diseases, good cooking and milling quality in order to encourage the change. In this study IR-8 variety will be used to represent the modern rice varieties as the basis for analysis of their impact on farmers' income and the economy of Thailand.

II-E. Motivating Rice Farmers to Adopt Change

The diffusion of a new idea can be a long process. The diffusion process differs from the adoption process, since the latter deals with the adoption of a new idea by one individual while the diffusion process deals with the spread of new ideas in a social system. Rogers states that the adoption period is the length of time required for an individual to pass through the adoption process from awareness to adoption,[13] in other words, the adoption period is the trial period.

In Thailand, the rice farms in large numbers are scattered over the whole kingdom. The diffusion of the new idea usually is slow, but it is possible that such a change as the IR-8 with a four-fold increase in yield would be very attractive since this means that the income of those who adopt will increase rapidly. It has a very profitable incentive to the farmers. Still, different groups of farmers will adopt at different rates due to the knowledge about the new variety and the package practices required for the new variety.

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[13]Everette M. Rogers, Diffusion of Innovations. (New York: The Free Press of Glencoe, 1964), pp. 12-19.

The rate of adoption will depend greatly upon the ability of the agricultural extension system in introducing the new idea to the farmers, and encouraging them to adopt the new variety. Once they recognize the profitable harvest of this variety, they will extend the idea to other farmers.

Seeing is believing, but this new variety requires improved package practices to go along with it, if the full potential of these new varieties is to be obtained. Without such practices, the yield increase will not be very attractive. Thus, the demonstration in planting and operation in the use of fertilizers, insecticide and irrigation practice is a necessary means of increasing the rate of adoption.

II-F. Assumption As To Rate of Adoption of IR-8 and Projected Increase in Rice Production

The new rice variety, IR-8 was introduced to Thailand in 1966 for experimental purposes. We assume that for 1967 the experiments were continued, but that no seeds were available for distribution, except for multiplication purposes; thus 1967 can serve as a base year for comparison. By 1970, multiplication should have proceded so that sufficient seed is available for all who want to use it, but limited seed and limited information may prevent full participation in 1968 and 1969. The assumed rates of adoption are within these limits.

The size of farms and the area per farm planted to rice ranges widely. In this projection it is assumed that large producers will be more informed and more innovative than those with medium areas and these in turn are more innovative than the subsistence farmers. While such classifications and attitudes overlap, we have divided the farms into three groups, on the basis of size, and applied different rate of adoption to each. This also provides an opportunity to demonstrate some of the potential impact on the distribution of farm income.

The large "commercial" farmer ranges from 60 rai to over 140 rai; the intermediate farms ranges from 30 to 60 rai, while the subsistence farmer has less than 30 rai. The statistics also report the amount of land on which rice was planted and the amount harvested (See Table 2.2). As a first approximation, the assumption is made that this area is constant by size groups, and the estimated rate of adoption is applied.

Adoption of new technology follows a typical lazy (⌒) sloped curve; thus a low rate of adoption in the early years and higher rates in later years. Also the maximum rate of adoption is limited by the existence of deep water irrigation, not suitable to short stemmed varieties. Very probably some farmers will use IR-8 alone or with very limited amounts

Table 2.2 Number of Holdings, Area and Production of Rice by Size of Holdings in Thailand, 1965

Size of Holding Rai	Number of Holding	Planted Area Rai	Harvested Area Rai	Production (ton)	Yield per Rai of Harvested Area kg.
2 - 5.9	318,194	1,056,635	976,035	473,906	384.1
6 - 14.9	823,289	6,130,703	5,526,670	1,749,114	316.5
15 - 29.9	792,430	12,162,640	10,519,901	2,895,986	250.2
30 - 44.9	386,754	9,786,692	8,260,894	1,895,986	229.5
45 - 59.9	175,441	6,006,237	5,021,123	1,111,783	221.4
60 - 139.9	147,019	7,531,879	6,277,093	1,362,437	277.0
140	7,678	786,495	646,706	726,362	195.4
TOTAL	2,650,805	43,461,281	37,228,362	9,252,696	248.5

Source: Statistical Yearbook of Thailand, National Statistical Office, Bangkok, Thailand, 1965, p. 177.

of fertilizer, but will learn that fertilizer is required. Thus the rate of adoption presented in Table 2.3 are for an IR-8 type rice and fertilizer. The actual use of improved varieties will be somewhat higher, but for some farmers, the yields will be only a little above standard varieties. The total acreage planted to IR-8 type rice is tabulated by applying these rates of adoption and adding the group.

The yield increase appropriate for adopting farmers depends upon a package of inputs. To be conservative, a yield in the lower range of yield increases has been selected. This figure is 960 kg. per rai. The increase in rice production will not be significant in the early years, because only a small area is affected. By 1971 the yield increase becomes significant and will be doubled by the year 1975 (See Table 2.4). We turn next to the significance of these increases.

Table 2.3. Assumed Rate of Adoption and Planted Area for IR-8 - 1967-1975

Year	Commercial Farms Number of holdings = 154,697		Intermediate Farms Number of holdings = 562,195		Subsistence Farms Number of holdings = 1,933,913		Total Planted Area Adopted to IR-8 (Rai million)
	Adoption Rate %	Planted Area IR-8 (Rai) Million	Adoption Rate %	Planted Area IR-8 (Rai) Million	Adoption Rate %	Planted Area IR-8 (Rai) Million	
1967*	0	8.3	0	15.8	0	19.4	-
1968	0.5	.042	0	-		-	.042
1969	1	.083	0.5	.079	0	-	.162
1970	4	.332	1	.16	0.3	.058	.55
1971	20	1.66	3	.48	1	.79	2.33
1972	55	4.57	8	1.28	2	.38	6.23
1973	80	6.64	12	1.92	5	.95	9.51
1974	85	7.06	25	4.00	10	1.9	72.96
1975	90	7.47	40	6.4	16	3.04	16.91

Note:* In 1967, all planted area are current variety, used as a base for stimulating the area on which IR-8 type rice is adopted, subsequently.

Table 2.4 Projected Increase in Rice Production as a Result of IR-8 - 1967-1975*

Year	Current Variety			IR-8			Production Increase	
	Planted Area (million Rai)	Average Yield (kg/rai)	Production million ton	Area Planted to IR-8 (million Rai)	Average Yield (kg/rai)	Production million ton	Total Production Million ton	Index of Production (1967 = 100)
1967	43.5	249	10.83	-	960	-	10.83	100
1968	43.46	249	10.82	.042	960	.04	10.86	100.2
1969	43.34	249	10.79	.16	960	.15	10.94	101
1970	42.95	249	10.69	.55	960	.53	11.22	104
1971	41.17	249	10.25	2.33	960	2.24	12.49	115.3
1972	37.27	249	9.28	6.23	960	5.98	15.26	140.9
1973	33.99	249	8.46	9.51	960	9.13	17.59	162.4
1974	30.54	249	7.60	12.96	960	12.44	20.04	185
1975	26.59	249	6.62	16.91	960	16.23	22.85	211

Note:* Since some farmers are not practicing the package very well, this prevents the attainment of the full yield potential of IR-8 type rice. I will assume that the average yield is the lowest yield obtained from the experimental plots which is equal to 960 kg/rai (6000 kg/ha).

III.

RICE MARKETING AND PRICES

The main purchasers of paddy are paddy merchants, retailers, money lenders and rice millers. Paddy trading in Thailand is almost completely free of government regulation. A supplier is free to sell his paddy to any one he chooses depending on whom will give him the highest price. Theoretically, with free trading in competitive markets, the price received by the suppliers should be the same no matter to whom he sells his product. We begin his analysis with the assumptions of perfect competition in the domestic market, but will modify it later.

III-A. Available for Export

Asian people prefer rice as a prevailing food, so their governments have a policy of trying to maintain sufficient supplies of rice for domestic consumption. This means that when output in the exporting Asian countries is lower than the normal level, they reduce the export quotas which tends to drive up the world prices. When output in the importing countries is lower than the normal level, they increase the quantity of their import demand, subject to their balance of payment constraints. This again tends to drive up the world prices.

If, as an effect of a new variety, production increases, this will result in increaded export quotas and if the quotas increase significantly in the world market, the price will fall. Generally, the analysis will be based on two cases. In the first case, Thailand is the only innovating country, as her exports increase the price will decline in accordance with the elasticity of demand in the world market, but all other countries maintain the same import-export pattern. That is, Thailand exports all of the increased production not used at home. Population increase and some drop in prices are also considered domestically.

III-B. Foreign Elasticity of Demand

The average elasticity of foreign demand for Thai rice has been computed by Dr. Ramakomud as -3.5[14] this means that the marginal revenue would be positive because the term $1 + \frac{1}{e}$ will be positive and the total revenue from the export of rice will be rising as the price of rice declines.

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[14]Ramakomud, S. Thailand's Foreign Trade: Structure and Policies, 1951-1960. Doctoral Dissertation, Indiana University, p. 58.

III-C. Assumption of the World and Domestic Rice Price

The world rice prices from 1956 to 1963 did not change very much (See Table 3.1). We begin with the assumption that in 1967, the world price of rice will be $138 per tone of milled rice. The price of domestic paddy moves up or down depending upon the world rice prices; it is assumed that the domestic paddy price was $74 per ton in 1967, the lower price reflecting the differences in export costs, government taxes, transport costs, difference between paddy and milled rice, etc.

III-D. Domestic Demand For Rice

The Thai diet depends heavily upon rice in all parts of the country and for all classes of people. The per capita consumption of rural people is about one-third higher than the per capita consumption of the urban people because some of the urban people have acquired and can afford some western food habits. They consume more meat and vegetable products. The Department of Rice estimated the annual per capita consumption of rice and reported that the average per capita consumption of rice for Thai people was 189 kilograms of paddy.[15]

The domestic consumption of rice will increase as the population increases. Dr. Kulthongkham indicated in his study that the rate of increase in consumption will be at the same

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[15]Department of Rice, Ministry of Agriculture, 1954.

Table 3.1. Comparison of export and domestic prices and paddy 1956-63 ($/ton 5% broken white rice)

Year	World Rice Prices[1]	Rice Export Taxes[2]	Exporters' Receipts[3]	Domestic Retail Rice Price[4] x (0.65)	Domestic Paddy Price[5]
1956	133.7	42.3	91.4	92.8	74.9
1957	137.1	44.0	93.1	92.1	71.2
1958	145.7	44.6	101.1	98.8	75.1
1959	130.0	44.6	85.4	83.6	68.8
1960	122.9	42.5	84.0	82.1	65.2
1961	135.0	42.5	92.5	92.6	73.5
1962	153.0	45.3	107.7	105.7	84.7
1963	144.5	45.3	99.2	94.8	75.3
Average	137.7	43.9	94.3	92.8	73.6

Source: [1]FAO, Production Yearbooks and Trade Yearbooks, Various issues.
[2]FAO, Rice Report No. 12, August 1961, p. 34.
[3]Column 1 - Column 2
[4&5]Chaiyong, Chuchart Sopin Tongpan, The Determination and Analysis of Policies to Support and Stabilize Agricultural Prices and Income of the Thai Farmers. Bangkok, Thailand, 1965, Statistical Appendix.

NOTE: 1.54 tons of paddy equals 1 ton of rice at the conversion rate of 0.65.

rate as increase in population.[16] Income and urbanization will affect the demand for rice. According to the same source, the income elasticity of demand is fairly inelastic.[17] Thus, an increase or decrease in consumer income would not result in an appreciable change in the demand for rice. One effect of new migration to urban area is that participants will learn to change food habits, shifting away from the high rice consumption of rural people but at a slow rate. While the increase in income will increase the demand for rice, the increasing urbanization will decrease the demand. These two effects are partially offsetting, we assume an increase in consumption of one percent per year, approximately two kg. per year, per capita. The total domestic consumption is tabulated in Table 3.2. The consumption will not keep on rising as the income increases. After 1975 one would have to look again at the extrapolation of rice demand increases; some demand will shift to wheat, vegetables, meat, etc. The surplus left over will be exported.

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[16] Kulthongkham, op. cit., p. 17.

[17] Ibid., p. 61.

Table 3.2. Estimated Domestic rice consumption in Thailand, 1964-1975.

Year	Per Capita Paddy Consumption (kg) (a)	Population Increase (b)	Total Consumption or Domestic Demand (Mil. ton)
	(1)	(2)	
1964	189	29.7	5.6
1965	191	30.59	5.84
1966	193	31.51	6.08
1967	195	32.46	6.33
1968	197	33.43	6.59
1969	199	34.43	6.85
1970	201	35.46	7.13
1971	203	36.52	7.41
1972	205	37.61	7.71
1973	207	38.73	8.02
1974	209	39.89	8.34
1975	211	41.08	8.67

Source: (1) Department of Rice, Ministry of Agriculture, 1954.

(2) National Statistical Office, Quarterly Bulletin of Statistics, Vol. XII, No. 3, 1964, p. 4.

NOTE: (a) Add two kg. per year as the effect of income increases.

(b) Compound rate of population increase at 3% per year.

III-E. Estimated Export Quantity and Prices

The amount of rice is estimated for export from 1967 to 1975 (see Table 3.3). In the early years of adoption, no extra rice export appear and the quantity of exports actually decreases in 1968, 1969 and 1970, actually a continuation of recent trends due to the fact that consumption increases more rapidly than production. The export volume increases at a significant rate in 1971 and will double by 1973.

In 1966, the total world import of rice was 7.3 million tons and the trend from 1962 shows that it was increasing at an average of 300,000 tons per year.[18] Thailand exported 2.25 million tons in 1967, this was about one-third of the total world exports. Examining quantities in relation to price elasticity, there appears to be little change in the world price of rice for 1967 to 1971 due solely to Thailand's changes in exports.[19]

Already in 1967, the effect of the adoption of IR-8 can been seen in an expanded production of rice in the Philippines, East Pakistan and India. Without this change in varieties and consequent increases in production, the decrease in Thai

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[18] U.S.D.A., Rice Situation (January 1968), p.27.

[19] I know this is not realistic, we can revise this on the basis of data on world demand and supply.

Table 3.3. Estimate on the net amount of rice available for export in Thailand, 1967-1975

Year	Paddy Production Million ton	Domestic Demand Million ton	Waste and Other Use Million ton	Available for Export (Paddy) Million ton	Available for Export in Term of Milled Rice Million ton
1967	10.83	6.33	1.08	3.42	2.22
1968	10.86	6.59	1.09	3.18	2.07
1969	10.94	6.85	1.09	3.00	1.95
1970	11.22	7.13	1.12	2.97	1.93
1971	12.49	7.41	1.25	3.83	2.49
1972	15.26	7.71	1.53	6.02	3.97
1973	17.59	8.02	1.76	7.81	5.08
1974	20.04	8.34	2.0	9.70	6.31
1975	22.05	8.67	2.21	11.08	7.20

NOTE: Waste and other use compose of the area destroyed by flood or insect in other words the planted area which lost from harvesting and other use include planting seeds for feed etc. Assuming to be 70% of total production.

exports 1968 to 1970 and the increase in population would require an annual increase in exports from other countries of at least 300,000 tons per year plus the 150 to 290 thousand ton deficiency in Thai exports. To simplify the analysis, and to take account of the somewhat more rapid rate of innovation in some rice producing countries, it is assumed that the increase in demand for rice in other countries is offset by a slow rate of adoption of IR-8 or similar modern varieties.

In 1977 and thereafter, the price will decline as the supply for the world market increases (see Table 3.4). The prices are calculated by applying the concept of price elasticity of demand.

$$\frac{\% \text{ change in quantity}}{\% \text{ change in price}} = -3.5$$

$$\therefore \frac{\Delta Q}{\Delta P} \times \frac{P}{Q} = -3.5$$

This means that if the supply increase the world price will decrease by a lower percentage than the supply. The calculated price as the supply increases or decreases in the world market are presented in Table 3.4. The effects of these changes will be examined for Thai economy.

Table 3.4. Estimated extra exports from Thailand and prices 1967-1975 (Milled rice)

Year	Extra exports from Thailand (1,000 tons)	Calculated Price (Ton)
1967	0	138 (1)
1968	-150	138
1969	-270	139.50
1970	-290	139.50
1971	+270	136.50
1972	+1,690	129
1973	+2,860	122.30
1974	+4,090	116
1975	+4,980	111

NOTE: (1) Actual price.

III-F. Estimated Price Changes on Second Case

The second case, assumed that the other Asian countries also innovate rapidly. Production will continue to increase as they increase the rate of adoption. Import countries will become self-sufficient and may have a surplus for export, while the export countries have even more surplus for export. Without new markets and new demand, this will create a surplus problem and the price will drop drastically. As this surplus situation and price decline occurs the rice exporting countries of 1970-1972 will be pressured by economic and political events to intervene in the market, and will also recognize that some action must be taken to control supply. To carry through this analysis, it is assumed that no effective government actions are possible until rice prices have dropped to two-thirds of their previous level, i.e., 67 percent. The kind of control, whether acreage, fertilizer, export quota allocation or other, will be discussed later as the impact on farmers is considered.

III-G. Assumed Total Rice Increase for All Asian Countries

Since the data on the production of Asian countries in 1967 are not available and the trend of production from 1963 has not changed very much, it is assumed that the production to 1967 will be the same as in 1966,[20] except that the change

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[20]U.S.D.A., Ibid., p. 29.

in population and demand from 1966 to 1967 is met by internal production increase. It is also assumed that the subsequent rate of production increase is the same as Thailand. The Asian countries included are Burma, Cambodia, Taiwan, India, Indonesia, Pakistan, Philippines and South Vietnam.[21] India, Indonesia and Philippines were importers, all others are exporters. The aggregate volume from these export countries was greater than the import countries by .4 million tons.

The population increase will increase consumption. The average increase in the population of Asian countries was 2.5 percent per year. It is assumed that the consumption of rice will increase at the same rate as population, plus the adjustment for income increases. The expansion of urbanization and increase in income will result in a net increase in the consumption, and these effects are assumed to be 1.5 percent per year. Because some of the major countries, such as India, have a higher income elasticity than Thailand. Thus the total increase in domestic consumption will be 4 percent per year. The results of calculation are presented in Table 3.5.

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[21]For South Vietnam, there was no data in 1966, it is assumed that the level of production and export will be the same as in 1964.

Table 3.5. Assumed production and consumption of rice for Asian countries 1967-1975 (Paddy)

Year	Production (Mil. ton)	Consumption (Mil. ton)	Extra Exports From Asian Countries (Mil. ton)
1967	100	100.4	-.4
1968	100.2	104	-4.2
1969	101	108	-7
1970	104	112.3	-8.3
1971	115.3	116.8	-1.5
1972	140.9	121.5	+19.4
1973	162.4	126.4	+36
1974	185	131.4	+53.6
1975	211	136.7	+74.3

Source: Calculated from the data in Rice Situation, January, 1968, p. 27.

Asian countries include: Burma, Cambodia, Taiwan, India, Indonesia, Pakistan, Philippines and South Vietnam.

III-H. Projection of Supply and Price Changes

The internal demand increased more rapidly than the increase in production until 1972 as shown in Table 3.5. The projection of demand for rice is greater than that of supply and causes the price of rice to rise from 1967 to 1971.

In 1972, as the adoption rate increases, there is more surplus. The importing countries in Asia become self-sufficient with a surplus for export and the export countries have even more surplus for export. These effects will increase the production to a doubling by 1975.

Extra exports from South and Southeast Asia appear in 1972 and increase rapidly thereafter (see Table 3.6). The price calculated in the last column is higher than that shown in Table 3.4 because in case two, we are considering population and income increases in all Asian countries and not just for Thailand alone. The projected world price decreases in 1971 and 1972 as domestic production more fully meets domestic demand. The price estimate for 1972 assumes that the producing nations do not yet recognize the very critical over supply situation and absorb part of the production (one-half of the export increase) in inventory build up. By 1973, additional supply pressure pushes the price to 67 percent of the 1967 level, where it is maintained by intergovernmental intervention.

Table 3.6. Estimated extra exports from all Asian countries and world price, 1967-1975 (Milled Rice)

Year	Extra Exports from South and Southeast Asia Country (1,000 tons)	Calculated Price ($)
1967	-.3	138
1968	-2.9	154
1969	-4.7	163
1970	-5.6	168
1971	-.8	142
1972	+13.8	115
1973	+25.26	92
1974	+37.5	92
1975	+57.53	92

IV.

THE EFFECTS OF IR-8 ON FARM COSTS AND RETURNS (UNDER ASSUMPTIONS OF ALTERNATIVE ONE)

IV-A. Production Costs of Traditional Varieties

The cost of producing rice includes the rent of lands and various operating expenses such as family labor, hired labor, seeds, insecticides and fertilizers. According to a recent study done by National Economic Development Board, the average costs of producing one ton of rice includes:[22]

Rent	$16.5
Hired labor	$ 5.5
Family labor	$73
Animal and machinery power	$ 7
Fertilizers	$ 7.3
Insecticides	$ 0.2
Seeds	$ 2
Interest and other expenses	$ 3.5
Total	$49

[22]National Economic Development Board, Cost of Paddy Production (Bangkok: National Economic Development Board, 1967), pp. 40-59.

At the average yield of 249 kg. per rai., the cost of production per rai was $10.70. In addition, there are costs for harvesting and threshing for the traditional varieties.[23] The marketing margin, which includes the services of paddy merchants and retail merchants, was reported by Dr. Udhis as averaging 28 percent of the consumers price; thus the average farm price will be 72 percent.[24] At average yields, the marketing cost at the base price level is $8.32 per rai, and the estimated gross farm return is $22.20.

IV-B. Added Costs of Producing New Variety

The new variety requires higher costs of production. The added cost includes the cost of seeds, an increase in fertilizer used, and more labor and machinery during harvesting and threshing. Other costs are assumed to be the same. For example, the insecticide used for the traditional variety is sufficient to

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[23] It is necessary to convert these figures to rai., so as to apply such changes to each rai and aggregate them.

[24] Narksawasdi, Udhis, Agricultural Indebtedness and Trade, (Bangkok: Ministry of Agriculture, second edition, 1964), p. 330.

control the rice disease of the new variety and the cost of weeding are also the same.

The price of the traditional variety seed per rai was $0.50, as farmers kept part of their harvest for the next year's plantings, but for the new variety, they have to buy seeds from dealers which will include the profit and transportation costs. It is assumed that the cost of new variety seeds will increase by 50 percent more than the traditional variety, that is by $0.25.

The average fertilizer costs reported by a TVA survey in Thailand was $0.13 per kg.[25] The added cost of fertilizer is $7.30 per rai.

The harvesting and threshing cost will increase, as production increases. The family labor cannot do all the work, so farmers have to hire more labor and use more machinery and animal power. However, the same amount of land will be covered and about the same amount of straw handled. This will reduce the per ton cost of harvesting and threshing for these items. Thus, it is assumed that the harvesting and threshing cost for one ton of rice included:

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[25]TVA, A Report on the Thailand Fertilizer Situation and Potential, (Bangkok: U.S.A.I.D., 1966), p. 147.

Family labor	$4.80
Animal and machinery power	$1.40
Hired labor	$2.70
Total	$8.90

For the additional rice production of 711 kg. the added cost of $6.30.

We also assume that the marketing margin for rice expressed in money, does not change as the price decreases, so the farm price will decline. If the retail price increases, the marketing margin will also increase at the same proportion. It is assumed that the marketing service costs at the base price level is $14.70 per rai.

The total added cost with the new variety os $22.55 per rai. The increase in income from additional rice production also needs to be calculated, and the impact on the income of three different types of farmers analyzed. These calculations are summarized in Table 4.1 to 4.6.

IV-C. The Impact of Farmer's Income

The change in net income for commercial farmers is highest (see Table 4.2), it is next for the intermediate farmers (see Table 4.3) and lowest for the subsistence farmers (see Table 4.4). For those of these three types of farmers who did not adapt the new variety; the income change will become

negative in 1971 to 1975. For subsistence farmers it will decrease by $60.5 million in 1975 (see Table 4.5).

The flow of income to innovators is greater than to non-innovators for each of the three sizes of farms, as shown in Table 4.6, over the eight years the early innovators have substantial gains compared with the non-innovators or the late innovators. Since the commercial and intermediate farmers are assumed to be early innovators, their gains may be compared to the subsistence farmers - mostly late innovators - or to non-innovators in the same size group. During the early years they benefit in two ways, from higher prices associated with rising populations, and from innovation. But even in the later years, the benefits of innovation outweigh the decline in the price as Thailand's increased exports press upon the world market. Non-innovators gain a little to 1970 from price and population increases, but lose from that time on.

The impact on net increase in income for three different sizes of farmers, innovator and non-innovator together show that the commercial and intermediate farmers received additional income. The subsistence farmers began to lose from 1972 as the price falls (see Table 4.7).

Table 4.1. Effect of price change on farmers adopting IR-8, 1967-1975

Year	Price per Ton of Paddy ($)	Additional Increase per rai ($)	Increase or Decrease per rai on Present Production ($)
1967	74	52.60	-
1968	74	52.60	-
1969	74.70	53.70	+0.17
1970	74.70	53.70	+0.17
1971	73.30	52.10	-0.17
1972	69	49.10	-1.20
1973	66	46.90	-1.90
1974	62	44.10	-3
1975	59	42	-3.70

Table 4.2. The impact on commercial farmers' income with IR-8

Year	Δ in return from new production[1] (Mil. $)	Increase or decrease in return on present production[2] (Mil. $)	Net Return (Mil. $)	Δ Costs of production (Mil. $) ($22.55/rai)	Change in net income (Mil. $)
1967	-	-	-	-	-
1968	2.2	-	2.2	0.95	1.25
1969	4.4	+.01	4.41	1.88	2.53
1970	17.6	+.06	17.66	7.54	10.12
1971	86.5	-.12	86.38	37.43	48.95
1972	224.4	-5.5	278.0	103.05	115.85
1973	311.4	-13.3	298.1	149.73	148.37
1974	311.3	-21.2	290.1	159.2	130.9
1975	313.7	-27.6	286.1	168.45	117.65

NOTE: (1) Increase in income per rai x number of rai

(2) Δ in price x .249 x number of rai.

Table 4.3. The impact on intermediate farmers' income with IR-8

Year	Δ in return from new production (Mil. $)	Increase or decrease in return on present production (Mil. $)	Net Return (Mil. $)	Δ Cost of production (Mil. $)	Change in net income (Mil. $)
1967	-	-	-	-	-
1968	-	-	-	-	-
1969	4.1	.01	4.11	1.79	2.32
1970	8.5	.03	8.53	3.63	4.90
1971	25	-.08	24.92	10.8	14.12
1972	62.8	-1.5	60.3	28.86	31.44
1973	90.1	-3.6	86.5	43.3	43.2
1974	176.4	-12	164.4	90.2	74.2
1975	268.8	-23.7	245.1	144.38	100.78

Table 4.4. The impact on subsistence farmers' income with IR-8

Year	Δ in return from new production (Mil. $)	Increase or decrease in return on present production (Mil. $)	Net Return (Mil. $)	Δ Costs of production (Mil. $)	Change in net return (Mil. $)
1967	-	-	-	-	-
1968	-	-	-	-	-
1969	-	-	-	-	-
1970	3.1	+.01	3.11	1.32	1.79
1971	9.9	-.03	9.87	4.28	5.95
1972	18.7	-.46	18.24	8.57	9.67
1973	44.6	-1.8	42.8	21.42	21.38
1974	83.8	-5.7	78.1	42.85	35.25
1975	127.7	-11.3	116.4	68.55	47.85

Table 4.5. The impact on farmers' income without IR-8

Year	Commercial Farms		Intermediate Farms		Subsistence Farms	
	Planted area (Mil. rai)	Change in net income (Mil. $)	Planted area (Mil. rai)	Change in net income (Mil. $)	Planted area (Mil. rai)	Change in net income (Mil. $)
1967	8.3	-	15.8	-	19.4	-
1968	8.26	-	15.8	-	19.4	-
1969	8.22	1.4	15.72	2.7	19.4	3.3
1970	7.97	1.3	15.64	2.7	19.34	3.3
1971	6.64	-1.1	15.32	-2.6	19.21	-3.2
1972	3.73	-4.5	14.52	-17.4	19.02	-22.8
1973	1.66	-3.2	13.88	-26.4	18.45	-35.1
1974	1.24	-3.7	11.8	-35.4	17.5	-52.5
1975	.83	-3.1	9.4	-34.8	16.36	-60.5

Table 4.6. Comparison of income changes for the innovators and the non-innovators on a per farmer basis, 1967-1975 (Case One)

Year	Commercial farmers		Intermediate farmers		Subsistence farmers	
	With IR-8 $	Without IR-8 $	With IR-8 $	Without IR-8 $	With IR-8 $	Without IR-8 $
1967	-	-	-	-	-	-
1968	1615	-	-	-	-	-
1969	1635	9	825	5	-	2
1970	1635	9	872	5	309	2
1971	1582	-9	837	-5	289	-2
1972	1362	-65	699	-34	250	-12
1973	1199	-103	640	-53	221	-19
1974	995	-159	528	-84	182	-30
1975	845	-200	448	-103	155	-37

Table 4.7. The impact on net increase or decrease per farmer, 1967-1975

Year	Net increase or decrease for commercial farms (Mil. $)	Net increase or decrease per farmer ($)	Net increase or decrease for intermediate farms (Mil. $)	Net increase or decrease per farmer ($)	Net increase or decrease for subsistence farms (Mil. $)	Net increase or decrease per farmer ($)
1967	-	-	-	-	-	-
1968	1.25	8.1	-	-	-	-
1969	3.93	25.40	5.02	8.93	3.30	1.70
1970	11.42	73.82	7.60	13.52	5.09	2.63
1971	47.85	309.31	19.15	34.06	2.39	1.24
1972	111.35	719.79	74.04	24.97	-73.13	-6.79
1973	145.17	938.42	16.80	29.88	-13.72	-7.09
1974	127.20	816.97	38.80	69.02	-17.25	-8.92
1975	114.55	740.48	66.38	118.07	-12.65	-6.54

V.

SOME MACRO-ECONOMIC EFFECTS OF IR-8 (Under The Assumption of Alternative One)

The macro-economic effect considered in this chapter involve the effects of a large flow of production, the increased demand for inputs and their effect upon the various marketing and transportation institutions. Since much of this rice is exported, the earnings of foreign exchange will be affected. And all of these increases will have their affect upon the level of G.N.P., both directly and indirectly.

V-A. The Agricultural Marketing System Transportation Services

Rice production will increase very slightly, under the conditions postulated, from 1968 to 1970, so that the existing transport facilities can handle all the production increase. By 1972, when production is expanding very rapidly, the transportation system will have to expand to handle this larger quantity of rice. The present transportation practice, using gunny bags, requires higher shipping charges. As the volume expands and the price declines in 1972, bulk transport means of rice shipment may be developed which would increase the capacity of today's transportation facilities.

Expansion of Inputs Market

The marketing services for inputs and other commodities must expand in the rural area away from Bangkok in order to supply farmers with the necessary inputs. Also as the farmers' income increases, they will usually demand more of other commodities, so that the rural distribution of inputs and consumption goods could develop hand in hand.

Marketing Services

The marketing services for rice must be developed. The existing storage bins are inadequate at present time. Nearly 80 percent are located in the Central Plain and only 20 percent in other parts of the country. Rice mills are also located in the Central Plain with a capacity of 60 percent of the total crop.[26] With the rise in production and increase in the rice export quota, the storage capacity must expand in all parts of the country to overcome the inadequate storage capacity of rice. New milling factories must be developed fast, not only to mill the export rice but also much of the rice consumed within the country as well. Decentralization of the rice mills must accompany the expansion to better serve other parts of the country instead of expanding along the Chao Phya River at the Port of Bangkok. In this general

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[26]Kulthongkham, Sawaeng, Rice Economy of Thailand, (Bangkok: Ministry of Agriculture, 1964), pp. 63-65.

expansion there will be opportunity for improved economic and financial analysis to determine the appropriate size and location of milling and storage facilities.

Overall, these increases in demand for marketing services of inputs, transportation and storage are a challenging situation. The necessity to provide facilities to keep up with the production increase, the opportunity for rising employment in all parts of the country, in the construction and operation of storage bins, handling of rice at the port etc., and expansion of milling factories will be generally stimulating to the economy.

V-B. The Net Earnings of Foreign Exchange (Considered Rice and Fertilizers)

The increase in the export quota of rice from Thailand will increase the foreign exchange earnings. But the new variety requires higher amounts of fertilizers. As the import demand for fertilizer increases, these will tend to decrease the net foreign exchange earning from rice exports (See Table 5.1).

A TVA study, on the fertilizer situation in Thailand, reported that the average C.I.F. price of fertilizers imported was $75 per ton in 1964.[27] It is assumed that this

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[27]TVA, Op. Cit., p. 47.

average C.I.F. price of fertilizer is stable up until the year 1975, even though recent technological innovations in nitrogen production are likely to result in lower prices for fertilizer relative to other industrial commodities.

In the early year of adoption, 1968 to 1970, the production increase is not sufficient for domestic consumption leading to a decline in the export quota, so there will be a net decrease in foreign exchange earning. By 1971 production increases significantly and provides greater surplus for export, which increases the foreign exchange earning from $36.86 million to $552.78 million in 1975, as presented in Table 5.1.

V-C. The Increase in G.N.P. from Increase in Rice Production

The increase in rice production will affect the increase in G.N.P. The G.N.P. of Thailand in 1966 was 92,120.7 billion baht ($4606 million) with estimated average increase of 8 percent with the per capita income of 2786.8 baht ($139.34).[28] It is assumed that in the absence of new rice varieties, the G.N.P. would increase at 8 percent up to 1975 (see Table 5.2). The marketable rice is only part of the

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[28]National Economic Development Board, National Income of Thailand (Bangkok, 1966), p. 84.

Table 5.1. Estimated net foreign exchange increase from rice, 1967-1975 (Under assumption of alternative 1)

Year	Increase in foreign exchange earning (Mil. $)	Increase fertilizer expenses (Mil. $)	Net increase or decrease in foreign exchange earning (Mil. $)
1967	(306.36)[1]	-	-
1968	-20.70	.32	21.02
1969	-34.34	1.22	-35.56
1970	-37.12	4.13	-41.25
1971	36.86	17.48	19.38
1972	216.72	46.72	170.00
1973	346.78	71.32	278.46
1974	473.28	97.20	376.08
1975	552.78	126.82	425.96

NOTE: (1) Use 1967 as a base to make comparison

(2) Fertilizer increases assume to be 10 kg. per rai for IR-8 areas.

Table 5.2. Direct increase in G.N.P. for each category

Year	Increase Farmers' income (Mil. $)	Labor and marketing services (Mil. $)	Government expenditure and export services (Mil. $)	Total (Mil. $)
1967	-	-	-	-
1968	1.25	.66	-	1.91
1969	12.27	2.42	-	14.69
1970	24.20	8.58	-	32.78
1971	69.39	36.52	9.45	115.36
1972	112.26	97.46	59.15	268.87
1973	148.25	148.72	100.10	397.07
1974	148.72	202.62	143.15	494.52
1975	168.28	246.84	174.30	489.42

G.N.P. As the production of rice increases, its effect will partially increase the G.N.P. of the country. It is assumed that the effect of changes in other sectors of the economy increase the G.N.P. at this constant rate of 8 percent. Only the direct and indirect effect of increased rice production will be analyzed and not the possible changes in other sectors as the government and international agencies develop more optimistic development programs.

Direct Effect of Increase G.N.P.

This increase in G.N.P. derives from various sectors of the economy. The income increase (or decrease) of the three types of farmers, the extra expenditure addition to G.N.P. such as extra wage payment for harvesting and threshing, the increased expenditures for domestic marketing services and for the export margin of which part goes to government, part to profit of exporters, etc., the total of all these effects will be added to G.N.P. These initial increases (which also can be estimated by calculating gross value of the expanded production) will permeate the consumer and producer markets and lead to further increases in G.N.P. the multiplier effect.

The income increase (or decrease) from each of the three types of farmers is shown in Table 4.7. The increased payment for wages and use of animals and machine power was discussed in Chapter IV. It is assumed to be a $6 per ton net addition to G.N.P. (plus $2.90 leakage via imports of machinery, etc.). Added domestic marketing services induced an expenditure of $19 per ton, $16 is net addition to G.N.P. (plus $3 leakage via imports of machinery, banking, etc.). The average export margin from 1967 on is $60.34, we assumed that $40 goes to the government as tax and premium and we assume also that the government will spend one-half or $20 for public services, such as increased transportation facilities, improved infrastructure, etc. The remaining part will go to milling factories, warehouses at the port and profit of exporters assumed to be $15 as a net addition to G.N.P. The estimated direct increase in G.N.P. are calculated and presented in Table 5.2.

The Multiplier Effect of Increase G.N.P.

As the income of rice farmers and others who deal in rice industry increase, they will demand more of other commodities like textiles, sewing machines, transistor radios etc.; in other words, they will spend more as they receive more income. But some will save some amounts to put into

investment. The use of this income causes an increase in the G.N.P. of other sectors of the economy and has an indirect effect in increasing the G.N.P. The consumption multiplier for rice producers and other handlers of rice are required for precise analysis but empirical studies in this subject for Thailand are not available at present. It is assumed that the average consumption expenditure of rice producer and other working in the rice industry are the same as the average country consumption.

In 1966, the private consumption expenditure accounted for an average of 70.8 percent of G.N.P.,[29] so the marginal propensity to consume should be less than the average expenditure. It is assumed that the marginal propensity to consume (MPC) is 0.6. Apply the fromula:

$$\text{G.N.P.} = \text{Direct increase} \times \frac{1}{1-\text{MPC}}$$

$$\times \frac{1}{1-.6}$$

$$\times 2.5$$

This means that the consumption multiplier is 2.5 for rice producers. The total effects are calculated by multiplying direct effect with the 2.5 multiplier. The results are presented in Table 5.3

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[29] NEDB, Ibid., p. 53.

Table 5.3 Estimated increase in G.N.P. direct and indirect effects

Year	Estimated increase G.N.P. without IR-8 (Mil. $)	Estimated increase in direct G.N.P. with IR-8 (Mil. $)	Estimated Total effects (Mil. $)	Estimated total G.N.P. with IR-8 (Mil. $)
1967	4974.50	-	-	4974.50
1968	5372.46	1.91	4.78	5379.15
1969	5802.26	14.69	36.73	5853.68
1970	6266.42	32.78	81.95	6381.15
1971	6767.75	115.36	288.40	7171.51
1972	7309.17	268.87	672.18	8250.22
1973	7893.90	397.97	992.68	9283.65
1974	8525.41	494.52	1236.30	10,256.23
1975	9207.44	589.42	1473.55	11,270.41

Total Increase in G.N.P.

The result of the direct increase in G.N.P. (see Table 5.2) shows that the increases are $1.91 million in 1968 and increases up to $589.42 million in 1975. The indirect effect also is calculated using the multiplier of 2.5 and the results are presented in Table 5.3. The increase ranges from 0.09 percent in 1968 to 16 percent in 1975. This increase in G.N.P. reflects a widespread increase in investment and in production of the other sectors of the economy of Thailand.

V-D. The Probable Effect Upon Imports

The marginal propensity to import in Thailand is greater than one which means that as incomes increase by one percent the increase in demand for imports is greater than one percent. As the income of farmers increase, they will use part of their income to increase the demand for imported goods at a rapid rate if the government does not intervene, and this will decrease the foreign exchange position of the country from that suggested by the crude data on exchange earnings. Other consumers, too, will seek to purchase imported commodities, possibly at a higher rate than farmers with similar effects upon exchange earnings. No data are available to compare the propensity for imported goods of farmers with factory workers, those providing marketing services, etc.

VI.

EFFECTS OF IR-8 ON FARM COSTS AND RETURNS AND POSSIBLE RESOURCE REALLOCATIONS: (Under the Assumption of Alternative 2)

When we take into consideration that other Asian countries also are adopting the new varieties, a different time pattern emerges. The increase in consumption in importing and exporting countries is greater than the increase in production in the early years of adopting. The general changes in population lead to rise in price in early year and other countries expand also lead to the early drop in price.

VI-A. Effect Of Price Change

The price decline in the foreign market will also cause a price decline in the domestic market. In the later years of the period, the price that farmers will receive does not cover the cost of production. If farmers are rational they will shift to other crops which will give them better net return and the area of rice cultivation will decline. Otherwise, the government will have to intervene with control of areas of production, allowing them to produce rice on a limited area. These effects are assumed to stabilize the export quotas at the 1972 level of 3.91 million tons.

VI-B. Added Cost of Producing New Variety

The cost of production for the traditional variety and the added cost for new variety are the same as previously calculated for fertilizers, seeds, insecticides, harvesting and threshing except for the marketing services. Since the price increase will be as large, marketing service charges will not increase as much. When domestic prices fall, transportation and wages expense are fixed; we assumed that the marketing services are increased proportionately with price increase, from $14.70 to $19.90 per rai and constant at base price level as the price falls. The total added costs are summarized and presented in Table 6.1.

VI-C. Control of Export Quotas as Price Fall

As production continues to expand and the exported quantities increase, the world price will fall drastically. It is assumed that the governments of the South and Southeast Asia countries will meet and set up an agreement on the control of exports for each country by 1972. Also, the world price of rice will be set at $92 per ton. Thailand and others agree to maintain the export quota at the 1972 level. The question arises at this point, how does the Thai Government administer this program?

Table 6.1. Effect of price changes and costs of farmers adopted IR-8

Year	Price per ton of paddy ($)	Additional increase per rai ($)	Increase or decrease per rai on present production ($)	Total added cost per rai ($)
1967	74	52.60	-	22.55
1968	82.50	58.65	+2.12	24.27
1969	87.30	62	3.31	25.23
1970	90	64	6.47	25.77
1971	76.20	54.20	.55	23
1972	61.60	43.80	-3.09	22.55
1973	49.60	35.30	-6.08	22.55
1974	49.60	35.30	-6.08	22.55
1975	49.60	35.30	-6.08	22.55

VI-D. Alternative Approaches to Control Export Quotas

There are various alternative approaches to these problems like a fertilizer control program, price control program and acreage control program. If the government imposes an acreage control program, they should take the social problem into consideration, i.e., the differential impact of low rate of farmers' income for subsistence compared with commercial and intermediate farmers. The adjustment might be made in such a way as to give subsistence farmers about the same level of income, as previously.

VI-E. Acreage Control Program

If an acreage control program is implemented, economic pressures probably will push farmers to adopt the new technology in an attempt to maintain the level of their income. The adoption may continue but the rice acreage would decline. The commercial and intermediate farmers contribute to the economy more than the subsistence farmers as the technological innovation begins. As the price increases in the early years, the income for early adopters will be higher compared with the later adopters, when price begins to decline. The subsistence farmers who adopt late do not receive much, if any increase in net income. As we take the unequal income distribution into consideration, we assume a social policy

such that the subsistence farmers are allowed to continue their adoption without any control.

The agreement on export quota, as previously assumed, was 3.91 million tons of milled rice which is equivalent to 6.02 million tons of paddy. We do not know what will be the exact Government's policy to solve this problem, but we assumed that the allotment program will be used; presumably the Rice Department has priorities on these activities because there are rice officers assigned to all villages. Those officers will be responsible for the allotment program, because they work with farmers and collect the statistics on the area holding in the villages. The area allotment program will be applied to the commercial farms which have the average holding above 60 rai's and the intermediate farms which have the average holding above 30 rai's, as previously assumed. Both of these two types of farmers compose a low percentage of the whole economy and a program can be more easily administered.

The implementation of the control program requires establishing a base area for which the reduction can be measured. In this reduction of area the allotment will be the same, whether the farmer is growing IR-8 or traditional varieties. In spite of the control over the acreage, we expect the adoption rate will continue.

The rate of adoption, increase in domestic consumption due to increase in population and income are the same as previously assumed. The control program begins in 1973; we assume that commercial farms are cutback by 20 percent and intermediate farms by 12 percent. In 1974, we assume that the commercial farms area is cut back by 40 percent and intermediate farms by 20 percent. In 1975, we assume that the commercial farms are cutback by 50 percent and the intermediate farms by 30 percent. The effects on export quotas are summarized in Table 6.2.

The variation of surplus production probably leads to greater production in some years than the export quota. The surplus will be accumulated through government inventories and will be used during short supply periods. The penalty for farmers who do not stay with their area assigned would be that they cannot sell their product to the government at fair price. It is assumed that, given the condition above, that the control program is effective and feasible for a short period of time. The impact on three different types of farmers' income are analyzed and presented in Tables 6.3-6.8.

VI-F. The Impact of Farmers' Income

The results of income changes in the second case is greater than in the first case, as the price increases more in the early years and declines in the later years. For both

Table 6.2. Cutback area for commercial farms and intermediate farms

Year	Commercial Farms			Intermediate Farms		
	Percent reduction	IR-8 (Mil. rai)	Current variety (Mil. rai)	Percent reduction	IR-8 (Mil. rai)	Current variety (Mil. rai)
1973	20	1.33	.33	10	.23	1.67
1974	40	2.8	.49	20	.8	2.36
1975	50	3.74	.41	30	1.92	2.82

Table 6.3. The effect of allotment program on production, consumption and the export quota (Paddy)

Year	Marketing quota for commercial farms (Mil. ton)	Marketing quota for intermed-iate farms (Mil. ton)	Production of sub-sistence farms (Mil. ton)	Total production (Mil. ton)	Export quota (Mil. ton)	Domestic consum-ption (Mil. ton)	Total consum-ption and export (Mil. ton)
1973	5.43	4.77	5.5	14.13	6.02	8.02	14.04
1974	4.28	5.42	6.17	14.29	6.02	8.34	14.36
1975	3.69	5.59	7.00	14.66	6.02	8.67	14.69

Table 6.4. The impact of commercial farmers' income with IR-8

Year	Δ in return from new production (Mil. $)	Increase or decrease in return on present production (Mil. $)	Net return (Mil. $)	Δ Costs of production (Mil. $)	Change in net income (Mil. $)
1967	-	-	-	-	-
1968	2.46	.09	2.55	1.02	1.53
1969	5.15	.27	5.42	2.09	3.33
1970	21.25	2.15	23.40	8.56	14.84
1971	89.97	.91	90.88	38.18	52.70
1972	200.17	-14.12	186.05	103.05	83.00
1973	187.44	-32.28	154.16	118.15	36.01
1974	150.38	-25.90	124.48	96.06	28.42
1975	131.67	-22.68	108.99	84.11	24.88

Table 6.5. The impact of intermediate farmers' income with IR-8

Year	Δ in return from new production (Mil. $)	Increase or decrease in return on present production (Mil. $)	Net return (Mil. $)	Δ Cost of production (Mil. $)	Change in net income (Mil. $)
1967	-	-	-	-	-
1968	-	-	-	-	-
1969	4.90	.26	5.16	1.99	3.17
1970	10.24	7.03	11.27	4.12	7.15
1971	26.02	.26	26.28	11.04	15.24
1972	56.06	-3.95	52.11	28.86	23.25
1973	59.66	-10.27	49.39	38.11	11.28
1974	112.96	-19.45	93.51	72.16	21.35
1975	126.37	-21.76	94.61	80.73	13.88

Table 6.6. The impact on subsistence farmers' income with IR-8

Year	Δ in return from new production (Mil. $)	Increase or decrease in return on present production (Mil. $)	Net return (Mil. $)	Δ Costs of production (Mil. $)	Change in net income (Mil. $)
1967	-	-	-	-	-
1968	-	-	-	-	-
1969	-	-	-	-	-
1970	3.71	.38	4.09	1.49	2.60
1971	10.30	.10	10.40	4.37	6.03
1972	16.64	-1.17	15.47	8.57	6.90
1973	33.54	-5.78	27.76	21.42	6.34
1974	67.07	-11.55	55.52	42.85	12.67
1975	107.31	-18.48	88.83	68.55	22.28

Table 6.7. The impact on farmers' income without IR-8

Year	Commercial farms		Intermediate farms		Subsistence farms	
	Planted area (Mil. rai)	Change in net income (Mil. $)	Planted area (Mil. rai)	Change in net income (Mil. $)	Planted area (Mil. rai)	Change in net income (Mil. $)
1967	8.3	-	15.8	-	19.4	-
1968	8.26	17.51	15.8	33.50	19.4	41.13
1969	8.22	27.21	15.72	52.03	19.4	64.21
1970	7.97	51.57	15.64	101.19	19.34	125.13
1971	6.64	3.64	15.32	8.43	19.21	10.57
1972	3.73	-11.52	14.52	-44.87	19.02	-58.77
1973	1.33	-8.09	12.21	-74.23	18.45	-112.18
1974	.75	-4.56	9.44	-57.40	17.5	-106.40
1975	.42	-2.55	6.58	-40.00	16.36	-99.47

Table 6.8. Comparison of income changes for the innovators and the non-innovators on a per farmer basis, 1967-1975 (Case Two)

Year	Commercial Farmers		Intermediate Farmers		Subsistence Farms	
	With IR-8 $	Without IR-8 $	With IR-8 $	Without IR-8 $	With IR-8 $	Without IR-8 $
1967	-	-	-	-	-	-
1968	1978	114	-	60	-	21
1969	2153	178	1128	93	-	33
1970	2398	347	1272	182	448	65
1971	1703	29	904	15	312	6
1972	975	-165	517	-87	178	-31
1973	291	-262	167	-150	65	-61
1974	216	-197	152	-136	65	-61
1975	179	-165	62	-119	72	-62

Table 6.9. The impact on net increase or decrease per farmer

Year	Net increase or decrease for commercial farms (Mil. $)	Net increase or decrease per farmer ($)	Net increase or decrease for intermediate farms (Mil. $)	Net increase or decrease per farmer ($)	Net increase or decreease for subsistence farms (Mil. $)	Net increase or decrease per farmer ($)
1967	-	-	-	-	-	-
1968	19.04	123.08	33.50	59.59	41.13	21.27
1969	30.54	197.42	55.20	98.19	64.21	33.20
1970	66.40	429.29	108.34	192.70	127.73	66.05
1971	56.35	364.26	23.67	42.10	16.60	8.58
1972	71.48	462.06	-21.62	-38.46	-51.87	-26.82
1973	27.92	176.41	-62.95	-111.97	-105.84	-54.73
1974	23.86	153.25	-36.05	-64.12	-93.73	-48.47
1975	22.33	144.35	-26.22	-46.64	-77.19	-39.91

the innovator and non-innovator, the increase in income is larger and the losses greater in this case as presented in Table 6.7. However, by the end of the period 1975, the differences in net position between the innovator and the non-innovator is less than in case one. In other words, the larger world price decline has reduced the benefits of technological change.

The impact on net increase in income for three different sizes of farmers, innovator and non-innovator together, in this case shows that the intermediate and subsistence farmers suffer losses as the prices decline in the later years (See Table 6.8). This is primarily the consequence of the assumed high rate of adoption among commercial farmers. The effect of increase or decrease in G.N.P. will be considered in the next chapter.

VII.

MACRO-ECONOMIC EFFECTS OF IR-8
(Under the Assumption of Alternative 2)

VII-A. The Agricultural Marketing System

The marketing system will expand to handle the increase in production and increase in price. Later, other Asian countries increase their exports, causing an over supply in the world market and the agreement to set export quotas is implemented. The expansion might stop but the government must do something as they are committed to control the amount of rice production.

VII-B. The Net Earnings of Foreign Exchange

The increase in demand from other Asian countries in the early years will cause an increase in world price and this affects the increase of foreign exchange earning to Thailand. The adverse effect of the price decrease in the later years and the control through export quotas result in a net decrease of foreign exchange earnings to Thailand. The results are summarized in Table 7.1. Note that in this table, contrary to Table 5.1, there is a net worsening of Thailand's foreign exchange earnings compared with the present, and compared with a $426 million increase for 1975, if Thailand were the only innovators.

Table 7.1. Estimated net foreign exchange increase from rice, 1967-1975 (Under Assumption of Alternative 2)

Year	Increase in foreign exchange earnings (Mil. $)	Increase fertilizer expenses (Mil. $)	Net increase or decrease in foreign exchange earning (Mil. $)
1967	(306.36)[1]	-	-
1968	72.34	.32	12.02
1969	11.49	1.22	10.27
1970	17.88	4.13	13.75
1971	47.88	17.48	29.77
1972	143.29	46.72	97.57
1973	53.36	59.62	-6.26
1974	53.36	70.20	-16.84
1975	53.36	84.37	-31.01

VII-C. The Changes in G.N.P.

The rice situation under the assumptions of alternative two and from the projection data on world prices can be divided into two phases, the price increase 1967 to 1972, and the period of price decrease or export quota control 1973 to 1975. As the world price increases, the government probably would increase the rice premium and control the export quota so as to stabilize the domestic market price. From previous experience (See Table 3.1) we assumed that the average rice premiums from 1967 to 1972 are $45 per ton. Part of the rice premium will be used by the government for public services, i.e., development of transportation facilities, construction of infrastructure, etc. It is assumed that $22 will be a net addition to G.N.P. The remaining part of export margin partly goes to the warehouses at the port, part to export merchants, part to milling factories, etc., assumed to be $15 as a net addition to G.N.P.

The marketing services increase ranging from $20.72 to $25.20 per ton. These effect an increase in net income to the export merchants allowing them to consume more of other commodities or increase their saving. It is assumed that the domestic marketing margin which induced expenditure of $21 per ton, $18 is net addition to G.N.P. (plus $3 leakage via imports of machinery, etc.).

The second phase, 1973 to 1975, occurs as the government implements the export control program. The government policy concerning exports will be changed in order to have effective control of export quotas. We assumed that the government will monopolize the export market of rice and the export premium, as a measure against exporters, will be eliminated. The purchase price of government is assumed to be the same as domestic rice price which is $49 per ton. The export will be under government to government contracts.

The export margin is $43. Part of it will be spent by the government for public services, assumed to be $15 as a net addition to G.N.P. The remaining part will go to milling factories, warehouses at the port, etc., assumed to by $10 as a net addition to G.N.P.

The labor cost and domestic marketing service in this phase are the same as previously assumed (Chapter V). The net addition of G.N.P. for export market services and government expenditure are $25 per ton. The direct increase in G.N.P. and multiplier effect are calculated and presented in Table 7.2-3.

VII-D. The Result of Changes

The results of the second case shows that the direct G.N.P. increase is greater than the first case in the early years.

Table 7.2. Direct increase in G.N.P. for each category

Total	Increase or decrease farmers' income (Mi. $)	Labor and marketing services (Mil. $)	Government revenue and export services (Mil. $)	Total (Mil. $)
1967	-	-	-	-
1968	93.67	.72	-	94.39
1969	149.95	2.64	-	152.59
1970	302.48	9.36	-	311.84
1971	96.62	29.84	10.00	146.46
1972	-2.01	106.32	62.53	166.84
1973	-140.87	104.72	42.25	6.10
1974	-94.92	110.88	42.25	58.21
1975	-81.08	109.78	42.25	70.95

Table 7.3. Estimated increase in G.N.P. direct and indirect effects

Year	Estimated increase G.N.P. without IR-8 (Mil. $)	Estimated increase in direct G.N.P. with IR-8 (Mil. $)	Estimated total effects (Mil. $)	Estimated total G.N.P. with IR-8 (Mil. $)
1967	4974.50	-	-	-
1968	5372.46	94.39	235.98	5702.83
1969	5802.26	152.59	381.48	6336.33
1970	6266.42	311.84	779.60	7357.86
1971	6767.75	146.46	366.15	7280.36
1972	7309.17	166.84	417.10	7893.11
1973	7893.90	6.10	15.25	7915.25
1974	8525.41	58.21	145.52	8729.14
1975	9207.44	70.95	177.42	9455.81

As the price decline in the later years, the G.N.P. increase at a slower rate. In 1968 the estimate of G.N.P. increase is 4.7 percent but only 1.9 percent in 1975 (See Table 7.3). The economic development in the early years should increase but the rate will contract in the later years.

VIII.

CONCLUSION AND IMPLICATION

The Thailand economy depends heavily upon rice as a staple food, to maintain the balance of trade and to provide foreign exchange earnings. Rice occupies the largest cultivated land area, produced the highest value of all the agriculture products and provides employment for the majority of the people. It supplies more than enough staple food for the country, earns the largest amount of foreign exchange, and yields the most stable revenue for the government.

VIII-A. Objective of the Study

Since 1960, the average increase in price production is quite low. This study deals with the effects of an innovation, a modern rice variety of the IR-8 type from the International Rice Research Institute. The data used in the study are secondary data which are inaccurate and incomplete; but this study deals more with the methodology rather than trying to identify the exact results. The rates of adoption among various types of farmers are assumed annually to 1975. The impact upon farmers' income are examined as prices change as well as some of the important macro-economic effects,

including exchange earnings, the demand for marketing services, the revenue to the government, the multiplier, and economic development effects.

VIII-B. Summary of Result

The yield increase of the new variety apparently will be three to four fold, compared with traditional varieties, with a reasonable amount of fertilizer used. Using the rates of adoption assumed, the production increases in the early year of adoption are small; as the rate of adoption increases, the production increases rapidly to a doubling by 1975.

The fertilizer inputs have to go along with the new variety; hence the demand for modern inputs will increase as the rate of adoption increased.

The price of rice is based on the world price. The analysis is divided into two cases. First, Thailand is the only innovator. We assumed that the other nations remain in the same import-export pattern as at present. The increase in supply in the early years is not enough for the domestic demand increases, so that price must increase. In the later years, as the supply increases rapidly, the prices decline. In the second case, the other South and Southeast Asian countries are taken into consideration as they too innovate. Some of them are importers. In the early years, the population

and income increase more rapidly than the production increases. By applying the price elasticity of demand, it is clear that world prices will increase rapidly. In the later years, all nations become self-sufficient and have a surplus for export. Thus, there is an over-supply in the world market and the prices drop drastically. In order to analyze the income to farmer effects in the later years, it was necessary to assume that the governments of all nations would meet and through agreement set export quotas to maintain the price at 67 percent of 1967.

The effect of changes in the early years are to increase net income for those who adopt the new variety, more than for those who do not adopt. In the later years, as the prices decline those who adopt still cover their costs while the non-adopters suffer losses.

The earnings of foreign exchange increase as the export quotas and prices increase. When the price decreases, in the later years, the rate of foreign exchange earnings still increases under case one and levels off under case two.

As the production increases, there is an increase in Thailand's exports, the income of farmers increases and the income of the rice industry increases. These increases effect a net addition to G.N.P. and increase per capita income of the people.

The commercial farmers and intermediate farmers who adopt the new variety early receive a higher increase in their net income compared with the subsistence farmers who adopt in the later years after the prices have begun to decline. But there are some farmers who operate land that is not suitable for the new variety. These farmers also lose as the price declines. In other words, many of the rich will become richer and many of the poor will become poorer.

VIII-C. Economic Implications

The government policy should attempt to devise policies which have more change to help subsistence farmers and those farmers who cannot adopt the new variety, such as those with deep water irrigation. The alternative to these problems are:

1. The development of industry to attract the people migrating from the farm.
2. Impose a progressive land tax upon the big farmers and support the small farmers.
3. Diversification by encouraging those farmers whose area holdings are not suitable to a modern rice variety to produce other crops such as maize, jute, kenaf and tapioca. The export market should be searched for opportunities to export these crops.

The above three alternatives are only suggested possibilities to help improve the income level of poor farmers. We do not really know whether the Government policy in the future will have such a concern.

BIBLIOGRAPHY

Bangkok Bank, Facts and Figures, Bangkok: Bangkok Bank Limited, 1966.

DeDatta, S. K., J. C. Moomaw and R. S. Dayrit, Nitrogen Response and Yield Potential of Some Rice Varietal Types in the Tropics, International Rice Commission Newsletter, Vol. XV, No. 3, September 1966.

Eicher, Carl K. and Lawrence W. Witt, Agriculture In Economic Development, New York: McGraw-Hill Book Company, 1964.

FAO, Agricultural Commodities Projections for 1975 and 1985, Vol. I, Rome, 1967.

FAO, Rice-Grain of Life, World Food Problem, No. 6, Rome, 1966.

FAO, The World Rice Economy in Figures, Commodity Reference Series, No. 3, Rome, 1965.

FAO, National Rice Policies 1966, Commodity Policy Studies, No. 18, Rome, 1966.

FAO, The World Rice Economy, Commodity Bulletin Series No. 36, Vol. 1, 2, Rome, 1962.

FAO, The Economic Relationships Between Grains and Life, Commodity Bulletin Series No. 39, Italy, 1965.

FAO, Report of the FAO/ECAFE Expert Group on Selected Aspects of Agricultural Planning in Asia and the Far East, Agricultural Planning Studies No. 2, Rome, 1963.

FAO, Agriculture in the World Economy, Rome, 1962.

FAO, Tenth Session of the FAO Study Group on Rice, International Rice Commission Newsletter, Vol. XV, No. 4, Dec, 1966.

Government of Thailand, National Statistical Office, Statistical Yearbook, Bangkok, 1964 and 1965.

Hathaway, Dale E. Government and Agriculture, New York: The Macmillan Company, 1963.

Kulthongkham, Sawaeng, Rice Economy of Thailand. Bangkok: Karn Sasana Press, December, 1964.

Ministry of National Development, Report of the Survey on the Determination and Analysis of Policies to Support and Stabilize Agricultural Prices and Incomes of the Thai Farmers. Bangkok: Department of Land Development, 1967.

Ministry of Economic Affairs, "50 Years" Statistics of Rice Exports, 1916-1964. Bangkok: Department of Customs, 1964.

Ministry of National Development, The National Economic Development Plan, 1961-1966. Bangkok: Office of the National Economic Development Board.

Ministry of Agriculture, Periodical Report of the Government of Thailand for the Year 1960-1962 to FAO of United Nations, Bangkok, 1964.

Murray, Brown, Technological Change and the Distribution of Income, International Economic Review, September, 1963.

Muscat, Robert J. Development Strategy in Thailand, New York: Frederick A. Praeger, 1966.

Narksawasdi, Udhis. Agricultural Indebtedness and Trade, Government of Thailand, Bangkok: Ministry of Agriculture, Second Edition, 1964.

Onslow, Cranley. Asian Economic Development, New York: Frederick A. Praeger, 1965.

Pejarabul, Virasidhi. Costs of Rice Production, Agricultural Economics Research, Government of Thailand, Bangkok: Division of Agricultural Economics, No. 6.

Roger, Everett M. Diffusion of Innovations, New York: The Free Press of Glencoe, 1962.

Ruttan, Vernon W. The Contribution of Technological Progress to Farm Output, 1960-1975, Review of Economics and Statistics, Vol. 38, February 1956.

Ruttan, Vernon W. Research on the Economics of Technological Change in American Agriculture, Journal of Farm Economics, Vol. 42, November, 1960.

Stakman, E. C. and et. al., Campaigns Against Hunger, Massachusetts: The Belknap Press of Harvard Univ. Press, 1967.

The Agricultural Economics Society of Thailand, The Role of Agricultural Economics in Economic Development: Proceedings of the First Conference on Agricultural Economics. Bangkok: Kasetsart University, February, 1962.

U.S. Department of Agriculture, Changes in Agriculture in 26 Developing Nations 1948 to 1963. Foreign Agricultural Economics Report No. 27, Washington, D.C., November 1965.

_____, Rice Situation, Washington, D.C., Jan. 1964-1968.