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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
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b) a comparison of the technical and economic advantages and disadvantages, to both the national economy and private industry, of existing rice mills in Thailand with those of a modern rice processing mill.

1.2. The purpose of the study was to formulate recommendations for appropriate methods to improve the efficiency of the existing rice milling industry either through the introduction of a modern, economically viable, optimum capacity rice processing industry, or, in the case of an unsatisfactory rate of return of the feasibility study, through the improvement of existing mechanical mills.

The consultant formed the opinion that the problem was closely involved with the structure of the economy, and that the closing down of existing large mills was due to infrastructural economic problems rather than to a real technical deficiency; the study therefore tried to demonstrate that the latest improvements of the percentage of recovery due to advanced techniques will permit sufficient margins to undertake gradual conversions in the rice economy.

1.3. For the implementation of the work a mission of four experts visited Thailand during 1970. The investigations conducted consisted of:

a) a study of the markets for whole grain and broken rice, rice bran and rice bran oil,

b) a study of rice production,

c) a survey of the rice processing methods at present practised in Thailand,

d) technical and economic determination of the best location and size for a modern plant,

e) a comparative feasibility study of three different modern processing systems, with and without by-product utilization,

f) a financial analysis of the two chosen solutions.

The findings, conclusions and recommendations are set out in the present Final Report and in Appendices I to VI.

Note: In accordance with the instructions of the UNIDO, Industrialconsult availed itself of the services of Food Engineering International, Inc. a subsidiary of the RIVIANA FOOD Inc., Houston, Texas, which holds the world-wide patent for the X-M process (Alternative III in the feasibility study).
F.E.I. alone should, therefore, be held responsible for the data (product yield estimates, capital costs, operating costs etc.) utilized in the feasibility calculations of the X-M processing plant.

CHAPTER 2

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

8. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

8.1. Conclusions

The situation of the rice milling industry in Thailand at present is such that the losses, in both quantity and quality, are very high; they vary between 4 and 14 million U.S. dollars, depending on the quality of the harvest and the quantity milled by the hullers. This situation has arisen chiefly because of the change in the number and production capacity of the milling plants which took place during the Second World War, when numerous standard mills and hulling plants replaced the large industrial mills located at the mouth of the river Chao Phya. The main reasons for this change were the high cost of transport and of paddy procurement and the withdrawal of capital from industry.

A radical change in the present structure of the rice industry is essential in order for the economy of the Thai rice sector to obtain the maximum benefit, especially from exports of high quality rice.

The feasibility study performed compared different types of modern rice-processing mills with a capacity of 90,000 metric tons (1) of paddy per year: the minimum capacity for a fair comparison of the

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(1) This is considered by Riviana Food Inc. to be a minimum requirement for the profitable adoption of the X-M process for polishing rice in the presence of a solvent and is at the same time an optimal capacity according to the experience gained in the United States where a new programme for the construction of modern, large mills sets the optimal range between 80,000 and 100,000 tons per year. Moreover, as a mill working 90,000 tons may already be confronted with paddy procurement difficulties, a fortiori a mill with a larger capacity would encounter even greater difficulties.

cont.

...duction processes examined, i.e.:

...en, fully-mechanical mill

modern, mechanical mill integrated with a bran oil extraction

...ional milling plant, which extracts the bran oil

in polishing ...ce.

...results obtained from the comparison of the economic feasibi-

...ses indicate that the modern mill has the highest

...an investment of 2.7 million dollars, is self-

...high financial rate of return on the funds sup-

...f the plant.

...ill requires the establishment of a plant with a

...known in the Thai rice processing industry, its in-

...to the possibility of obtaining sufficient paddy.

...be achieved by: a) paying a higher price for paddy

...in order to attract sellers away from their tradition-

...and to compensate for higher transport costs and the losses

...in the drying process; b) radically changing the present mar-

...with long-term procurement policy. The pre-financing of

...is a measure to achieve this result. The farmer

...attain economic stability and a sufficiently mature outlook for him

...understand that a better return could be obtained, even if prices re-

...mained, but only providing that higher yields and lower financial

...achieved.

...mued

...of the above reasons it was not possible to compare these two modern

...milling processes with traditional Thai mills, in view of the seasonal

...ion of the local m... their small size and the reduced time of

...ation (one-two shifts a day).

The estimated net profit of the mill before taxes is 570,000 $/year, assuming that the paddy is purchased at 62.50 $/ton, the average price paid by the present mills; a price of 68.00 $/ton could therefore be paid for the paddy before profits are completely extinguished.

As regards the utilization of by-products, the feasibility study has shown that the highest profit procured by the extraction of oil from the bran is $ 120,000 yearly. It is clear even from a comparison of Alternatives I and II that the oil-extraction process is profitable, since it produces an increase in the net profits of the mill. This is important in the specific case of Thailand, where the defatted bran is at present marketed at the same price as raw bran.

It should also be added that crude oil extracted by milling in a plant integrated with an oil extractor has a very low free fatty acid content, which makes it a very valuable source of edible oil.

In conclusion, the feasibility study indicates that a large-scale modern rice-processing mill with a capacity to process 90,000 tons of paddy a year can be economically viable in Thailand, but an essential prerequisite for its successful operation is a government-controlled scheme for the large-scale procurement of paddy at controlled prices.

2.2. Recommendations

It is urgently necessary to restructure the Thai rice industry, since the losses of edible rice are very high.

The hullers should be replaced by standard mills, manufactured locally or imported, possibly improved in accordance with the most modern technology. The hullers should be considered only in the case of rice to be milled for consumption by the producers themselves.

Large-scale industry for rice-processing should be re-established, as far as possible, thus improving the milling yield and the quality of the product, and greatly benefitting exports.

Since the large-scale rice industry has been disintegrating since the war, for various reasons, it is necessary to rectify the situation by:

a) creating infrastructures to reduce the costs sustained by the big mills for paddy procurement and transport;

b) mechanizing the handling system for paddy and rice inside the mills, in order to reduce labour costs;

c) making capital available to the large industry at low cost;

d) reinforcing the fiscal control of the small mills, to ensure that all the mills are taxed justly and proportionally;

e) encouraging the big mills, as far as possible, to supply milled rice for export under bi-lateral agreements;

f) giving support to the local manufacturers of milling machinery.

Together with the concentration of rice-processing (mainly for export) in large mills, particular attention should be paid to the modernization of the mechanical milling systems used by the standard medium-sized mills, introducing pre-grading of the paddy, rubber-roller shellers instead of disc-shellers and blending of the head rice with the brokens.

The utilization of the rice husks and fuel for the production of motive power should be encouraged, as it represents the best use for this by-product. In this way, not only will valuable foreign currency be saved on imports of fuel oil, but the problem of air and river pollution will be solved (at present the husks are disposed of by burning or discharge into the rivers).

The industrialization of rice milling entails the rationalization of the system of assessing the quality and value of the paddy according to the milling yield and qualitative characteristics. The present grading system, founded on visual inspection, is subjective and not suitable for a modern paddy procurement system.

In particular the moisture content of the paddy must be ascertained accurately enough to provide an adequate basis on which to determine increases or reductions in the price.

EQUIVALENTS

Weights and measures: In this report, tons indicate metric tons. One "kwien", a local measure of paddy, is assumed to equal 1 metric ton. One "picul", another measure of weight, is converted into kilograms at the rate of 60 Kg per picul.

The measure of area "rai" is equivalent to 1600 square metres.

The measure of production per hectare has been calculated or given by the bibliographic documents on the basis of the area harvested and not the seeded area.

Upland food crops = maize, mung beans, cassave roots, sugar cane, vegetables, fruit, other edible seeds.

Oil seeds = castor beans, ground nuts, soy beans, sesame seeds, coconuts (which are considered oil seeds).

Fibres = cotton, kapok and bombax, ramie, silk (raw and cocoon), kenaf and jute.

Miscellaneous crops = cardamoms, dried chillies, onions and shallots, garlic, tamarinds, betel nuts, tobacco.

The values of currency in "bahts" have been converted into U.S. Dollars at the exchange rate of 20.62 bahts per U.S. Dollar (official exchange rate as on August 1 1970).

CHAPTER 3

RICE PRODUCTION IN THAILAND

Contract # 26/73

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(1 of 2)

ESTABLISHMENT OF A MODERN RICE PROCESSING MILL

(TECHNICAL - ECONOMIC FEASIBILITY STUDY AND COMPARATIVE STUDY BETWEEN EXISTING AND MODERN RICE MILLS)

KINGDOM OF THAILAND

FINAL REPORT

INDUSTRIALCONSULT
VIA SERENTA, 7 - ROME, ITALY

1971

3. RICE PRODUCTION IN THAILAND

3.1. Present situation

The main characteristic of rice production in Thailand is that, among the several producing countries of Asia, it has benefited less from the "Green Revolution" on account of the peculiar varieties of rice grown (long slender grain with waxy and translucent texture, commonly known as Siam Patna).

In fact high - yielding varieties recently developed have not been introduced in the country as a result of of the lack of enthusiasm of the local consumers and of the exporters for this type of rice.

Rice is produced mostly for self-consumption (around 60%) and the rest is marketed in the big towns or exported.

Rice production is unevenly distributed throughout the four regions of the country. However, the Central Region constitutes the so-called rice bowl and produces over 50% of the country's total.

Total production of milled rice increased in the past ten years from 6.8 M. T. to over 13 M. T. in 1969/70.

Between 1952-53 and 1963-64 output increased by about 1/3. However, 42% of this increase was attributable to increased area and only 58% to increased yield. The implication is that increased

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Note: Appendix I contains relevent facts and supporting data to this Chapter.

capital intensity and technical improvements have played little part in the rise of output.

The expansion of production is expected to continue; however, any major increase in production will need to come from yield increases. Improved production practices are not generally applicable on the large flood plains of the Central Region, where controlled irrigation is not possible. The population living in the North-East of the country, being traditionally rice farmers, have first cleared all the low-lying land suitable for paddy production. At present excessive population density occurs in many areas and rice cultivation has been extended to marginal lands.

Table 1 gives estimates of increases in production from 1970 to 1975.

Rice: production in million tons

Table 1

Year	Non-glutinuous	Glutinous	Total	Increase over previous year
1970	8,461	3,626	12,087	0.895
1971	9,130	3,916	13,054	0.967
1972	9,800	4,220	14,020	1.044
1973	10,650	4,580	15,226	1.128
1974	11,511	4,933	16,444	1.218
1975	12,431	5,320	17,750	1.315

Table 2.

POPULATION - PRODUCTION - CONSUMPTION - EXPORT

Year	Population million	Rice milled production (*) ton x1000	5% reduction (**) ton x 1000	Export ton x 1000	Available domestic consumption 1000 ton	Consump. pro capite Kg/year
1955	22.762	4,767	238.3	1,265	3,264	146
6	23.445	5,393	269.6	1,570	3,553	154
7	24.148	3,630	181.0	1,133	2,316	98
8	24.873	4,584	229.2	1,092	3,263	133
9	25.619	4,401	220.0	1,203	2,978	118
60	26.388	5,120	256.0	1,576	3,289	127
1	27.180	5,397	269.8	1,271	3,856	144
2	27.995	6,124	305.4	1,418	4,401	160
3	28.9	6,619	330.9	1,420	4,868	168
4	29.8	6,308	315.4	1,896	4,097	137
5	30.7	6,084	304.2	1,895	4,885	159
6	31.7	7,818	390.9	1,510	5,917	187
7	32.7	6,333	316.6	1,490	4,526	139
8	33.8	7,191	409.5	1,020	5,811	171
9	34.8	8,851	442.5			

(*) Paddy converted into milled rice at a yield of 65% up to 1960, 66% from 1961 onwards

(**) Reduction for seed, wastage and damages during storage

The available domestic consumption and exports are shown in Table 2.

The average surface area of the rice farms is between 3 and 3.5 hectares. More than 2 million farms crop some 5.2 tons each as a rough average.

At present rice cultivation is based on somewhat primitive methods.

Despite the great abundance of water, today it is only possible to grow rice by rain fall, and to obtain a single crop per year. The lack of artificial irrigation makes it difficult to work on any other basis.

All the cultivation operations are carried out, almost exclusively, manually or by animal-power; only a few agricultural machines, mostly of Japanese make (cultivators), are used for working the land.

Seed-bed preparation starts as soon as the first rains fall, in June or July; transplanting takes place 18-25 days after the sowing of the nursery.

The quantity of seed calculated for transplanting 1 hectare is 13-16 Kg, which is remarkably low.

The seedlings are transplanted two or three together at a distance of 20-25 cm.

Approximately 80% of the surface area is cultivated by transplanting. There are sound agronomic reasons for adopting this method, in preference to that of direct seeding, and in addition the large amount of labour available makes this even more desirable.

Rice cultivation on dry land exists, but on a very limited scale.

In the central plain region "floating varieties" of rice are grown, where the depth of the water is at least 2-3 metres.

Harvesting is generally carried out by hand from November to January, after the rice field has been drained.

The moisture content of the paddy at harvesting is 20-22% and after drying, which is effected by spreading the paddy on stalk on the ground in the sun, this is reduced to 12-15%.

Threshing machines are almost unknown. Threshing is usually carried out by hand or by treading the paddy on the stalk on a threshing-floor with water-buffaloes or by driving rubbentyred tractors over it. In the South, where rice is produced in small quantities mainly for home consumption, it is stored on the stalk and threshed by human labour as it is needed.

The paddy is then winnowed by means of mechanical blowers or by letting it fall from bamboo trays in a natural draught.

The paddy is stored in huts built of bamboo and clay or even in the home until the time of sale or consumption.

3.2. Rice production plans and targets

Thailand's second five-year plan (1967-71) has set a production objective at 13,700,000 M. T. of paddy against 9,600,000 of the base year. Rice production is now the subject of a development programme, rather than specific-objective plan. Low rice yields are acknowledged to be the result of inadequate water control, poor soil fertility, little or no control of insects and pests and poor varietal response to fertilizer. In the near future improved varieties under moderate management will yield up to 3 M. T. per hectare, compared with the present level of 1.7 M. T. per hectare, and even more under intensive management.

As said before, out of a total rice area of 7,500,000 hectares only 2,000,000 have limited irrigation.

New additions will increase this area, beginning in 1970 with the completion of schemes to serve about 66,000 hectares in the North. In the South, about 72,000 hectares should be served by 1972 and within ten years the Pah Mong dam on the Mekong river could supply large areas of the North-East where yields are very low because of sandy soils and irregular rainfall.

CHAPTER 4

THE MARKET OF RICE

4. THE MARKET OF RICE

4.1. Rice export: whole grain and broken rice

With a rice-growing area amounting in the last few years to an average of 65,000 sq.Km., i.e. over half of its entire cultivated surface area, Thailand has recorded in the same period a production of about 10 million tons of paddy per year, equivalent to 6,000,000 - 6,500,000 metric tons of milled rice. In the last two years the rice-growing area has risen considerably, and the production of paddy has now passed 12 million tons per year.

On average, about 1/4 of the above quantity has been exported, the rest being consumed locally. Exports were mainly to the other Asian countries, such as Malaysia, or other nearby countries, e.g. Indonesia, India, Hong-Kong, etc.

Table 29 gives the production of milled rice, based on an estimated yield of 68% and 65% in terms of paddy for each of the years 1960-1961 to 1967-1968.

If we compare the above data with those shown in Table 30 relative to exports of milled rice from 1960 to 1968, we will immediately note the importance of Thai rice exports, both with regard to the total quantity of milled rice produced and, more especially, to the value of the processed rice exported as compared with the overall value of exports from Thailand (see Diagram IX).

Note: Appendixes III and IV contain statistical data and supporting information to this Chapter.

The data shown in Table 31 regarding the distribution of the various categories and qualities of processed rice, rice products and by-products exported from Thailand in the period 1960-1968 would appear very significant.

The percentage of broken and lower-quality products still appears extremely high, but this is because the importing countries are often short of foreign exchange and are forced to buy products of less high quality.

4.1.1. Evolution of exports of processed rice by the main Asian exporting countries

Since 1964 Thailand has been the largest rice-exporting country in the whole of Asia, followed by continental China, Burma and Taiwan, as may be seen from the data given in the tables of Appendix II.

It should be noted that until 1964 Burma held the first place in exporting milled rice; however its exports in the last four years have gradually dropped until they now amount to a mere 1/4 of those recorded for the period 1961/1963.

Those from mainland China were rising until three years ago, but have now fallen considerably, as have those of almost all the other Asian countries which traditionally export rice.

This may be explained by the following:

- an improvement in the standard of living of the people, with the progressive increase in consumption of and demand for agricultural products on the home market;
- an improvement in the productive capacity of the other economic sectors of the country.

Thailand - like all other developing countries, both Asian and non-Asian - requires first and foremost a progressive expansion of its secondary and tertiary economic sectors, which might absorb the surplus of the agricultural population, thereby permitting the country to modernise rice-growing and agriculture in general, by mechanising production and making increasing use of all the other technical means placed at the disposal of modern agriculture by the various industries (chemical fertilizers, pesticides etc.).

A basic condition for the improvement of the Thai rice market, especially as far as exports are concerned, would on the other hand appear to be the establishment of an efficient rice industry, assuring a product of high commercial value.

It is of course true that the characteristics of the different varieties, the methods of cultivation, harvesting and drying substantially influence the milling yields, but it is equally true that the milling process itself can have a considerable effect on the yield of the processed product from both the qualitative and from the quantitative points of view.

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In this, the general economic development of Japan will undoubtedly have played its part, as well as the progress achieved in agriculture. The population has now reduced its consumption of rice, substituting it with other foods.

However, it should be borne in mind that the tendency towards an improvement in the standard of living and diet of peoples throughout the world will have a direct influence on exports of all agricultural products, including rice, in the sense that the poorer products will tend to be replaced by better-quality ones.

This improvement in quality should be taken into consideration in the case of rice growing in Thailand, both from the agricultural and industrial points of view.

The progressive adoption of high-yielding varieties in more countries and over wider areas will have important economic and trading implications and is likely to cause significant changes in trade patterns. The resulting acceleration in production will also make it more difficult to plan production so that supply and demand remain in equilibrium at reasonably remunerative prices.

4.1.2. Countries to which Thailand exports rice

Tables 33 - 39 of Appendix II show the different countries to which Thailand exported rice in the period 1963-1969, and also the quantities of rice imported by each country, which fluctuate give considerably in direct relation to the variations in exports.

This - as pointed out earlier - may be connected with an improvement in the diet of the inhabitants of these same exporting countries. However, it may also be connected with the fact that it has now become more difficult for those Asian countries which traditionally export rice to find a market for their production, on account of the growing competion of non-Asian rice-exporting countries as a whole and the other rice-producing countries, as well as total world exports.

Exports of milled rice, taking those of 1963 as 100:

Year	Thailand	Burma	Mainland China	Other Asian Countries	non-Asian countries	Total world exports
1961-1963	100.0	100.0	100.0	100.0	100.0	100.0
1964	133.8	83.9	155.4	115.1	121.2	117.0
1965	130.4	81.2	142.4	114.2	136.6	121.1
1966	106.4	67.9	231.6	105.2	135.5	114.5
1967	104.3	32.5	229.7	90.0	162.9	112.2
1968	68.6	20.8	178.8	65.3	187.7	102.9
1969	69.5	27.1	140.7	68.1	178.5	102.0

It may also be interesting to note that Japan which, prior to 1969, was not included among rice-exporting countries, has in the last year exported large quantities of rice.

Of the countries which traditionally import Thai rice, only Hong-Kong has maintained its yearly demands more or less unchanged, except in the last two years, when there has been a slight drop in demand compared with 1963. Other countries, such as Malaysia and Indonesia, have sharply reduced the quantity imported from year to year; India and Singapore imported considerable quantities of Thai rice in 1965 and in 1966 respectively, but thereafter progressively reduced their initial demands, especially in the case of India.

Taking as 100.0 the imports for 1963 as regards Hong-Kong, Malaysia and Indonesia, and for 1965 and 1966 respectively for India and Singapore, we obtain the following figures for imports in the period 1963 - 1969:

Imports of rice from Thailand

Year	Hong-Kong	Malaysia	Indonesia	India	Singapore
1963	100.0	100.0	100.0	-	-
1964	107.4	119.7	127.9	-	-
1965	107.8	100.5	28.5	100.0	-
1966	110.9	34.6	48.1	84.3	100.0
1967	113.5	42.1	34.3	86.3	88.5
1968	87.7	36.5	11.0	97.2	80.0
1969	90.7	31.2	23.6	58.7	93.0

It is possible, of course, that the increase in the price of exported rice from Thailand, up to 1967, may have helped to cause these reductions. Similar price increases have been recorded for Burmese rice, and exports have decreased even more than those of Thailand (see Table 40).

However, since the end of 1968, the export prices of Thai rice have decreased significantly (see Table 3, below), especially those of low-quality and broken rice, the demand for which has slackened on the part of traditional buyers.

Market prices of Thai rice (F.O.B.) for export (US $ per M.T.)

Table 3

Description	Annual averages				August
	1966	1967	1968	1969 (provisional)	1970
Government to Government contracts					
White rice, 35% brokens	133.6	128.0	147.2	120.3	112.5
White rice, 10% brokens	130.0	140.5	190.5	173.4	122.4 (1)
Private trade					
White, 5% brokens	165.6	253.7	203.3	185.5	145.2
Husked, 100%	155.6	220.6	207.1	180.0	145.2
Brokens, A1 super	126.1	130.5	151.5	104.7	66.4

(1) February

The problem could arise for rice, as in the case of several other agricultural commodities, of a general excess capacity of supply above the effective import demand.

This would require further adjustments not only in prices but also in trade patterns and production policies. Prices, both national and international, may therefore tend to remain under pressure.

4. 2. Exports of milled rice, products and by-products of the Thai rice industry.

Table 41-43 (Appendix II) give a measure of the types of rice, products and by-products, subdivided according to quality and commercial definition, exported from Thailand to various Asian countries (1).

Hong-Kong and Singapore are the only countries which import high-quality rice, even if a large proportion of it is re-exported (generally after remilling). The other importing markets, especially India and Indonesia, prefer to import the lowest-grade rice, mostly parboiled, in addition to fairly large quantities of broken rice and special rice products such as rice flour.

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(1) It is estimated that in 1969 Thailand exported (together with 751,000 tons of milled rice including parboiled and glutinuous rice) 330,000 tons of brokens and 6,000 tons of husked (in 1968 : 679,000; 379,000; 8,000).

For obvious reasons paddy is not exported from its country of origin.

With regard to the bran, this is not exported as it is completely utilized as animal fodder within the country.

The exchange price of bran paid by the millers to the farmers or retail tradesmen is liable to large fluctuations during the 12 month span of one year. The diagram on the following page shows the trend of prices on the home market during the period January-December.

A portion of the bran is forfeit to the oil-extraction industry. The resulting defatted bran can nevertheless only be disposed of in the same saw bran.

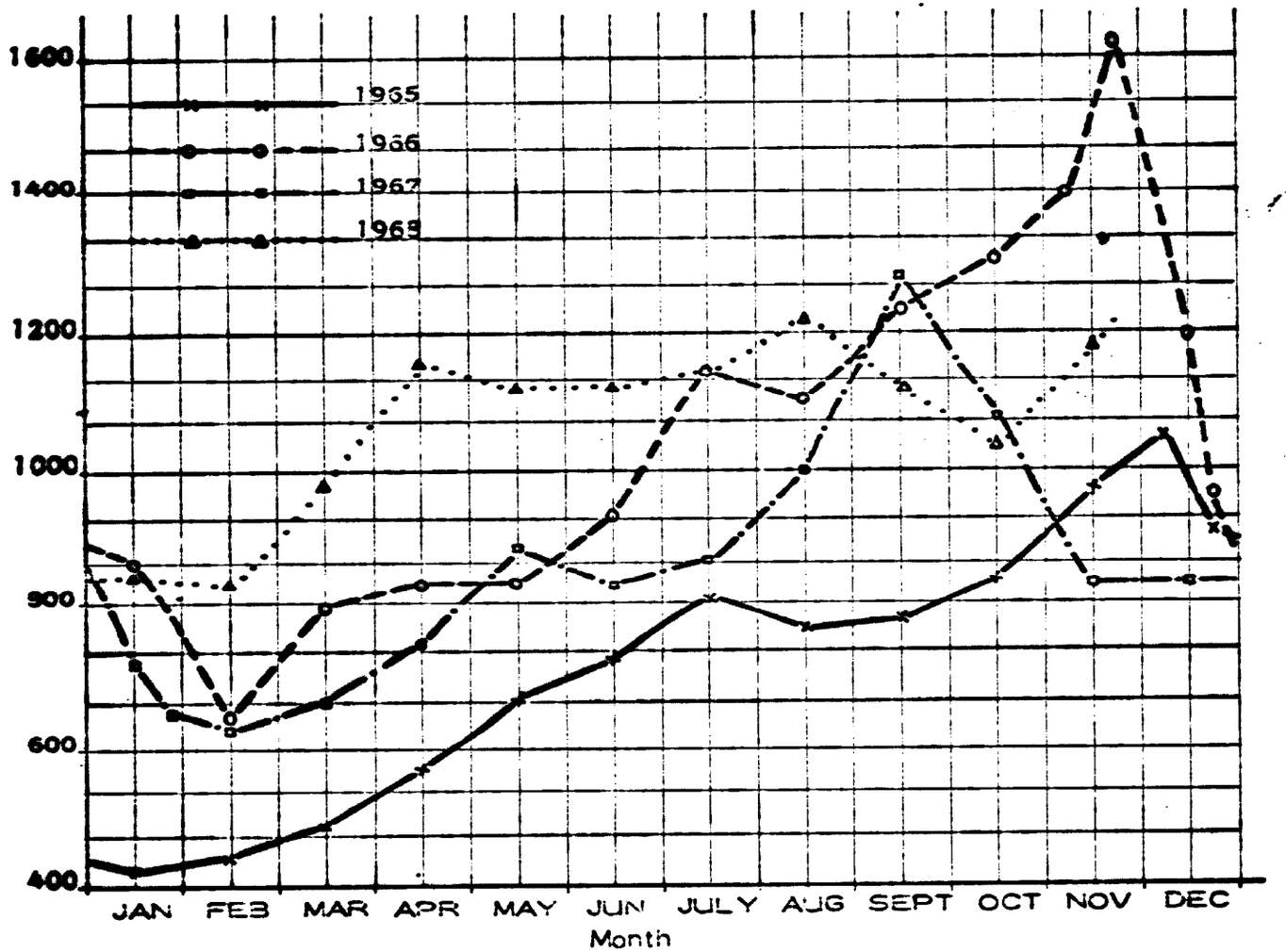
Hardly any bran is exported from rice-producing countries to other countries, except from Indonesia to Singapore and from India to the United Kingdom (defatted bran).

The wax separated off the crude oil obtained from the bran has no commercial value, as the quantities thus obtained are so minimal (2-4%) that its refinement is not economically viable even in countries, such as Japan, where oil is extracted from the husk on a large scale.

4.3. Procurement of paddy by the Thai mills

Since the average size of the rice farm in Thailand is only 3 hectares, the average yield is 2 tons per hectare, and 60% of the

BANGKOK PRICE OF RICE BRAN IN BAHT/TON



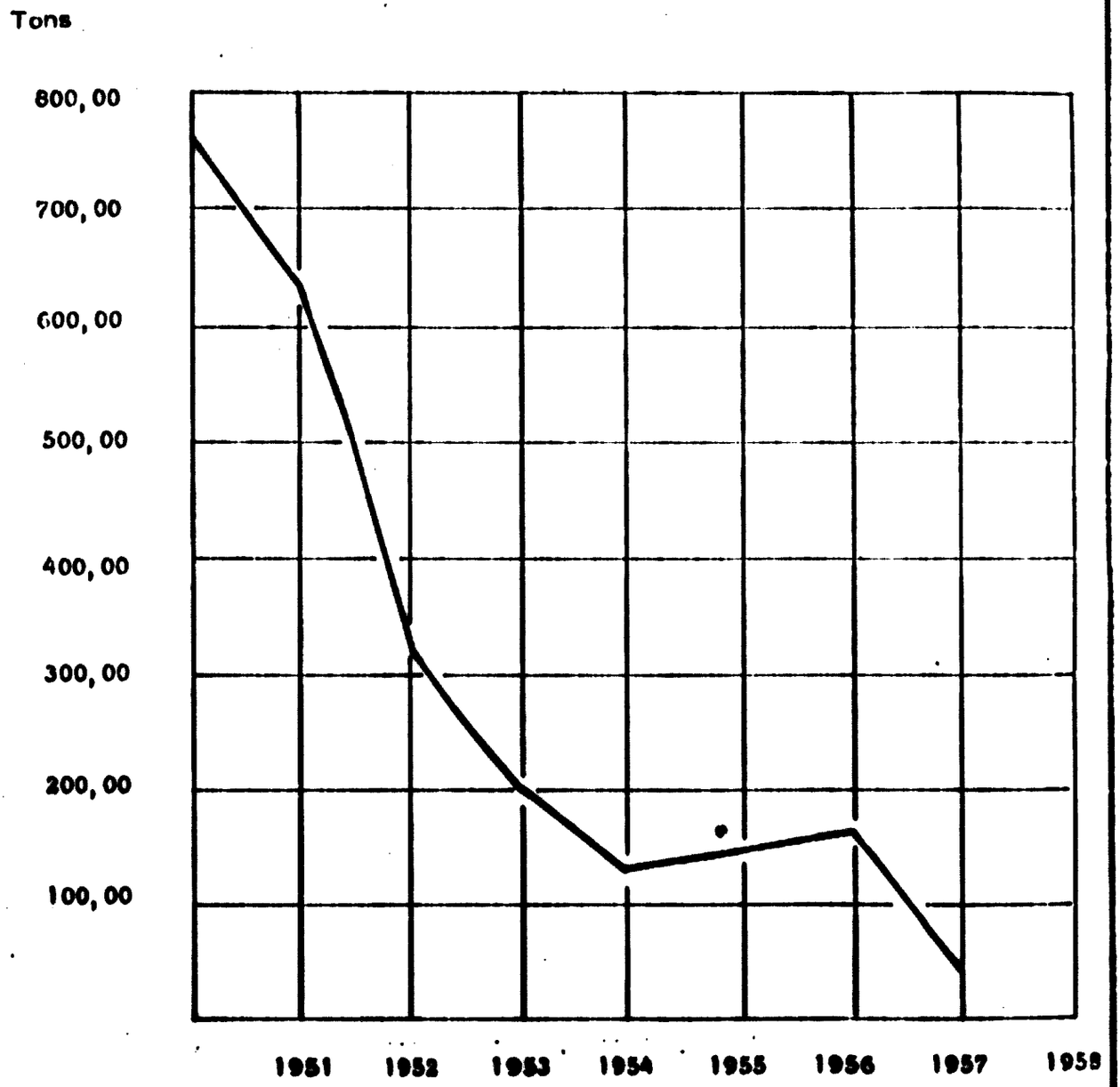
Price of rice bran (US$ 1 = 20.6 baht).

Source: Market Division, Department of Internal Trade, Ministry of Economic Affairs.

production is consumed by the farmers themselves, the main problem for paddy procurement consists in collecting the product for commercial trade. Collection, storage and sale of the paddy to the millers is effected by the middlemen, who constitute the link between the producer and the miller. The number of middlemen operating in the country is not well-known, nor is the average quantity of paddy handled by each middleman. This is because the middlemen perform their function in different ways, e.g. after collecting paddy they may sell it to other middlemen, sell it directly to the miller or, as is usually the case, operate a milling plant themselves. A very common practice is that of the middleman who collects the paddy and mills it in huller plants or small mills on a service basis, selling edible rice directly to the consumers, retailers or wholesalers. Since the war, the procurement of paddy by a mill of large capacity (more than 5 tons/h) has been one of the major problems. The hullers and standard mills, by operating on a service basis for the middlemen, have increased their profits, so that the sale of rice to the large mills has been subject to the payment of a higher price to compensate the loss of the profit previously made by the middlemen by trading white rice.

Table 56 of Appendix IV and the diagram on the following page give a clear indication of the continuous reduction in the quantity of paddy which reaches Bangkok, where most of the large mills are concentrated. From the figures it should be noted that, in addition to the sharp reduction in quantity, the concentration of the delive-

Tendency of quantity of paddy shipped to Bangkok mills.



ries during the first four months of the year is significant. This is because the millers have been forced to procure most of their paddy at harvest time, when prices are lower because of the increased supply.

At present, it is possible to procure large quantities of paddy for the operation of a large mill only through the following alternatives:

- making use of the present system of trade, through the middlemen, encouraging them to collect and sell the product to the mill at a higher, more attractive price. The higher price is largely determined by the situation of the individual middleman, and also the fluctuations in the cost of the paddy and the price of processed rice on the various markets. Another important factor is the financial and speculative capacity of the industry.

- restructuring the entire paddy collection and trading system, eliminating the middlemen or integrating them into the structure as dependents of an organization under the management of the rice-mills, a farmers'cooperative or the State. In the case of this alternative it should be borne in mind that it is necessary to replace the middlemen not only in collecting the paddy but also in the numerous other services they render to the farmers.

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The terms and conditions governing the paddy trade include payment in advance (financing the harvest or part of it) or on delivery (the latter practised by the Government), the collection of the paddy from the farmer (i. e. transport at the expense of the middleman), assessment of the quality and hence the price. This assessment is done by means of the analysis of a representative sample carried out in a subjective way by agreement of the two contracting parties.

The middleman at present usually sells the product at the millside free of transport expenses, and receives payment on delivery . The price is established by agreement of the parties concerned at the time of purchase, after a rudimentary examination of the paddy has been carried out by shelling a sample on an abrasive surface using a piece of wood

4.4. Importance of rice exports to the Thai economy

Table 4 gives a clear idea of the importance of rice exports for the economy and trade balance sheet of Thailand.

In fact, over the last ten years, the value of rice exports has amounted on average to over 1/4 of the total export earnings.

Table 4 also compares the quantities and values of rice exports with those of maize.

4. TOTAL EXPORTS WITH REGARD TO THOSE OF RICE AND MAIZE

Years	Total Value Exports(FOB) (Millions of dollars)	Rice Exports Quantity (millions of tons)	Rice Exports Value (Millions of doll)	% Total Value Exports(1)	Maize Exports Quantity (Millions of tons)	Maize Exports Value (millions of doll	% Total Value Exports(
1960	436.5	1.20	128.5	29.8	0.514	27.5	6.3
1961	500.9	1.58	180.0	36.0	0.567	30.0	6.0
1962	476.5	1.27	162.0	33.9	0.472	25.0	5.2
1963	483.5	1.42	171.0	35.3	0.744	41.5	8.5
1964	617.0	1.90	219.5	35.5	1.115	67.5	10.9
1965	647.0	1.80	216.5	33.4	0.804	48.5	7.4
1966	691.0	1.51	200.0	28.9	1.218	76.0	10.9
1967	694.0	1.48	233.0	33.5	1.093	68.0	9.7
1968(1)	648.0	1.02	184.0	28.3	1.380	88.0	13.5
1969(1)	794.0	1.83	293.5	36.9	1.530	99.0	12.4

(a) Source: "Economic Progress of Thailand - general indicators" - Office of National Economic Development Board - October 1968

(1) Estimated

It should be borne in mind that, after rice, maize is Thailand's main cereal crop; at present approximately 1.7 million tons are produced, as compared with 10-12 million tons of paddy.

But while the production of the latter has remained more or less constant since 1960 (except for a 20% increase in 1966-67 and in the last two years), the production of maize has more than tripled since 1960, and so have exports.

From Table 46 and Diagram XI , we can make further interesting comparisons between exports of rice and those of other main Thai products such as rubber, teak and tin ingots.

The production of rubber in Thailand at present amounts to approximately 230,000 tons per year, having gradually risen from a production of about 172,000 tons in 1961. However, exports have gradually fallen in value, clearly on account of the growing competition of synthetic products taking the place of rubber.

The volume and value of Thai exports of teak and tin have also decreased, as a result of advances in industrial technology.

Thailand's role as a supplier of rice to South-East Asia is today threatened by the drive to self-sufficiency in neighbouring countries based on new, high-yielding varieties.

Rice exports have halved since 1964-65 owing to changes in the trade patterns of traditional clients and of major competition from the U.S.A. and from Japan even in the European markets. In the future, export earnings may diminish on account of lower export prices rather than because of a further decrease in the volume of exports.

A number of major irrigation projects in the rice areas are being undertaken, partly with I.B.R.D. finance, and the spread of the new varieties and increasing application of modern methods - at present limited - can be expected.

The price of rice exported by Thailand and other Asian countries, evidently on account of a growing demand for rice by international markets, rose gradually until 1969, as did that of the rice exports of non-Asian countries. This caused prices to rise on the home markets of the rice-producing countries as well.

The increases in prices on the Thai home market have been slightly less than those of exported rice: they are nonetheless of the order of 50%, as may be seen from the figures given in Table 46.

This difference is due to the rice premium tax imposed on exports by the Thai Government; this tax helps to keep the local market price stable while allowing the export price to be adjusted in accordance with the world market price.

However, it would appear that the tendency for export prices to rise came to a standstill in 1969, with a considerable drop in prices at the beginning of 1970 (note the figures given in Table 47).

The present requirements of the home market are estimated on average to be well in excess of total production, and it is forecast that they will increase rapidly over the next ten years (Table 48) as a result of the rise in population. There should therefore be no great concern lest the above-mentioned reduction in exports have a

negative influence on Thai rice production, since it is necessary to increase the unitary yield and also considerably extend the seeded area in order to meet the future demands of the home market alone.

CHAPTER 5

THE THAI RICE PROCESSING INDUSTRY

5. THE THAI RICE PROCESSING INDUSTRY

5.1. Background

From the introduction of rice into Thailand until the second half of the nineteenth century, milling was carried out domestically or on a very small scale, with simple, rudimentary equipment or machinery.

Mechanical milling, on an industrial scale, was introduced into Thailand, with machinery imported from Europe, after 1975.

At about the turn of the century many mills were constructed in Thailand, along the river Chao Phya and near the ports of Bangkok, Dhonburi and Ayudhya, to process the rice on an industrial scale. These rice mills were of large capacity, constructed on strictly rational principles and equipped with machinery of European design.

The motive power for the installations was provided by large steam engines; the fuel for the boilers usually consisted of rice-husks.

Until the end of the Second World War, milling in Thailand was carried out mainly in two kinds of installations: large commercial complexes, with a high output, concentrated along the river Chao Phya and in the neighbourhood of the port of Bangkok processed the rice for export or for marketing in the large towns,

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Note: Appendix IV contains relevant facts and supporting data to this Chapter.

whils smaller, medium-capacity mills, similar to the large ones but on a smaller scale, processed the rice destined for local consumption or for sale in the village.

Immediately after the Second World War, the system of milling in Thailand was changed by two technical innovations: the huller and the so-called "Standard mill".

The huller is worked by an internal combustion engine, and mills the rice in a single operation, carrying out shelling and whitening at the same time. In Thailand, the hullers were imported, and later manufactured locally, with great success, and before long the entire milling system changed completely, with very important consequences and serious repercussions. The huller plants are generally to be found in the production areas. They have a very limited capacity (less than 5 tons/day), and can be purchased and installed at low cost, since all that is necessary is a shed to house them. Processing is usually carried out on a service basis, i. e. the operator does not buy the paddy, but only processes it, returning the milled rice to the owner.

The huller must be held responsible for various negative aspects of the rice economy; these may be summarized as follows:

1) The reduction in the food value of the product, which is processed to a high degree of milling to give an invitingly white appearance. It loses part of the substances contained in the

specks of bran left on the kernel by the imperfect manual milling.

2) The considerable reduction in the quantity of edible rice produced by the hullers in comparison with larger mills.

3) The inferior quality of the edible rice, on account of the high proportion of broken or mechanically damaged grains.

4) The production of a single by-product, consisting in a mixture of powdered husks, bran, polish and small fragments of grain, instead of separate, distinct by-products.

The "Standard mill" is the result of the development and construction, by local manufacturers, of rice-processing machinery similar to that imported from Europe but of smaller dimensions and capacity.

It is therefore not only due to the huller that the big mills in the neighbourhood of Bangkok and Dhonburi were forced to close, but also because medium-sized plants began to be manufactured locally for installation in or near the various production areas.

The hullers and standard mills are largely responsible for the spread of rice-processing on a service basis, i. e. milling for payment without the purchase and sale of the rice.

This practice was almost unknown to the big mills, and today

constitutes one of the most important problems to be solved in modernizing, rationalizing and improving the economic yield of the rice industry.

5.2. The present types of rice mill in Thailand

In 1960 a study was carried out on the Thai rice industry. This classified the number, type and characteristics of the mills as follows:

(1) Small mills: plants with a capacity of 1-5 tons/day. They generally consist of one or more hullers, which carry out the entire milling process in one operation. At the end of 1956 there were 3518 of these plants, 16% of them in the Central Region. Their total capacity amounted to 7,960 tons, i.e. 11% of the overall milling capacity of the Thai rice industry (see Table 57).

These plants were most common in the Northern and Southern Regions; in the North-Eastern Region they represented 13.7% of the capacity of the industry, while in the Central Region they represented only 3.2%.

The small mills or hulling plants were especially numerous in areas where communications and transport were difficult, and in the neighbourhood of the production areas, where they processed rice for local consumption.

(ii) Medium-sized or standard mills: plants with a capacity of 5-30 tons/day. They generally consist of several machines, each executing one phase of the milling (multi-stage milling). The product is transported in continuation from one machine to another by means of mechanical conveyors.

At the end of 1956 there were 2,179 standard mills in Thailand, with a total capacity of 26,341 tons/day. The Central Region possessed 1,244 of them, i.e. 57% of the national total, with a production of 17,736 tons/day, forming 67% of the total production of the medium-sized mills (see Table 58).

(iii) Large mills: plants with a capacity of over 30 tons/day. Besides being equipped with a large number of processing machines, they also have fully-mechanized conveyor systems to transport the product from one part of the mill to another.

In 1956 the number of large mills in Thailand totalled 370, with a total productive capacity of 36,98 tons/day (see Table 59). The largest of these mills were concentrated in the Bangkok and Dhonburi regions (40) and in Ayudhya (34). Of the national total, 227 were in the Central Region, i.e. 61.35%, with a productive capacity of 35,506 tons/day, equal to 69.20%.

There were 41 mills with a capacity of more than 100 tons/day.

Of the 6,067 rice mills in Thailand in 1956, by 1970 many had disappeared, but many more new plants had been erected. The most recent official statistics give the total number of rice mills as 24,638, of which 85 have a productive capacity of over 50 tons/day, and the remainder of 5-50 tons.

In the last fourteen years almost all the large mills have closed, especially in the areas of Bangkok, Dhonburi and Ayudhya, while the small mills or hulling plants have increased from 3,518 to 18,642: an increase of almost 500%. On the other hand, according to the data collected, the standard mills, i.e. the mills with a capacity of 5-50 tons/day, but using a processing system different from that of the hullers, have increased from 2,179 to 5,911, almost 250%.

5.3. The causes of the change in the number and size of the mills

5.3.1. The official reasons for the change in the number and size of the rice mills in Thailand are as follows:

- the cost of transport
- the cost of labour

If the rice is transported as paddy to the large mills at the mouth of the river Chao Phya from the production areas, the cost of transport is 30-35% more than for milled rice, since not only is the edible part of the product (65%) transported, but also the parts which form the by-products of milling: the husk and impuri-

ties (25%), polish and bran (10%). These by-products are of far less commercial value than the main product, edible rice.

The cost of labour in the towns of Bangkok and Dhonburi is considerably higher than that usually paid in the agricultural areas where the rice is produced, since in the latter those employed in the rice mills after the harvest find employment in agriculture at other times of the year.

In addition, it must be remembered that in the case of the hulling plants the cost of labour is very difficult to calculate, since they are run by owner-operators whose families often provide the necessary labour.

5.3.2. It would seem, however, that the above reasons are not the principle factors which have determined the changes in the Thai rice industry. There have been other reasons for these changes and more precisely the following:

a) <u>The high cost of capital</u>. As mentioned above, the large mills usually buy the paddy, and very rarely process it on their own behalf. Apart from the capital tied up in the actual installation and services, the working capital necessary for running the plant is extremely high. The paddy is paid for on delivery, stored for a certain length of time and not always dispatched and paid for as soon as it has been milled.

The basic characteristic of the rice industry is nevertheless that of a processing industry for an agricultural product, harvested once a year and subject to a constant, inelastic demand. Bearing in mind that the rate of interest on bank loans in Thailand today is about 14%, for loans for industrial purposes, it is quite clear that working capital is of fundamental importance in the rice industry. In a developing country such as Thailand, it is in most cases possible to employ a large sum of capital at a better interest rate and with less risk than that offered by the rice industry.

Taking the minimum average cost of paddy as 50 US $/ton, and allowing an average storage period of only three months, the cost of the capital employed (at the current interest rate on bank loans) amounts to US $ 1.75 per ton, at least.

The standard mills and hulling plants have overcome this difficulty by milling on a service basis, so that they do not have to tie up any great amount of capital.

b) Taxation of the rice-milling industry. As far as the State is concerned, rice is the most reliable source of revenue, and is of the greatest importance. It is subject to various taxes, such as municipal tax, export duty and the "rice premium". (1)

To illustrate the effect of taxation on the cost of rice and milling, a calculation based on the price of a ton of paddy in 1957

(1) The Thai Government's fiscal policy concerning rice is often subject to variations. The latest change of major importance occurred in 1968, when the so-called export "premium" (a levy on exports) was drastically reduced. There are rumours that other important variations may be introduced in 1971.

is given (1):

Stages	Expenses in Baht (US$)	Middleman's profit Baht (US$)	Government taxes Baht (US$)	TOTAL Baht (US$)
1	85 (4.25)	88 (4.40)	27 (1.35)	200 (10.00)
2	86 (4.30)	63 (3.15)	33 (1.65)	185 (9.10)
3	133 (6.65)	30 (1.50)	100 (5.00)	263 (13.15)
			160 (8.00)	
			648 (32.40)	648 (32.40)
Rice Premium	304 (15.20)	181 (9.05)	808 (40.40)	1293 (64.65)

The three stages shown above are: 1) the sale of paddy to the middleman, 2) processing, which is covered by the "processing tax" and a municipal sale tax, and 3) export, which includes customs duty of 4.2% as municipal tax and the so-called "rice premium". Considering the processing tax alone, which amounts to 33 Baht/ton of paddy (1.75 US$/ton), to be paid to the Government by the rice mill, it is evident that the operators endeavour to avoid taxation. The large mills are forced to pay the tax because of their situation and internal structure, and in fact the amount of rice processed is recorded by a gauging device installed by the Government on the main transmission shaft, which checks the movement of the processing machines.

(1) See: Rice Farming in Siam, Bangkok, 1969.

The pure cost of processing in a traditional mill is claimed to be about 3-3.50 US $/ton to which must be added between 3-3.50 US $/ton for marketing, general expenses, interests on working capital, taxes and profits. By avoiding the Government Municipal processing tax alone, the mills can save 50% on the net cost of processing (US $ 1.50).

c) Exportation on the basis of contracts of sale between Government and Government. In 1967, 650,631 tons of milled rice were exported on the basis of Government contracts, out of a total of 1,442,726 tons. In the years 1963 and 1969, exports on this basis decreased to 350,711 tons in 1963 and 325,312 tons in 1969.

During the first seven months of 1970, Government exports constituted about 23% of the total exports, i.e. approximately 197,000 tons of milled rice.

The large mills in Thailand were originally constructed to process large quantities of rice destined for export, either directly (industrial exporters) or indirectly, through private exporters. The intervention of the Government in exportation has undoubtedly been a determining factor in the decentralization of the rice industry.

The sale of rice by the Government is usually based on price factors influenced by political aspects, and the rice premium can be modified to a certain extent to offset reduction in price. It has,

however, placed the large mills and industrial exporters in great difficulties, and these have preferred to turn to other forms of activity.

(d) Market supplying milled rice for export. Replacing the industrial exporter, the Government and typically commercial exporting firms have created and developed a market to supply milled rice for export. It suits the exporter to have a large number of different concerns from which to buy the milled rice, as he can then choose the most competitive offer.

The standard mills and hulling plants, and also a very large number of middlemen, form the basis of this market, from which the exporter can obtain the product he requires to fulfil his sale contracts.

(e) Local production of machinery. The large mills were generally equipped with imported machines, which were usually large and with a high capacity.

The local production of machinery for the rice industry, which was developed after the War, is based solely on the manufacture of hulling machines or small, low-capacity shellers and whitemers.

The large mills have therefore found it impossible to replace their machines or obtain spare parts from the local manufacturers,

as do the small and medium-sized mills. For a large mill it was necessary to import spare parts or new machines from the country where the machinery was constructed; this involved licences and permits, in addition to the high cost.

Consequently, from the point of view of maintenance and repair as well, the large mill is at a disadvantage.

(f) Lack of adequate infrastructure. The development of the export market, as a result of Government intervention, was not preceded or followed by the creation of the infrastructure necessary to back up the large rice mills. These found themselves caught between a free market for paddy and a heavily restricted market for milled rice and certain exportable by-products (brokens) under the control of the Government.

The middleman who provided the large mills with paddy could sell the milled product directly to the exporter, using the small and standard mills to process it on a service basis, with costs which were extremely competitive, if indeed he was not actually paid by the mill, under particular conditions.

Only massive intervention by the Government, by buying the paddy from the farmer and creating large collection centres, would have saved the large mills from almost complete extinction by resolving the crisis of paddy supply.

5.4 The consequences of the change in the number and size of the rice mills in Thailand

The sharp reduction in the number of large mills and the enormous rise in the number of small and, to a lesser extent, medium-sized mills have inflicted considerable damage on the economy of the country: damage which it is impossible to estimate with precision.

In 1956 the hulling plants represented 11% of the rice industry in Thailand, and numbered 3,518; about 89% of the rice was processed in the standard and large mills. By 1970 the number of hulling plants had risen to 18,642.

Today these plants process about 80% of the rice consumed by the country, i.e. approximately 3.5 million tons of paddy. The standard and large mills process the remaining 20%.

The disappearance of the large rice mills has been only partly compensated by the rise in the number of standard mills; of the 5,145 plants with a capacity of 5-50 tons/day, 3,700 have an output of less than 10 tons/day.

The yield of the hulling plants is estimated at 2-8% less than that of the standard and large mills; a minimum of 2% more than the larger mills is lost in terms of edible rice, and this may be as much as 8%, depending on the quality of the paddy.

On the basis of the official figures, which state that 3.5 million

tons/year are milled in the hulling plants, the Thai economy suffers the following losses:

- in terms of edible rice: 63,000-280,000 tons/year;
- in terms of value, at present prices for rice (25% brokens) and bran : US $ 3,690,000 - 14,560,000.

In addition, the inferior quality of the product must be taken into account, as the hullers give a much higher percentage of brokens. As a result, it can be calculated that the milled rice produced by the hullers, because of its high brokens content, is sold at US $ 25 less per ton (the difference in price between 100% white head rice and 25% brokens).

5.5 Present cost of milling in Thailand

According to local official sources the total processing cost in an "standard mill" is approximately $ 7-7.50/M.T. of paddy. This includes the pure milling costs, depreciation, interest on working capital, overheads and the miller's profit. The pure milling cost of the large mills is 10% less than in standard ones (US $ 3 per ton as against US $ 3.30 per ton) (1).

It has been calculated that labour costs represent 45-60% of the operating cost of a mill. Repair and maintenance come second in order of importance, making up 7-10%. Amortization and depreciation of the plants are negligible, as most of the plants were con-

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(1) It was not possible to ascertain the basic data on which this calculation was founded, and it is doubtful whether these include all the economic and financial costs; but the first figure seems to correspond fairly closely to the results of our feasibility study (which includes all economic and financial costs).

structed a long time ago (see Table 68).

The custom of debiting the processing cost in the case of milling on a service basis is of great importance. The hulling plants usually mill the rice, without buying and selling it, on behalf of the producer or trader to whom it belongs. The cost of this service is paid partly in money and partly in kind, e.g. the edible rice is restored to the owner and the by-products from milling (husks, bran, polish and small brokens, less than a quarter the size of the grain) are kept by the operator.

Although some of the standard mills purchase the rice they mill, many of these too process rice on a service basis, in competition with the hulling plants.

The cost of processing in standard mills is higher than in hulling plants, but on the other hand the rice they produce is of superior quality, containing a smaller percentage of brokens.

A survey carried out in 1967 showed that 80% of the standard mills operated both by purchasing and selling the rice and on a service basis.

8.6 The need to reorganize and improve the Thai rice industry

The home market, as well as the export market, is now tending to demand a higher quality product. The North American rice

industry broke into the international market after the War, and has been increasing its trade ever since; this has made it necessary to base competition on the quality and consistency of the product as well as its price.

On the other hand, both traditional and new markets which buy mainly because of a low price require that this be achieved without reducing the price paid to the farmer for the paddy.

The processing industry therefore finds itself called upon to absorb the pressure of production on the one hand and the consumption market on the other: the one demands that the price paid for paddy be maintained or even increased, while the other requires the price at which milled rice is sold to be reduced as much as possible.

Numerous measures, both technical and of other kinds, must be undertaken in order to modernize and improve the Thai rice industry, so that it will be able to supply the demands of the market, both now and in the future.

Direct action, which is the responsibility of the mills and those connected with them, is as follows:

- research and selection of new, modern processing methods;
- the definition of a new industrial organization, consisting of mills which are economically and technically more efficient and which vary in accordance with their location and the role they

are called upon to fulfil;

- modernization of the reception, storage and transport of the product and by-products within the plants, and all auxiliary services;
- exploitation of the by-products, using them alongside the main industry or creating new industries.
- new procurement policy.

CHAPTER 6

ESTABLISHMENT OF A MODERN RICE PROCESSING MILL

6. ESTABLISHMENT OF A MODERN RICE-PROCESSING MILL

6.1 The modern rice-mill

At present, rice-processing can be divided into the following categories, according to the methods adopted:

- entirely mechanical milling;
- mechanical milling assisted by organic solvents.

6.1.1 Mechanical milling may in turn be divided into:

- single-stage milling, using only one machine to produce edible rice from paddy (as in the case of the hullers);
- multi-stage milling, in two or more operations, using several machines which each carry out one stage of the milling process (shelling, whitening, polishing etc.).

Multi-stage milling is carried out by two distinct methods, taking their names from their countries of origin: the European (or "traditional") method and the Japanese method.

Thailand is at present at the point where these two systems meet, or perhaps conflict.

The European method was introduced into the country with the rice mills. It is based on the use of disk shellers, whiteners with an inverted vertical cone and polishers or brushers with a vertical cone or cylinder.

The Japanese system, which began to spread in Asia and other parts of the world only after the War, uses shellers with rubber rollers, whiteners of two different types (friction or emery) and hori-

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Note: Appendix V contains relevant facts and supporting data to this Chapter.

zontal cylindrical polishers.

There is also a difference in the methods adopted to separate the shelled rice from the paddy. The traditional or European system uses an oscillating tray divided into compartments, while the Japanese method consists of a tilted steel-mesh tray, which is stationary for small plants or vibrating for large mills.

Mechanical processing, whether by the traditional European system, the Japanese system or a mixture of the two, must however be considered from a rather different point of view than in the past. While technological progress has changed very little the principles on which the various machines operate, it has made considerable advances as regards the flow chart, by introducing new auxiliary machines.

In the last few years, excellent results, from the point of view of both quantitative and qualitative milling yield, have been produced by the so-called "fragmented" processing system. Since every machine processes the grains of rice in a certain position, and the efficiency of the operation depends on one or more biometric axes of the grain, it can be seen that uniformity in the biometric dimensions is of the utmost importance. For example, in the case of the sheller

with abrasive horizontal discs, shelling is carried out by pressing the ends of the grain when it is in a vertical position. The space between the two discs must be such as to allow all the grains to be husked if they are all of the same size. If there are longer grains, they are bound to be broken or damaged, while grains shorter than average will not be husked at all. In the case of the roller sheller, on the other hand, the grains are husked lying in a horizontal position. Those thinner than the space at which the rollers have been set cannot be shelled, while grains which are too large are liable to be broken.

The same is true of all the other processing machines. If the rice were divided into batches of grains with perfectly uniform length or thickness, they could be processed on a rational basis, giving the highest possible yield. Especially in Thailand, where the paddy to be milled is usually a mixture of different agronomic varieties, pregrading, and also grading of the milled rice would certainly constitute a step forward.

After milling, the different batches of pregraded rice, processed separately, would be kept apart. The separation of brokens from whole grains, from the different products milled, could be carried out in a perfectly rational way, and the brokens, subdivided according to size, and kernels of two or more sizes could be collected separately at the end of the milling process.

By controlling the proportion in which whole grains and brokens of various sizes are mixed, it would be possible to produce absolutely

uniform batches of rice, answering to the precise norms laid down in the standards for milled rice.

The grading of the product on the basis of size could also be combined with that according to specific gravity, removing grains or brokens of a chalky texture; these could then be mixed with the saleable product, again in accordance with the percentages laid down in the official rice standards.

The Thai economy would benefit considerably from this, especially as regards rice exports, as batches of rice corresponding perfectly to the conditions of the sale contract,as regards quality, could be exported. At present, it is not rare for batches of rice bound for export to contain a percentage of brokens lower than the permitted proportion, in order to avoid any protest or rejection on the part of the buyer.

This obviously harms the economy of the country, since, by substituting whole rice for brokens, the real value of a batch of rice becomes considerably higher than the price charged. One of the main objectives of the Thai rice industry must be to install plants designed on the basis of a flow chart which includes the pregrading of paddy, processing in separate batches of graded paddy, separate storage of milled rice and by-products and accurate mixing of the various products to achieve the correct qualitative composition.

Mechanical milling with the help of organic solvents is the latest technological development in modern rice-processing. We

shall deal with this subject in greater detail in Appendix V.

The method is used only for the whitening process; shelling, grading, etc. remain unchanged and must be carried out by the normal mechanical methods. In other words, processing by means of organic solvents takes the place of normal whitening, between shelling and grading of the milled rice. Pre-grading of the paddy and dosed mixing of the different types of milled rice and brokens cannot be replaced by the use of organic solvents, but on the contrary should be combined with this method in order to obtain the best results.

6.2. Technical alternatives considered for the choice of a modern rice-processing mill.

6.2.1. Size of the mill

Since a modern rice-processing system has to include the extraction of the crude oil from the bran, there are two possibilities:

- the integration of a modern mechanical mill with a solvent extraction plant aiming at removing from the bran the oil in the crude state;
- the adoption of the X-M process to polish the rice in the presence of a solvent.

For a successful technical and economic operation both these technologies require a minimum processing capacity estimated at not less than 15 tons/h in terms of raw paddy, and continuous operation for 24 h/day and at least 300 days/year for a total of 90,000 tons of raw paddy .

This is considered, by Riviana Food Inc., to be a minimum requirement for the profitable adaption of the X-M process for polishing rice in the presence of a solvent and is at the same time an optimal capacity according to the experience gained in the United States where a new programme for the construction of modern, large mills sets the optimal range between 80,000 and 100,000 tons per year. Moreover, as a mill working 90,000 tons may already be confronted with paddy procurement difficulties, a fortiori a mill with a large capacity would encounter even greater difficulties.

For the above reasons it is not possible to compare these two modern milling processes with the traditional Thai mills, in view of the seasonal operation of the local mills, their small size and the reduced time of operation (one-two shifts per day).

The feasibility study has been carried out on three modern processing mills with the same daily and yearly capacity (15 tons per hour for 24-hour operation, 300 days per year, for a total of 90,000 tons of raw paddy). Of these three mills, the first has been calculated adopting a fully mechanical processing system, including all the most up-to-date types of lay-out and processing machines, pre-grading of the paddy, shelling by rubber rollers, whitening by means of emery and/or friction polishers, complete grading of the milled product, blending of the final saleable rice.

The second mill, with the same capacity and design as the first mechanical one, has been considered integrated with a bran oil extraction plant. This plant has been chosen from the various models available on the market because of its high output in crude oil, low cost of operation and well-known technology. It is a Japanese-made plant of the batch type, with a daily capacity of 30 metric tons/h of bran input for 24 hours.

TABLES

The third mill adopts the K-84 process in polishing the rice. Pre-grading of the paddy, shelling and white rice grading and blending are in this case identical to the other two mills.

Diagram XV shows a modern flow chart in which machines of a different type or design, including organic solvent whiteners, could be used for the various stages of the process (See also Table 68).

6.2.2. Location factors

The factors affecting the location of the mills which have been considered are the sources of the paddy, transport facilities and market outlets for the finished product. Since paddy production in Thailand is concentrated principally in the central plain, which is the region producing the bulk of the product for commercialization, the new modern mill should without doubt be located in this area. The cheapest way to transport the paddy is by water; this method has several advantages over road transport. In addition, a modern mill of such a large size has to be considered as producing rice more or less exclusively for export, which calls for transport facilities by water from the mill-side to the cargo ship. The most natural and rational location therefore seems to be alongside the river Chao Phya, which was also the natural location for the large commercial mills which once operated in Thailand.

The cost of the land, which is highest near the towns of Bangkok and Dhonburi, will determine whether the location chosen is more precisely north or south of Bangkok and how far away it is from the town. Water, drainage and electricity have not been considered as factors determining the location, since each plant will be equipped with electric generators and independent water pumping and distribution systems. The availability of labour and housing facilities were also not considered as factors affecting the choice, since the area along both sides of the river is densely populated and the inhabitants are well distributed among residential villages. In addition, labourers move easily for several kilometers with small boats driven by engines.

A second alternative for the location of the mill in the near future might be alongside or in the middle of one of the proposed irrigation schemes, financed through international financial sources, where double-cropping will be introduced. The cost of procuring paddy for the plant will in this way be greatly reduced, because of the shorter storage time and the smaller seeded area required to produce the necessary 90,000 tons. In this case, too, inland water transport facilities must be available for the movement of the products, together with connections to the road system serving the scheme.

6.2.3 Drying and storing the paddy

A modern rice-processing plant with a capacity of 90,000 tons of paddy per year requires huge storage facilities, since at present there is only one crop per year. In addition, from Table 5 it has been estimated that the buying period for the considered mills is concentrated mostly (80%) in the first four months of the year. Storing the rice in bulk makes it imperative to provide artificial drying, because the paddy production in the country does not ensure a bulk of product of uniform and low moisture content. An "in bin" drying system has been chosen for the modern mill drying and storage facilities. This system makes it possible to reduce the moisture content of the paddy by utilizing large quantities of ambient air without any preheating, and it ensures uniform drying of the product independent of the differences in the moisture content of the several batches.

6.2.4 Characteristics and milling yield of the three alternatives chosen.

The paddy to be processed in the three mills has been estimated as having average quality characteristics and milling yield. Since no real standardization of quality characteristics and milling yield is possible in the country, a grading system for procuring paddy has to be established on a well-defined scientific basis. The purchasing price of the raw material must be calculated in accordance with standard quality requirements. Refraction of the price has to be applied for

5. QUANTITY OF PADDY MILLED IN RICE MILLS IN BANGKOK (1951-1958) in tons

Month	1951 Quantity	%	1952 Quantity	%	1953 Quantity	%	1954 Quantity	%
January	113,265	15.06	85,820	13.95	46,717	13.61	27,281	13.52
February	76,747	10.21	79,902	12.98	31,841	9.27	17,656	8.75
March	95,588	12.71	37,920	6.16	46,037	13.41	24,891	12.33
April	47,291	6.29	47,759	7.76	37,643	10.96	17,023	8.43
May	43,333	5.76	48,684	7.91	25,336	7.38	5,884	2.91
June	39,419	5.24	40,563	6.59	24,139	7.03	7,364	3.65
July	51,307	6.82	43,897	7.13	27,485	8.01	11,749	5.82
August	64,559	8.58	48,381	7.85	26,654	7.76	19,879	9.85
September	55,866	7.43	46,587	7.57	20,418	5.95	27,549	13.65
October	43,829	5.79	48,955	7.95	12,260	3.57	22,968	11.38
November	38,906	5.17	50 679	8.23	16,739	4.87	14,405	7.14
December	82,960	11.03	36,483	5.92	28,076	8.18	5,198	2.57
Total	752,661	100.00	615,450	100,00	343,345	100,00	201,839	100.00

Table 8 continued

Month	1985 Quantity	1985 %	1986 Quantity	1986 %	1987 Quantity	1987 %	1988 Quantity	1988 %
January	18,742	13.23	20,085	13.03	20,462	12.70	9,201	19.81
February	23,633	16.68	16,350	10.60	23,684	14.70	8,161	17.40
March	26,036	18.38	18,513	12.01	23,463	14.56	10,319	22.00
April	17,610	12.43	6,342	4.12	16,232	10.08	6,231	13.28
May	5,334	3.76	8,511	5.52	14,341	8.90	3,113	6.64
June	6,475	5.09	8,466	5.49	11,371	7.06	4,573	9.75
July	11,488	8.11	10,020	6.51	19,761	12.27	2,822	6.01
August	6,941	4.90	11,210	7.18	10,654	6.61	1,365	2.91
September	3,489	2.46	11,614	7.54	6,017	3.74	1,034	2.20
October	4,096	2.89	15,989	10.38	5,165	3.21	-	-
November	1,439	1.02	10,936	7.10	3,946	2.45	-	-
December	14,399	10.09	16,084	10.42	5,993	3.72	-	-
Total	141,685	100.00	154,035	100.00	161,089	100.00	46,999	100.00

Source: Ministry of Economic Affairs

lots of grain in accordance with the real characteristics revealed by the laboratory tests. An important point to be emphasized is that considerable losses will be encountered during drying and storage. In fact, the procurement of the material at harvesting time, the drying and conservation entail losses which can be calculated at about 3-6% on average. In the specific case of the establishment of an X-M process, it is very probable that the moisture content of the paddy will have to be reduced to less than 14%; this means that further losses may be sustained, since a 14% moisture content is estimated as the standard moisture content for cargo milled rice destined for export. Fully mechanical milling and the integration of the mechanical mill with a bran oil extraction plant does not call for a further reduction below a 14% moisture content.

A rice grading laboratory has been considered for the three alternatives, in connection with the paddy procurement and pricing, which must be rationalized on a scientific basis.

Milling yields for the three mills have been calculated on the basis of data collected in the country as well as in other rice-producing countries in Asia and elsewhere.

For the improved modern mechanical milling plant (Alternative II), a total milling yield of 69% has been considered, of which 11% has been calculated as broken rice. Assuming an average total milling yield, for the existing Thai mills, of 66% , of which 18% consists of brokens, the yield obtained from the improved mill under consideration

is higher in total and 1% less in brokens. The same yield is calculated for Alternative II, since the mechanical milling plant is exactly the same as that considered for the first alternative.

The milling results of the X-M processing plant (Alternative III) have been calculated, on the basis of experience in North America, at a total yield of 70.9%, of which 9.3% is brokens. Milling degree has been based on 10% bran extraction, which more or less represents the Thai milling degree for high-grade exportable rice.

For Alternative II the crude oil output from bran has been calculated as 15% (of the weight of the bran). It should be noted that by integrating a bran oil extraction plant with the rice-mill the crude oil extracted by the X-M polishing process has the lowest F.F.A. content obtainable. The de-fatted bran output for the second alternative has been calculated as 80% of the weight of the raw bran processed, and 6.8% of the weight of the raw paddy processed in the case of the X-M method. (See also Table 12).

All the 3 alternatives for the modern mill consider the utilization of the paddy husk as fuel in producing electricity. All the machines foreseen for the different sections of the plant are driven by independent electric motors.

The feasibility calculation does not take into account the cost of the gunny bags, considering that in Thailand used bags are

utilized for the domestic rice trade, while exporters provide in many cases a standard type of bag to the different millers from whom they buy the product to be exported.

6.8.5 Personnel and management

In the case of mechanical milling, personnel and management does not represent an important problem; in fact, rice milling is a well-known industry in the country, and experienced personnel and management staff are readily available. In the case of oil extraction from bran, five plants have already been established in the country; these plants are operating with a locally-trained management and personnel. The X-M process does represent a completely new technology, calling for knowledge and skill in the fields of both milling and oil extraction.

In order to utilize local management and personnel, a good and intensive training must be conducted during the first years of operation of the plant by the only manufacturer and licensee existing today in the world. Since the X-M process milling plant has to be operated under licence, the training of local personnel and management must be the subject of a special clause of the licensing contract.

Personnel requirements for the three alternatives have been determined, taking into consideration the number of skilled and unskilled labourers given by the plant manufacturers for Japan and the United States, and increasing this number for certain posts in accordance with local conditions (See also Table 9, 8 and 9)

6.2.6 The price of paddy

The price of paddy assumed for the economic calculations in the feasibility study (US $ 68.50 per ton) has been taken as the average price of good-quality paddy delivered in bulk to the mill-side (1).

Since no big mills are at present in operation in the Bangkok area, and the output of the mills considered is very high, the additional expense of transport might be taken into consideration in comparsion with the existing medium-sized and small mills. Prices of white head rice and white broken rice have to be taken for products in the loose state, since the cost of the bag or special package has to be added if not provided by the buyer.

The prices of the raw bran (US $ 29.15 per M.T.) and crude oil (US $ 275.00 per M.T.) are the average prices on the Bangkok market at the time of the survey in Thailand. Rice bran in particular is subject to great variations in price in the different months of the year.

6.2.7 Silo capacity for paddy

Assuming an annual input of 90,000 tons of paddy with the plant operating for 300 days per year, and estimating that 80% of the paddy will be procured during the first 4 months of the year, the silo capacity required is 36,000 tons.

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(1) This price is derived from the average of the prices of paddy Special N° 1 grade (§ 68 per M.T.) and Special N° 2 grade (§ 69 per M.T.) paid by the Government for the crops - year 70/71.

(continued overleaf)

The remaining 20% of the paddy will be acquired during the rest of the year.

6.2.0 Storage of clean rice and by-products

The storage capacity for clean rice and by-products has been calculated for at least 45 days of production (rice + brokens + bran), bearing it in mind that the milled rice has to be for the most part exported, and that the defatted bran can be kept easily for a long period of time waiting for the best selling prices on the market. By increasing the height of the stack of bags an additional storage capacity may be obtained in the semi-godowns.

Other specifications regarding the processing machinery and oil extraction plants, power stations etc. are given below, in Appendix VI (Specifications of machines).

(continued) The values quoted here for paddy rice should be taken as those paid by the millers to the middlemen. The real prices paid to the producer vary, depending not only on factors of quality but also on the obligations contracted by the producers towards the middleman. At present the marketing situation is such that the rice farmer cannot afford to do without the middleman, who acts as money-lender, purchasing the necessary inputs for production, and takes the place of tradesmen and transportation company; he often owns land, which he rents to the farmer; and mills rice free of charge, withholding by-products as payment. In consequence, the price paid to the farmer for unmilled rice is not only well below the $ 62.50 mentioned above, but is also lower than the minimum price of $ 50 per ton guaranteed by the Government. Should the various services hitherto rendered by the middleman be carried out by cooperatives with the assistance of large mills, the real price paid to the farmer would make his production more profitable than it is today.

CHAPTER I

INTRODUCTION

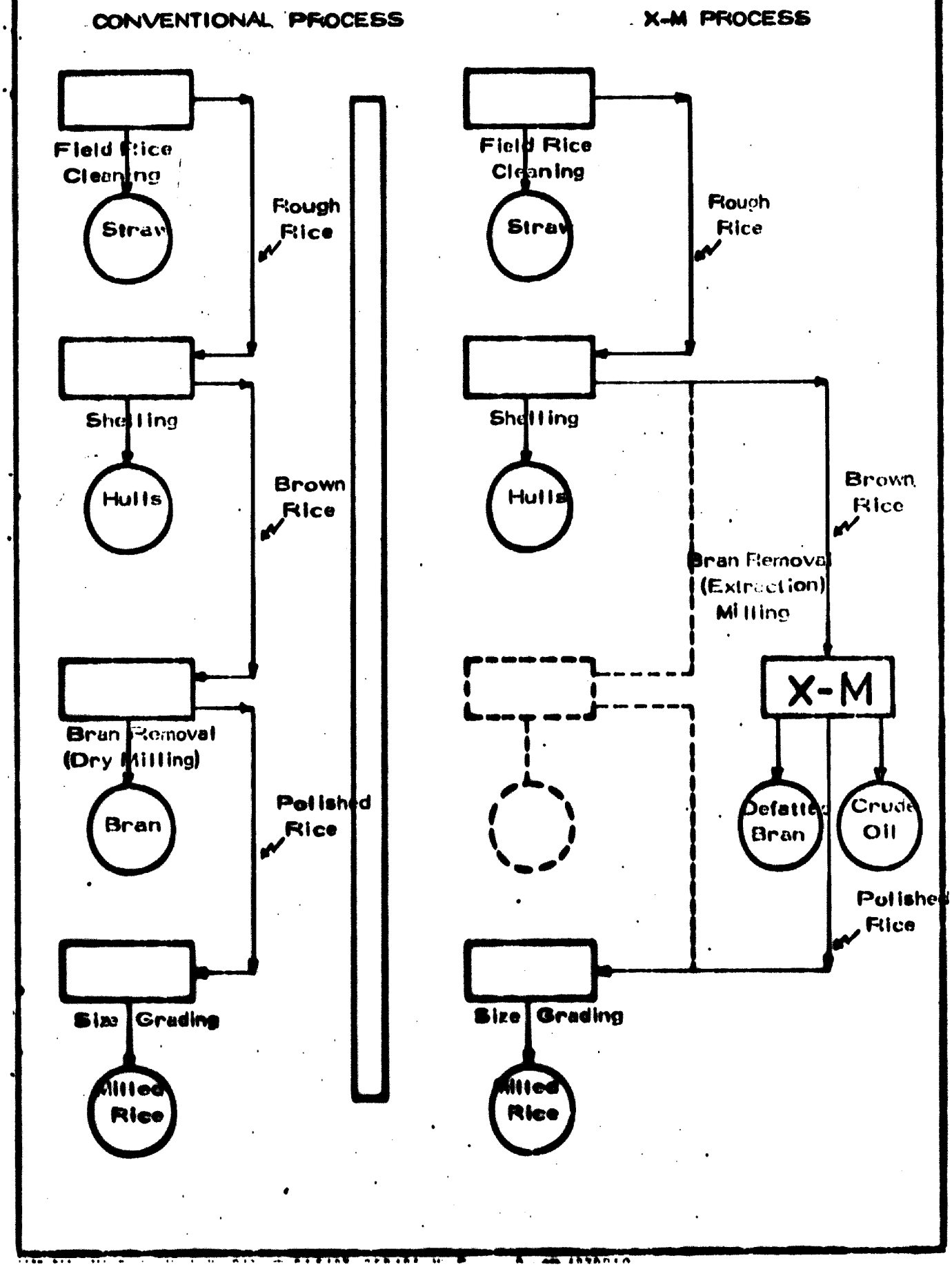
Comparison between conventional and X-M plants, with reference to Thailand (1)

Recovery from 100 Kg. of paddy in the two plants.

Product	Conventional Milling Yield in Kg	X-M Process Milling Yield in Kg	% difference in comparison with conventional milling process
White Head rice	56	62.5	+ 6.5
White Broken rice	12	8.3	- 3.7
Total edible product	68	70.8	+ 2.8
Raw Bran	11	9	- 4.2
Defatted Bran	0	6.8	
Crude oil	0	1.4	+ 1.4
Husk and losses	21.0	21.0	
	32	29.2	
Total recovery	100.0	100.0	

(1) The above figures for the conventional milling process have been taken from milling tests carried out during 1966 by Mr. A.C. Huysmans, F.A.O. agricultural and processing engineer (see Table 64). These tests were conducted in a rice mill situated near Bangkok, equipped with typical standard processing machinery.

Figures for the X-M process are derived from the commercial operation of the Riviana plant at Abbeiville, Louisiana, during the period April-September 1966, in which 14,500 tons of paddy were processed.


CONVENTIONAL PROCESS
X-M PROCESS
Field Rice Cleaning
Straw
Rough Rice
Shelling
Hulls
Brown Rice
Bran Removal (Dry Milling)
Bran
Polished Rice
Size Grading
Milled Rice
Field Rice Cleaning
Straw
Rough Rice
Shelling
Hulls
Brown Rice
Bran Removal (Extraction) Milling
X-M
Defatted Bran
Crude Oil
Polished Rice
Size Grading
Milled Rice

CHAPTER 7

FEASIBILITY ANALYSIS : ECONOMIC APPRAISAL

7. FEASIBILITY ANALYSIS : ECONOMIC APPRAISAL

Throughout the drawing up of this Report, economic evaluations have been made and set out. Economic evaluations were used to select the various possible layouts, sizes and locations for the processing mill and the development of infrastructures and alternative sources of power.

After examining all the feasible technical alternatives and having chosen the most suitable, it only remains to evaluate, and thus to compare, the selected rice-processing methods.

7.1 Economic prices

For the sake of simplicity, economic or shadow prices were not used in the economic evaluation. The same prices employed in the analysis of the operating results and of the financial aspects were utilized. In general this would not appear strictly admissable because of the differences which may be encountered between economic prices and market prices, and which may lead to over- or under-estimating the various costs and benefits.

Nevertheless, in the specific case of the present study, this simplification is considered acceptable, because the market prices were, in fact, already adjusted to exclude import duties and other relevant indirect taxes (e. g. fuel oil) and some to reflect estimated relative variations with respect to the general

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Note: Appendix VI contains relevant and supporting data to this Chapter.

level of prices. Unit prices adopted in the economic rate of return calculations are shown in Table 13 (1).

9.2. Costs and benefits

The investment costs taken into account in the economic evaluation are: construction materials, machinery and equipment (2), works equipment, consumable stores (spare parts), engineering overheads and contingencies for omissions and miscalculations. All investments necessary for the implementation of the plant are considered, and complete coverage is also given to current costs (i.e. operating and maintenance costs) (see Table 6).

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(1) The cash flow tables (17, 18 and 19) make it possible to calculate the lowest price at which white rice and broken rice may be sold. This corresponds to the total profit in a stabilized year divided by the quantity of rice produced (e.g. Table 14) for Alternative I:

White rice: $\frac{\text{US \$ } 5,637,600 - 309,200}{52,200 \text{ tons}}$ = 102.00 - 108.00

Broken rice: $\frac{\text{US \$ } 570,150 - 478,050}{52,200 \text{ tons}}$ = 27.27 - 58.50

Alternative II - White rice: \$ 98.84; Broken rice: \$ 10.22

Alternative III - White rice: \$ 97.81; Broken rice: \$ 10.10

The highest price at which paddy could be purchased in order for Alternatives I, II and III to break even, i.e. not make a profit or loss, is:

Alternative I: $\frac{\text{US \$ } 5,265,000 + 309,200}{90,000 \text{ tons}}$ = 66.93 \$

Alternative II: = 67.81 \$

Alternative III: = 66.87 \$

(2) For alternative III, the amount saved on the cost of the mechanical

(continued overleaf)

The current costs correspond to the sum of "raw material input", "operation and maintenance" (including salaries), "petrol and water" and "overheads and contingencies", which are shown in Tables 8, 9, 10, 11, 14 and 15.

Finally, it is important to note that depreciation charges have not been taken into account when calculating the rate of return of the various alternatives. Depreciation charges are in any case accounting items, and their omission emphasizes more clearly the nature of the rate of return as an interest rate with which capital recovery occurs.

The net benefits from rice processing included in the evaluation derive from the increase in the paddy processing output and from the incomes of these by-products, after deduction of the corresponding operating and maintenance costs.

7.3. Rates of return

The rate of return (on the investments) has been calculated on the stream of total net benefits which derive from the different operations, after deduction of current costs and of the stream of investment costs.

The rate of return corresponds to the discount rate which equalizes the present value of the two streams. As already stated, the reference year for calculation is the beginning of the construction period of the mills. This is to avoid the use of two different interest rates, namely the interest rate to apply to investment costs during the construction period and the one represented by the rate of return.

The period analysed is that of the construction of the mills (two years) plus their economic lifetime, for a total of 38 years, which has been calculated on the basis of the individual average lifetimes of the

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(8) continued, polishing equipment needed for Alternative I i.e. 12 cones plus elevators and conveyors, is offset by the cost of the belt conveyors required to transport the shelled rice from the mill to the X-M plant and the polished rice back to the mill.

various fixed assets (see Table 6). Considering the period to which the analysis refers and bearing in mind the short economic life of certain fixed renewable assets, the stream of investment costs includes the replacement of such assets.

The residual economic value of fixed assets still standing beyond year 35 is considered as a terminal value (1).

Table 6 gives the two series of the investment costs and the total net benefits, for calculating the rate of return. Tables 7 - 12 also show basic data used for the calculations.

The results of the economic evaluations using the principle of Discounted Cash Flow rate of return on the capital invested, for the three alternative modern rice processing mills, are set out below:

Alternatives		Internal Rate of Return (%)
Alternative I :	modern, fully mechanical mill	23.4
Alternative II:	modern, mechanical mill integrated with a bran oil extraction plant	23.6
Alternative III:	solvent extraction milling plant, which extracts the bran oil in polishing the rice	25.0

(1) The terminal value is shown at the bottom of Table 6 and is given by the sum of the investment portion which has an average life exceeding 35 years. In the rate of return calculations this appears as a "net benefit". The "actual salvage value" for non-project uses at the end of their useful life has not been considered; this value is likely to be very small and, as is frequently done, has been disregarded. The value of the scrap is usually too small to make it worth while dismantling the equipment.

The data given in the above table show that the rate of return on the capital invested is over 23% for the first two alternatives and nearly 27% for the X-M processing mill; a rather favourable rate, indicating that the establishment of a modern, optimum capacity rice processing mill which uses up-to-date methods of processing paddy and its by-products is an economically feasible venture.

INVESTMENTS	[illegible]	otal	[illegible]		o[illegible]
[illegible]					
[illegible] building [illegible]					
[illegible]ment	[illegible]	[illegible]	[illegible]		[illegible]
[illegible] for rice mill	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible] aeration [illegible]		[illegible]	[illegible]		[illegible]
[illegible]					
[illegible] from trucks [illegible]		[illegible]	[illegible]		[illegible]
[illegible]					
[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]
[illegible] laboratory	[illegible]	[illegible]	-	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	-		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]		[illegible]
[illegible]cles	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	-	-		[illegible]
[illegible]		-	-		[illegible]
[illegible]	[illegible]	-	-		[illegible]
[illegible]		-	-		[illegible]
[illegible]					
[illegible]	[illegible]	-	-		-
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]

SECTION 1

SECTION 2

1. INTRODUCTION

1.1. In response to a request from the Government of Thailand, the UNIDO agreed to provide the Government with a technical-economic feasibility study for the establishment of a modern rice processing mill and for a comparative study of the technical and economic advantages and disadvantages of the existing rice mills in comparison with a modern rice processing mill.

Subsequently, with Contract N° 70/23 dated 21 July 1970, the UNIDO appointed INDUSTRIALCONSULT to implement the study requested.

The aim of the study was to obtain:

1) a complete detailed technical and economic feasibility study for the establishment, in Thailand, of a modern, economically viable, optimum capacity rice processing mill, using locally grown paddy rice. The mill should be modern in design and utilize up-to-date methods of processing rice with a view to:
   a) obtaining the maximum possible yield of whole grain rice,
   b) minimizing the amount of broken rice,
   c) extracting the protein-rich rice bran, which is suitable for human consumption,
   d) extracting rice bran oil, which is unsaturated oil,
   e) extracting rice wax for the chemical industry.

Table8 - Staff requirements and total yearly salaries :

Alternative I

STAFF REQUIREMENTS	From year 3 onwards			Year 1		Year 2	
	Total No.	Monthly salary (US $)	Total yearly salaries (US $)	Total No.	Monthly salary (US $)	Total No.	Monthly salary (US $)
1. Reception & storage	36		20,760			18	10,2[illegible]
- Rice grading specialists	6	75	5,400			3	2,700
- Assistant rice grading specialists	6	50	3,600			3	1,[illegible]
- Shift engineers	2	75	1,800			1	[illegible]
- Operators	4	50	2,400			2	1,20[illegible]
- Labourers	18	35	7,560			9	3,[illegible]
2. Rice milling	10		7,500			7	5,[illegible]
- Plant manager	1	100	1,200			1	1,20[illegible]
- Shift engineers	3	75	2,700			2	1,[illegible]
- Operators	6	50	3,600			4	2,[illegible]
3. Power station	6		4,500			4	2,[illegible]
- Boiler operators	3	75	2,700			2	1,[illegible]
- Assistant boiler operators	3	50	1,800			2	1,20[illegible]
4. Packing, storage & dispatch	26		10,920			13	5,[illegible]
- Labourers	26	35	10,920			13	5,460
5. Maintenance	13		8,940			7	4,[illegible]
- Assistant plant engineer	1	85	1,020			1	1,020
- Welders	2	75	1,800			1	900
- Blacksmith	2	75	1,800			1	900
- Electrician	2	75	1,800			1	900
- Workmen	6	35	2,520			3	1,260
6. Management	9		8,640	2	3,600	6	6,[illegible]
- Management	1	175	2,100	1	2,100	1	2,100
- Technical supervisor	1	125	1,500	1	1,500	1	1,500
- Employees	7	60	5,040	-	-	4	2,[illegible]
7. Drivers	4	40	1,920	2	960	4	1,920
TOTAL	104		63,180	4	4,560	59	37,620

Table 9 - Staff requirements and total yearly salaries: Alternative II

Staff requirements at full capacity of the mill (starting from year 4)

STAFF REQUIREMENTS	Total number	Monthly salaries (US $)	Total yearly salaries ($ US)
Oil Extraction Process	23		17,[illegible]
- Superintendent (university graduate)	1	125	1,[illegible]
- Shift operators	8	75	7,[illegible]
- Junior shift operators	10	50	6,[illegible]
- Boiler operators	3	75	2,700
- Workers	1	35	420
Maintenance	3		2,340
- Electrician	1	75	900
- Mechanic	1	75	900
- Workman	1	35	420
Office Employees	2	60	1,440
Laboratory Employees	1	100	1,200
Sub-total	29		22,680
Plus: Mechanical Milling staff requirements (as for Alt. II)	104		63,180
TOTAL	131		85,860

Table 10 - Staff requirements and total yearly salaries : Alternative [illegible]

Staff requirements full capacity of the mill (from year 4 onwards)

Staff requirements	Total number	Monthly salary (US $)	Total yearly salaries (US $)
X- [illegible]	2[illegible]		1[illegible]
- Superintendent (university graduate)	1	125	1,[illegible]
- Shift operators	4	75	3,[illegible]
- Aid for shift operations	12	50	7,2[illegible]
- Boiler operators	3	75	2,[illegible]
- Workman	1	35	4[illegible]
Laboratory	3		2,[illegible]
- Electrician	1	75	[illegible]
- Mechanic	1	75	9[illegible]
- Workman	1	35	42[illegible]
Office Employees	2	60	1,[illegible]
Laboratory Employee	1	100	1,2[illegible]
Sub-total	27		20,2[illegible]
Plus : Mechanical Filling staff requirements (as for ALT. I)	104		63,1[illegible]
TOTAL	131		83,440

Table 11 - Other processing costs of the three alternatives

Description	Quantity in metric tons	Total in US $
Alternative I		62,100
- Spares and maintenance supply	...	60,000
- Water	...	100
- Fuel for:		
2 pickups	...	1,200
2 cars		800
Alternative II		195,850
- Fuel (Bunker C) for steam production	1,400	29,400
- Fuel (Light Diesel Oil) for electricity production	145	6,520
- Solvent losses	90	9,000
- Plus: maintenance of additional machinery	...	11,350
- Plus: mechanical milling processing costs (Alt. I)	...	62,100
Alternative III		195,850
- Fuel (Bunker C) for steam production	1,600	33,600
- Fuel (Light Diesel Oil) for electricity production	550	24,750
- Solvent losses	567	56,700
- Liquid petroleum gas	...	1,000
- Operating supplies	...	5,000
- Plus: maintenance of additional machinery	...	12,000
- Plus: mechanical milling processing costs (Alt. I)	...	62,100
Input of raw material (paddy)	90,000	5,625,000 (1)

(1) At an average price of US $ 62.50/MT

Table 12 - Monthly interest necessary for paddy procurement and monthly working capital requirements for a stabilized year (for the three alternatives)

Months	Procurement schedule (M.T. of paddy)	Working capital required for procurement of paddy (U.S.$)	Months of interest	Interest (14%) (U.S.$)	Income from sales (U.S.$)
January	18,000	1,125,000	9	118,120	-
February	18,000	1,125,000	9	118,120	-
March	18,000	1,125,000	1	13,120	590,000
April	18,000	1,125,000	1	13,120	590,000
May	4,500	281,250	1	3,280	590,000
June	4,500	281,250	1	3,280	590,000
July	4,500	281,250	1	3,280	590,000
August	4,500	281,250	-	-	590,000
September	-	-	-	-	590,000
October	-	-	-	-	590,000
November	-	-	-	-	590,000
December	-	-	-	-	590,000
January	-	-	-	-	590,000
Yearly total	90,000	5,625,000		[illegible]	[illegible]

Note: The total of the interest on the capital anticipated for the stabilized year consists (for Alt. I) of: ₤ 272,320 for the paddy plus ₤ 17,680 for other short-term interest for procurement of other processing materials, e.g. arrack, fuel, other materials, thus giving a yearly total of ₤ 290,000.
For Alt. II, the total amounts to ₤ 290,000 (₤ 272,320 + 17,680) and for Alt. III to 296,000 (272,320 + 23,680).

Table 13.- Income from processing

Description	Quantity		Value in US $	
	% of extraction	M. Tons	Unit price	Total
Alternative I				
White head rice	58.0	52,200	108,00	5,637,600
White broken rice	11.0	9,900	58,50	579,150
Raw bran	10.0	9,000	29,15	262,350
Defatted bran	-	-	-	-
Crude oil	-	-	-	-
Husk and losses	21.0	18,900	-	-
Total recovery	100.0	90,000		6,479,100
Alternative II				
White head rice	58.0	52,200	108,00	5,637,600
White broken rice	11.0	9,900	58,50	579,150
Raw bran		-	-	-
Defatted bran	8.0	7,200 (a)	29,15	209,880
Crude oil	1,5	1,350 (b)	275,00	371,250
Husk and losses	21,5	19,350	-	-
Total recovery	100,0	90,000		6,796,880
Alternative III				
White head rice	62.5	56,250	108,00	6,075,000
White broken rice	8.3	7,470	58,50	437,000
Raw bran	-	-	-	-
Defatted bran	6.8	6,120	29,15	178,400
Crude oil	1.4	1,260	275,00	346,500
Husk and losses	21.0	18,900	-	-
Total recovery	100,0	90,000		7,036,900

(a) Defatted bran: 80% of 9,000 M.T. of raw bran
(b) Crude dewaxed oil: 15% of 9,000 M.T. of raw bran

Note. The following assumptions have been made for the working capacity in the first four years:
Alternative I - year 1:0; year 2:30%; year 3:50%; year 4:100%
Alternative II - year 1:0; year 2:30%; year 3:50%; year 4:100%
Alternative III - year 1:0; year 2:40%; year 3:80%; year 4:100%
(Crude oil: Alt. II - year 3:20%; year 4:50%; year 5:100%
Alt. III - year 2:40%; year 3:80%; year 4:100%)

SECTION 1

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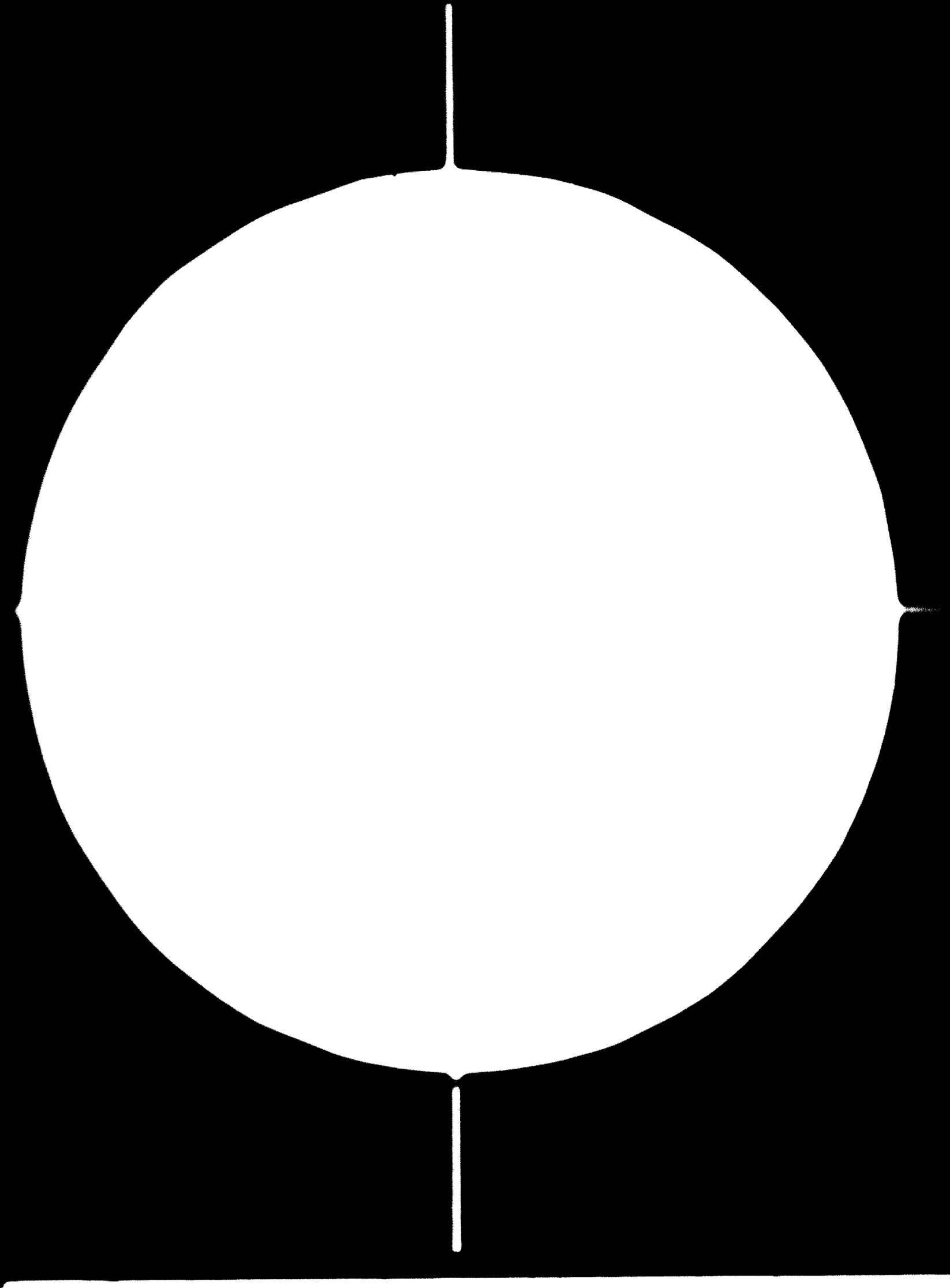

Table 17 - Cash Flow (in thousands of U.S. $)
Alternative I

Description	Year 1	Year 2	Year 3	From year 4 to year 13	From year 14 to year 33
Sources	1,242.5	1,[illegible]	[illegible]	703.[illegible]	7[illegible]
- Cash flow	755.3	-	-	-	-
- Increase in [illegible]	491.8	1,[illegible]	1[illegible]	-	-
- Gross profits	- 4.7	184.[illegible]	[illegible]	554.[illegible]	[illegible]
- Depreciation of Plant and Eq.	-	-	30[illegible]	10[illegible]	[illegible]
Applications	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
- Investments	1,275.0	1,[illegible]	-	-	-
- Interest on loans (1)	19.9	90.5	146.7	-	-
- Interest on working capital	0.6	115.0	170.0	285.0	285.[illegible]
- Amortization (2)	-	-	-	[illegible]	-
- Cash surplus	-	69.4	167.6	11[illegible]	[illegible]

(1) Interest of 8% on suppliers' credit for the three-year period of grace

(2) Calculated as 70% of a total investment of 1,750,900 $ plus 258,100 $ of interest on the 8% interest loan.

Table 18 - Cash Flow : Alternative II
(in thousands of US $)

Description	Year I	Year 2	Year 3	Year 4	From year 5 to year 13	From year 14 to year 15
Sources	1,279.1	1,692.2	1,[illegible].3	787.3	927.9	927.9
Own funds	979.7	-	-	-	-	-
Borrowings	301.0	1,517.4	715.4	-	-	-
Cash generated	-4.7	172.8	269.3	627.5	768.1	768.1
Depreciation and write-offs	-	-	114.1	159.8	159.8	159.8
Total sources	1,275.4	1,690.2	1,098.8	787.3	927.9	927.9
Investments	1,263.4	1,435.9	548.0	-	-	-
Interest on loans (1)	11.6	81.5	167.4	-	-	-
Interest on working capital	0.6	116.0	174.0	288.0	290.0	290.0
Amortization (2)	-	-	-	377.6	377.6	-
Cash surplus	-	56.8	209.4	121.7	260.3	637.9

Note 1: Interest of 8% on suppliers' credit for the three-year period of grace.

Note 2: Calculated as 70% of a total investment of 2,273.300 $ plus 260,500 % of interest on the 8% interest loan.

Table 19 - Cash Flow (in thousands of U.S. $)
Alternative III

Description	Year 1	Year 2	Year 3	From year 4 to year 13	From year 14 to year [illegible]
Sales	1,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
- [illegible]	1,[illegible]	-	-	-	-
- [illegible]	747.1	[illegible]	[illegible]	-	-
- [illegible]	- 4.7	[illegible]	[illegible]	[illegible]	[illegible]
- [illegible]	-	-	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	-	-	-
[illegible] (1)	28.7	[illegible]	[illegible]	-	-
[illegible] including credits	0.5	148.0	272.0	[illegible]	[illegible]
- Amortization (2)	-	-	-	[illegible]	-
[illegible] surplus	-	[illegible]	[illegible]	[illegible]	[illegible]

(1) Interest of 8% on supplier credit for the three-year period of grace

(2) Calculated as 7% of a total investment of 2,593,300 $ plus 384,400 $ of interest on the 8% interest loan.

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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(2 42)

ESTABLISHMENT OF A MODERN RICE PROCESSING MILL

(TECHNICAL-ECONOMIC FEASIBILITY STUDY AND COMPARATIVE STUDY BETWEEN EXISTING AND MODERN RICE MILLS)

KINGDOM OF THAILAND

APPENDIXES I - VI

INDUSTRIALCONSULT
VIA SERENA, 9 - SERIATE (ITALY)

1971

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

REPLACEMENT OF A MODERN RICE PROCESSING MILL

(TECHNICAL - ECONOMIC FEASIBILITY STUDY AND COMPARATIVE STUDY BETWEEN EXISTING AND MODERN RICE MILLS)

REPUBLIC OF THAILAND

APPENDIXES I - VI

INDUSTRIAL CONSULT
VIA SERENA, 9 - ROME, ITALY

1971

APPENDIXES

I RICE PRODUCTION IN THAILAND

II THE MARKET OF WHOLE GRAIN AND BROKEN RICE (STATISTICAL DATA)

III MARKETING, TRANSPORT AND STORAGE OF PADDY

IV SURVEY ON EXISTING RICE MILLS IN THAILAND

V MODERN RICE PROCESSING METHODS

VI SPECIFICATIONS OF MACHINERY, EQUIPMENT AND BUILDINGS FOR THREE ALTERNATIVES OF THE MILLING PLANT

APPENDIX I

RICE PRODUCTION IN THAILAND

1. GENERAL DATA

Area of Thailand = 514 000 sq. m.

- LAND USED (1968)	% LAND USED
Forest land	53.2
Farm holding land	24.5
Swamp land	0.6
Unclassified	21.7
TOTAL AREA USED	100.00

- PERCENTAGE OF TYPES OF FARM HOLDING (1968)

Paddy land	51.4%
Tree crops	13.2%
Upland crops	17.3%
Wood land	8.6%
Others	9.5%

2. LABOUR FORCE BY SECTOR

	1961	1966	1971 Est
Agriculture, forestry, hunting and fishing	83.1%	79.9%	75.6%
Mining	0.2%	0.3%	0.3%
Manufacturing	3.6%	4.7%	5.9%
Construction	0.6%	0.7%	1.0%
Total in million	12.450	14.550	16.760

3. POPULATION

Year	Whole country million	Density
1960	26.4	51.4
1	27.2	52.9
2	28.0	54.5
3	28.9	56.4
4	29.8	58.4
5	30.7	60.3
6	31.7	62.2
7	32.7	64.2
Est 8	33.7	66.0
" 9	34.8	68.0
" 71	39.2	76.3
" 76	45.1	87.7
" 81	51.2	99.6

Rate of growth population Aver. 60-66 = 3.2

Estimated rate of growth population 67-71 = 3.3%

" " 71-76 = 3.0%

" " 76-81 = 2.6%

I. Introduction

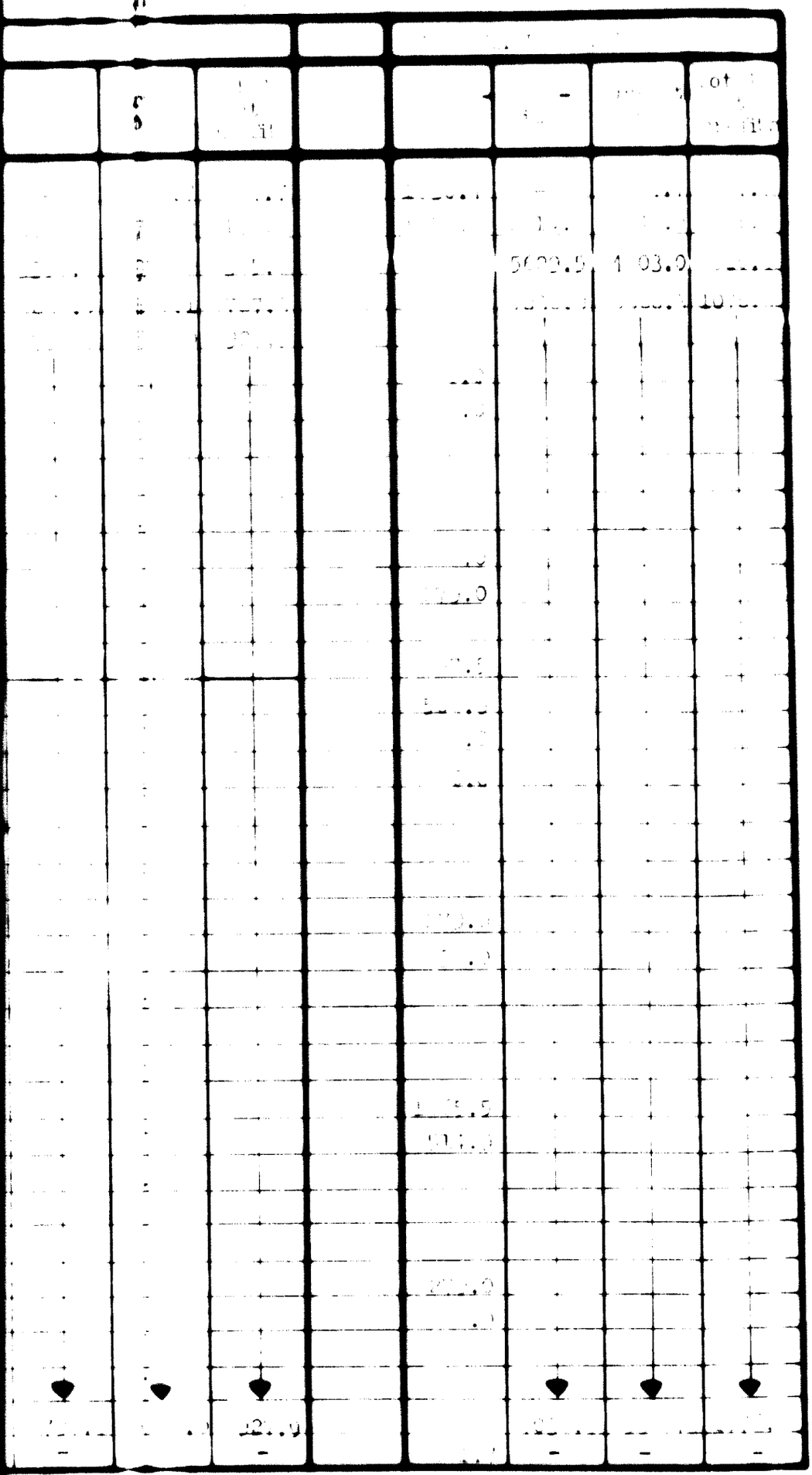
I. 1. The Thai economy is to a large extent dependent on agriculture and, more specifically, on rice cultivation; in fact the gross income in respect of agriculture is equal to approximately one-third of the national income, although it is gradually diminishing in percentage terms, over the years (Table 2).

The surface area turned over to agriculture amounts to about 25 % of the total area of the country; that utilised for rice cultivation is 51 % of the country's agrarian surface area.

The population engaged in agriculture, fishing and hunting amounts to about 80% of the national total of active labour forces (Table 3).

The sum-total of the Thai population, as at the latest census carried out in 1967, is 32,700,000 inhabitants. The annual increase of the population from 1960 to 1967 was at the rate of 3.23% per annum. The forecast increase in population by 1975, at the above-mentioned fixed rate of increase, gives a population of approximately 42,000,000 (Tables 4 - 5 and Diagram 1).

The country is divided into four areas or regions: Central plain, North-Eastern, Northern, and Southern; of these, it is in the first region that rice cultivation is carried out most intensively; this region is economically and administratively dependent on the capital of the country, Bangkok.



SECTION 2

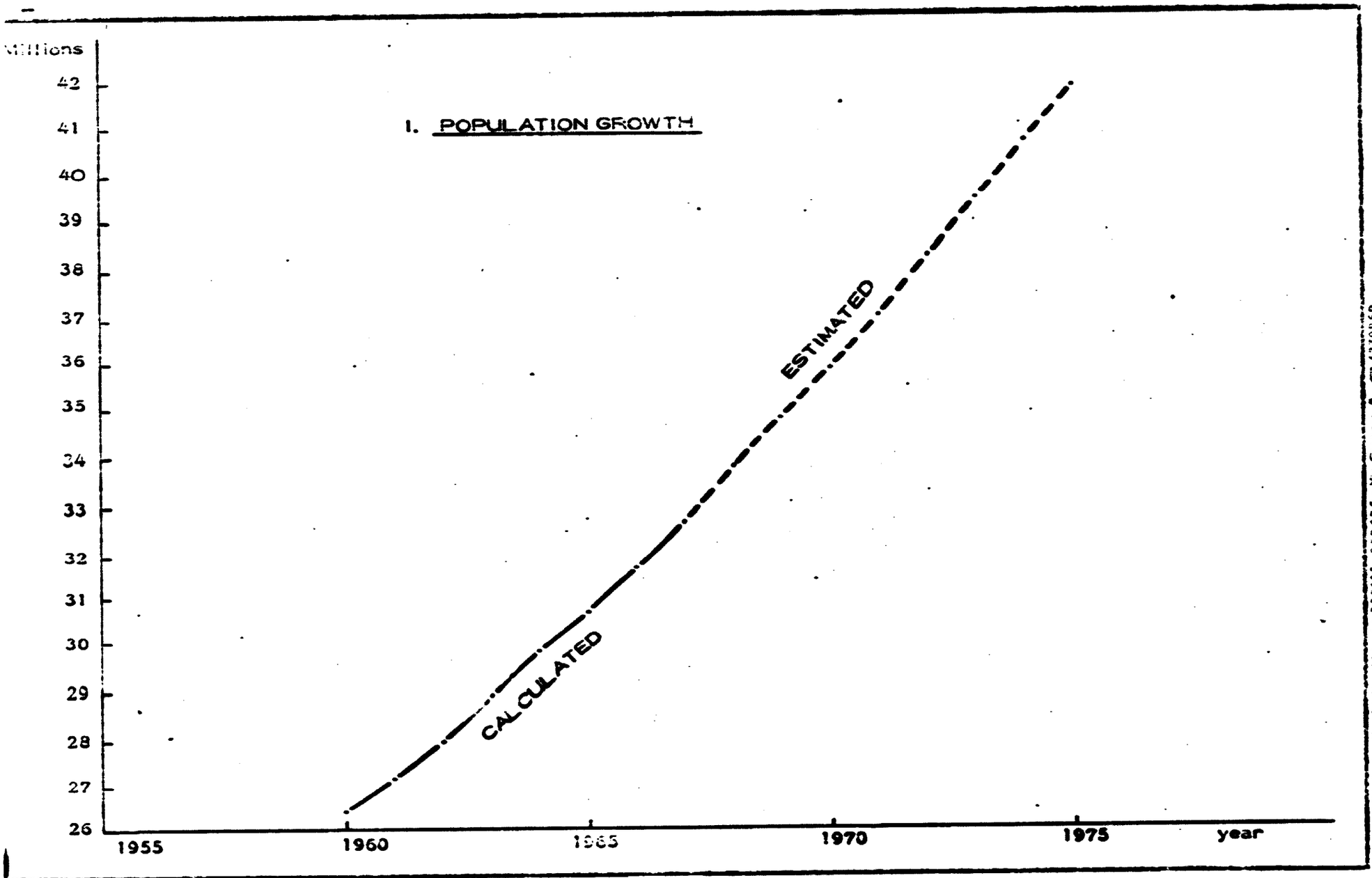
4. PERCENTAGE DISTRIBUTION OF GROSS DOMESTIC PRODUCT BY MAIN ACTIVITIES

	1961	1964	1965	1966	1967
Agriculture	39%	33%	32%	35%	31%
Industry	16%	19%	20%	20%	21%
Other	45%	48%	46%	45%	48%
Net national product at factor cost or:					
National income (million $)	2,115	3,141	3,398	4,039	4,321
National pro-capite $	106.86	119.04	126.92	146.25	154.41

	1960	1963	1966	1967	1968 Est.	1969 Est.
Agriculture	38.9%	36.4%	35.1%	30.6%	28.5%	27.7%
Manufacturing	10.5%	11.4%	12.0%	13.1%	13.0%	13.4%
Other	50.6%	52.4%	56.9%	56.3%	58.5%	58.9%
National income (million $)	2,445	2,940	4,040	4,320	N.A.	N.A.
Pro capite $	102.80	115.00	146.2	154.4	N.A.	N.A.

ANNUAL GROWTH RATES OF NATIONAL INCOME

	1961 %	1964 %	1965 %	1966 %	1967 %
Gross national product	7.5	7.0	10.2	19.1	9.1
Gross domestic product	7.4	7.0	10.1	19.1	9.0
National income	6.9	6.8	8.2	18.9	7.0
Pro capite GNP	3.9	3.5	6.6	15.2	5.6
Consumption expediture	7.4	5.9	7.1	10.6	12.9
Gross fixed capital formation	13.1	13.2	13.1	20.8	15.6
Private	3.3	6.9	17.6	20.1	11.3
Public	34.0	24.3	- 2.5	13.3	23.1


Millions
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
1. POPULATION GROWTH
ESTIMATED
CALCULATED
1955
1960
1965
1970
1975
year

5. POPULATION INCREASE

Year	Million	Increase million	% increment	± increment per cent	Density Man/km sq.
1960	26.04	-	-		51.4
1	27.2	+ 0.8	3.03		52.9
2	28.0	+ 0.8	2.94	- 0.09	54.5
3	28.9	+ 0.9	3.21	+ 0.27	56.4
4	29.8	+ 0.9	3.11	- 0.10	58.4
5	30.7	+ 0.9	3.02	- 0.09	60.3
6	31.7	+ 1.0	3.26	+ 0.24	62.2
7	32.7	+ 1.0	3.15	- 0.11	64.2
Estim. 8	33.8	+ 1.1	3.23	+ 0.08	65.7
" 9	34.8	+ 1.0	3.23	+ 0.00	67.9
" 70	35.9	+ 1.2	3.23	+ 0.00	69.8
" 1	37.1	+ 1.1	3.23	+ 0.00	72.1
" 2	38.3	+ 1.2	3.23	+ 0.00	74.5
" 3	39.5	+ 1.2	3.00	- 0.23	76.8
" 4	40.7	+ 1.2	3.00	- 0.23	79.1
" 5	41.9	+ 1.2	3.00	- 0.23	81.5

From the administrative point of view, Thailand is subdivided into 71 provinces. Thirty-five of these are in the Central plain, fifteen in the North-Eastern, seven in the Northern and fourteen in the Southern regions. A further administrative and agricultural subdivision is the agricultural district, of which there are 15, 176 in the whole country.

I. 2. At present rice cultivation is based on somewhat primitive methods.

Despite the great abundance of water, today it is only possible to grow rice by rainfall, and to obtain a single crop per year. The lack of artificial irrigation makes it difficult to work on any other basis.

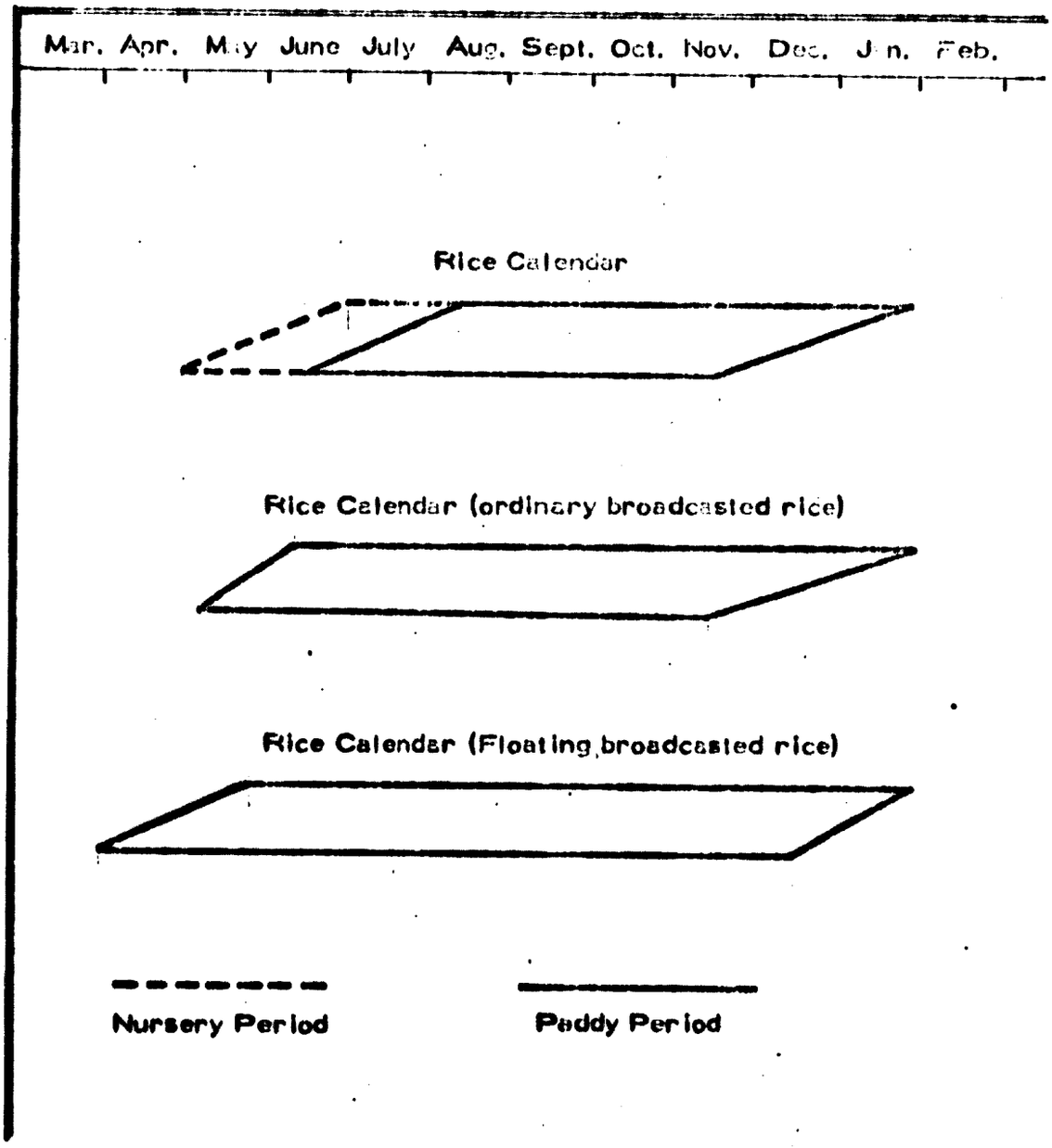
All the cultivation operations are carried out, almost exclusively manually or by animal-power; only a few agricultural machines, mostly of Japanese make (cultivators), are used for working the land.

Seed-bed preparation starts as soon as the first rains fall, in June or July; transplanting takes place 18-25 days after the sowing of the nursery. (See Diagram II).

The quantity of seed calculated for transplanting 1 hectare is 13-16 Kg, which is remarkably low.

The seedlings are transplanted two or three together at a distance of 20-25 cm.

II. Rice Calendar of the Central Plain Zone, Thailand



Approximately 80% of the surface area is cultivated by transplanting. There are sound agronomic reasons for adopting this method, in preference to that of direct seeding, and in addition the large amount of labour available makes this even more desirable.

Rice cultivation on dry land exists, but on a very limited scale.

In the central plain region "floating varieties" of rice are grown, where the depth of the water is at least 2 - 3 metres.

In the same region there are also vast areas of salty land, below sea level, which normally remain uncultivated; it is however possible to cultivate such areas after the rains have had the effect of desalting them.

Not enough attention is paid to the land, and for this reason it is not uncommon to see large areas of rice field flooded with excessively deep water; this results in a lower production of paddy.

When direct seeding takes place, the dry rice seed is broadcasted over the dry ground. The rice field is then flooded, either by rain or by means of simple and primitive devices. to raise water from canals.

Normally no fertilisers are used.

Agronomic experts advise the addition of 100-120 Kg/hectare of 16-20-0, that is to say, of 16-20 Kg/hectare of nitrogen, 20-24 Kg/hectare of phosphorus anhydride, with no potassium oxide. (See Tables 6 – 7 for imports and consumption of fertilizer.)

6. QUANTITY OF FERTILIZERS IMPORTED

YEAR	NITROGENOUS	PHOSPHATIC	POTASSIC	MIXED AND N.E.S.	TOTAL
	Tons	Tons	Tons	Tons	Tons
1955	14,266	2,225	119	3,981	20,591
6	15,628	1,375	3,042	3,265	23,310
7	22,777	4,958	530	11,626	39,891
8	20,282	3,895	418	5,102	29,697
9	23,670	12,181	1,128	10,786	47,765
60	32,268	8,460	942	10,238	51,908
1	33,239	12,291	375	8,865	54,770
2	33,164	21,329	1,604	10,370	66,467
3	46,730	30,508	2,005	18,134	97,377
4	39,438	38,451	782	30,307	108,978
5	35,998	24,099	2,199	29,288	91,584

7. COMMERCIAL FERTILIZER CONSUMPTION

	N_2	P_2O_5	K_2O
1948-50/1952-53	15	6	1
1952-53/ 56-57	18	14	4
63-64	184	111	48
64-65	162	90	47
65-66	179	113	46
66-67	246 *	243*	79 *
67-68	450 *	320*	95 *

* Non official dates

It is advised that the fertilizer be applied in two stages, 3/4 one day prior to transplanting onto wet ground, the remaining 1/4 3-4 weeks after transplanting.

There are 38 varieties of rice cultivated, of which only those shown in Table 7. are recommended.

The growing period of the varieties cultivated, from seeding to harvesting, is 130-180 days: 18-35 days in nursery, 70-80 days between transplanting and flowering, and 30-35 days from flowering to harvesting.

Perhaps it is improper to speak of varieties as, in fact, pure seed is rarely used, most of the rice grown is a mixture of different varieties.

The main rice experimental station of Bangkhen is situated in the Bangkok area, and is connected with a further 20 regional stations which are dependent on it: 3 in the Northern, 7 in the North-Eastern, 7 in the Central plain and 3 in the Southern regions.

Research work on hybridisation between IR8, IR9, IR22 and indigenous varieties is being carried out. Varieties distributed by the IRRI are not commercially grown, since the quality of the rice is considered inferior to the Thai varieties.

The breeding programme, in the search for new varieties, is aimed especially at examining the following aspects:
a) positive response to large doses of fertilizer;
b) resistance to lodging;

8. RECOMMENDED VARIETIES OF RICE (1964)

				Date Harv.	Average Yield T/Ha
NORTHERN					
1)	Leuang Yai	84		Nov. 30	3.1
2)	Muey Nawng	62	M glutinous	" 20	3.3
3)	Niew sampahtaving		"	" 26	3.3
4)	Gam Pai	15	"	" 30	3.6
NORTHEASTERN					
1)	Khi Tom Yai	98	glutinous	" 18	1.7
2)	Niew sampahtawng		"	" 25	1.5
3)	Gam Pai	41	"	" 30	1.9
4)	Khao Dawk Mali	105		" 20	1.6
5)	Jao Leuang	11		" 26	1.8
CENTRAL PLAIN					
1)	Gow ruang	88		" 15	2.8
2)	Jao Leuang	11		" 23	2.7
3)	Leuang pratew	20		Decemb. 13	2,9
4)	Puang nahk	16		25	2,7
SOUTHERN					
1)	Leuang	152		Jan. 27	2.1
2)	Nang Pa-Yak	132		Feb. 16	2.2
FLOATING RICE					
1)	Ta-Pow Gaew	161		Decemb. 9	3.6
2)	Jek Chuey	159		9	3.5
3)	Lob Mue Nahng	111		19	4.9
4)	Ping Gaew	86		29	4.9
5)	Nahng Cha-Lawng		glutinous	Nov. 30	3.4

Total number of cultivated varietes : 38

CHAPTER 8

FEASIBILITY ANALYSIS : FINANCIAL APPRAISAL

c) resistance to pests, e. g. :

1) yellow orange leaves;

2) stem borer: pink, white or brown;

3) gallmidge;

4) bacterial leaf-blight;

5) blast.

The experimental production of the new varieties gives high yields: 8 to 8, 5 tons/hectare.

The Extension Service of the Department of Agriculture is responsible for the commercial production of pure seed; approximately 20 tons of foundation seed are produced per year. This seed is then distributed to private farmers for further multiplication under the control of the aforementioned Department.

The seed is distributed by means of farmers' associations; no private organisations exist for the production and sale of seeds.

The production of seed is undoubtedly insufficient for the country's requirements; on the other hand the farmer tends to continue using seed recovered from the preceding crop for economic and traditional reasons.

When weeding is necessary, it is carried out by hand.

The following products are sometimes used for pest control: "diazinon" in granular form and BHC for the stem borer; "sevin" for the yellow orange leaves, distributed by hand-operated sprays; "malathion-mike" as an insecticide; "cerasan", which is used to

treat the seed against parasitic fungi. Arsenic-based products are used as rat poison.

Harvesting is generally carried out by hand from November to January, after the rice field has been drained.

The moisture content of the paddy at harvesting is 20-22% and after drying, which is effected by spreading the paddy on stalk on the ground in the sun, this is reduced to 12-15%.

Threshing machines are almost unknown. Threshing is usually carried out by hand or by treading the paddy on the stalk on a threshing-floor with water-buffaloesor by driving rubbertyred tractors over it. In the South, where rice is produced in small quantities mainly for home consumption, it is stored on the stalk and threshed by human labour as it is needed.

The paddy is then winnowed by means of mechanical blowers or by letting it fall from bamboo trays in a natural draught.

The paddy is stored in huts built of bamboo and clay or even in the home until the time of sale or consumption.

II . Surface area covered by rice cultivation and land tenure

It has not been possible to obtain official data concerning the total number of rice farms; however, information collected would indicate the existence of approximately two million.

The average surface area of the rice farms is between 3 and 3,5 hectares. By free extrapolation of 1963 FAO data at that time there were 2,103,000 rice farms with an average seeded area of 3,46 hectares, and a production somewhere in the region of 5,2 tons each.

The cultivated surface area is divided into a large number of small holdings.

The total cultivated area in Thailand between 1955 and 1966 varied between 5 and 7,5 million hectares.

Without considering the figure for cultivated surface area in 1969, which is less reliable than those recorded in previous years, the average yearly increase in cultivated area from 1955 to 1968 amounted to 0,93%. For the period between 1961 and 1968, this increase rises to 2,9%; while in the latest period, namely 1965-1969, the increase in cultivated area was as high as 3,09% (as is illustrated in Diagram III).

In the medium term, up to 1975, it is predicted that the seeded area will increase at a constant yearly rate of 3,0%, as from 1968; this leads us to forecast cultivated areas as follows:

Year	Production in million tons	Increase over previous year
1969	6,679	194,000
1970	6,879	200,000
1971	7,085	206,000
1972	7,297	212,000
1973	7,516	219,000
1974	7,741	225,000
1975	7,973	232,000

If we consider Tables 8 and 9 it is clear that the area used for growing maize and fibre plants is increasing at a much faster rate than that of rice. It may reasonably be deduced that the land reclaimed year by year, or put under new crops, will be utilised for dry crops, yielding a higher income, rather than for rice.

Rice crops each year undergo considerable damage, at times of vast proportions, caused mainly by: a) overflowing of the rivers during the rainy season; b) insect parasites; c) fungus-type or viral diseases; d) drought; e) destruction by animals.

The area of cultivation on which harvesting was rendered impossible by damages to the crop averaged 8.5% between 1955 and 1969, and 9.8%between 1964 and 1968 (See Diagram III and Tables II-12).

An average forecast of future development in the next few years predicts that the seeded area actually harvested - calculating an average yearly damage of 8% of the predicted seeded areas (see above) - could be the following per year:

9. ACREAGE OF PRINCIPAL CROPS (1955 = 100)
(In thousands of hectares)

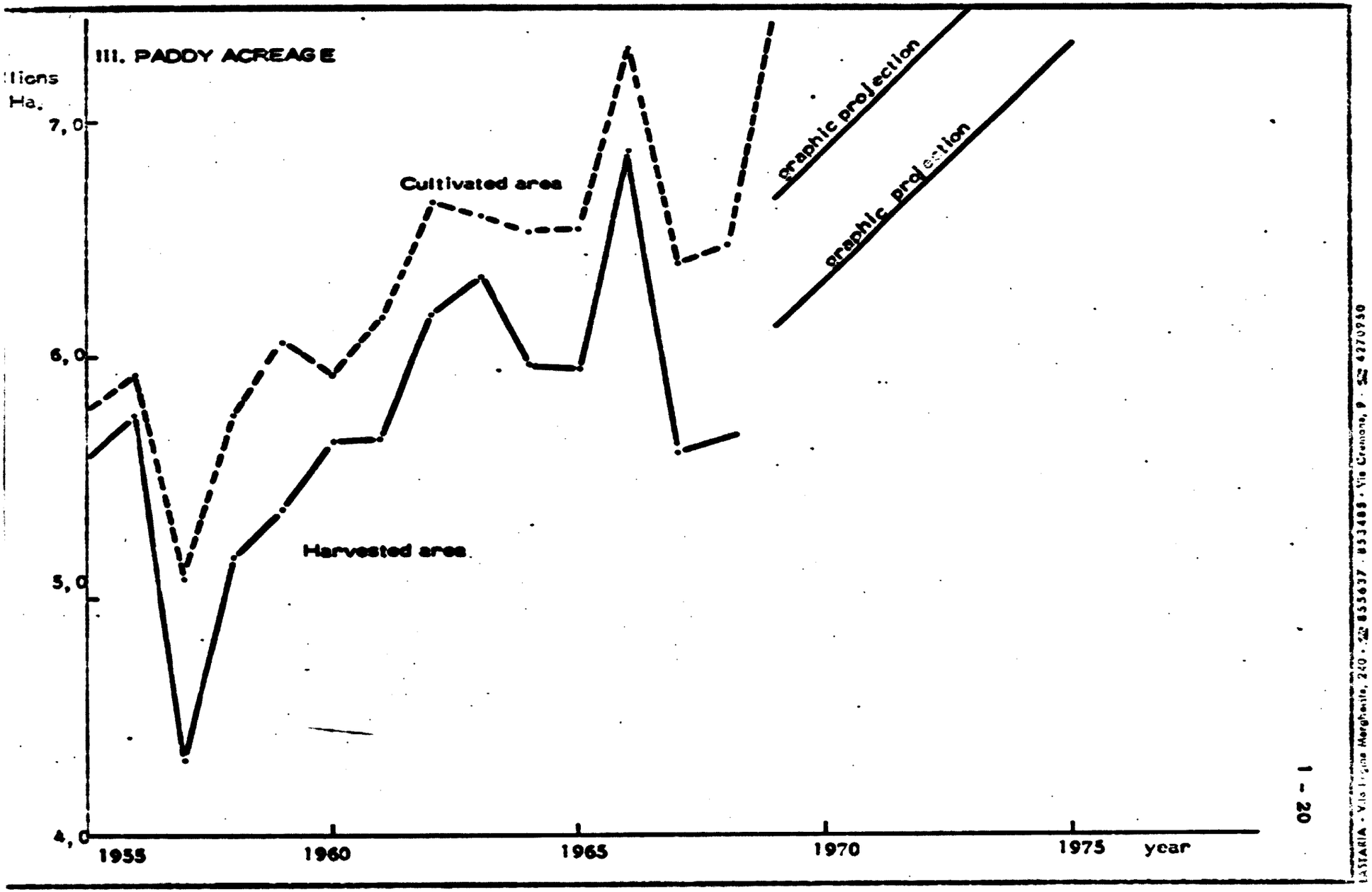
Year	Upland food		Oil seed		Fibre crops		Maize		All except rice	Rice
	Area	%	Area	%	Area	%	Area	%	Area	%
1955	207.36	100	256.16	100	43.20	100	55.52	100	978.72	100
6	247.20	119	274.24	107	62.28	144	82.24	148	1069.60	109
7	301.76	148	308.00	120	119.60	277	96.96	175	1334.08	136
8	342.88	166	302.40	118	115.20	267	126.72	228	1389.76	142
9	456.80	220	305.12	119	150.40	348	199.85	360	1567.20	160
60	567.20	274	357.60	140	259.20	600	285.60	514	1893.76	193
1	566.72	273	343.04	134	382.24	885	306.56	552	2067.84	211
2	602.08	291	390.88	153	219.36	608	328.00	591	2020.64	206
3	807.84	390	404.44	158	285.76	661	417.92	753	2377.12	243
4	921.76	444	402.40	157	345.44	800	551.84	1000	2538.24	259
5	940.48	453	428.00	167	540.80	1252	576.80	1039	2871.20	293

10. INDEX NUMBER, SEEDED AREA OF PRINCIPAL CROPS
(Average 1950-53 is taken as 100)

Year	Rice	Maize	Upland food	Oil	Fibre	All crops except rice
1955	100	130	129	120	81	118
6	104	193	154	128	114	129
7	88	228	188	144	106	161
8	100	298	214	142	120	167
9	105	470	285	143	179	189
60	103	671	354	168	375	228
1	107	720	353	161	642	249
2	116	771	375	183	339	243
3	115	982	503	190	433	286
4	114	1297	573	188	544	306
1965	112	1355	586	208	875	346

II. AREA OF PADDY
(In thousands of hectares)

Year	Holding area	Cultivated area (a)	Harvested area (b)	Damaged area	Index (a) 1955=100	Index (b) 1955=100
1955	6434.4	5770	5576	6.8%	100	100
6	7878.2	5927	5762	4.3%	103	103
7	6643.7	5075	4317	15.5%	88	77
8	6683.8	5758	5169	10.2%	100	93
9	6811.3	6065	5363	13.2%	105	98
60	6917.2	5921	5643	4.7%	103	101
1	6980.6	6179	5656	8.5%	107	101
2	7134.3	6659	6191	7.0%	115	111
3	7294.8	6601	6354	3.7%	114	114
4	7461.0	6539	5971	8.7%	113	107
5	7472.4	6553	5960	9.1%	114	107
6	7636.7	7306	6878	5.9%	127	123
Est. 7	7841.0	6410	5601	12.6%	111	100
Est. 8	-	6485	5666	12.6%	112	102
Est. 9	-	7580	-	-	131	-


III. PADDY ACREAGE
llions
Ha.
7,0
6,0
5,0
4,0
Cultivated area
Harvested area
graphic projection
graphic projection
1955
1960
1965
1970
1975
year

Year	Production in million tons	Increase over previous year
1969	6,145	479,000
1970	6,329	184,000
1971	6,518	189,000
1972	6,709	191,000
1973	6,914	206,000
1974	7,122	207,000
1975	7,335	213,000

Diagram III shows the data recorded annually up till now and forecasts for the next five years.

Of the total cultivated area of the country, 45-50% is in the Central plain region and 35-40% in the North-Eastern region.

Table 12 shows the area harvested in the different regions.

Thirty-eight different varieties of rice are grown in Thailand. These can be divided into two categories: glutinous and non-glutinous.

In the North-Eastern region mainly the glutinous types are grown accounting for about 80% of the total area of the country cultivated with this type.

In the Central plain area, on the other hand, almost exclusively the non-glutinous types of rice are grown, accounting for approximately 40% of the total area of the country cultivated with rice growing and for 70% of the non-glutinous rice grown in Thailand (Tables 13 and 14).

The official or estimated data concerning total area of the country annually cultivated with the two different types of rice are given

12. HARVESTED AREA OF PADDY RICE BY REGION (4 REGIONS - 71 PROVINCES)

Year	Central - Ha x 1000	Northeastern - Ha x 1000	Northern - Ha x 1000	Southern - Ha x 1000
1955	2632	2323	387	428
6	2706	2483	378	457
7	2595	1670	382	329
8	2730	2159	393	475
9	2732	2467	410	455
60	2723	2329	410	450
1	2822	2462	412	479
2	2885	2857	406	496
3	2961	2715	424	501
4	3126	2475	434	504
5	2942	2096	432	490
Est.6	2148	2926	1445	481
Est.7	1976	1934	1278	413

13. GLUTINOUS AND NON GLUTINOUS PADDY RICE CULTIVATED AREA BY REGIONS 1000 Ha

YEAR	CENTRAL PLAIN		NORTHEASTERN		NORTHERN		SOUTHERN		TOTAL	AREA
	Gluti-nous	Non glu-tinous	Gluti-nous	Non glu-tinous	Gluti-nous	Non glu tinous	Gluti-nous	Non glu tinous	Glutinous	non Glutinous
1955	94.8	2536.8	1.733.0	589.9	361.6	25.9	23.8	403.7	2212.3	3556.3
6	99.2	2606.9	1.829.4	653.3	243.4	34.2	28.8	428.6	2300.8	3722.9
7	95.5	2504.8	1.305.6	353.0	341.0	46.4	18.7	410.2	1760.3	3314.4
8	141.1	2636.8	1.488.5	670.6	335.7	57.6	22.4	453.1	1939.7	3818.1
9	89.6	2642.7	1.772.5	694.9	375.4	34.9	19.7	435.8	2257.1	3808.3
60	91.7	2632.6	1.686.2	642.9	388.5	30.7	23.8	425.8	2189.3	3732.0
1	93.3	2729.0	1.647.2	822.9	375.4	37.1	22.1	457.1	2122.1	4046.1
2	96.8	2795.7	1. 940.5	910.9	375.0	36.0	21.4	482.6	2433.8	4224.1
3	95.8	2865.0	1.822.1	893.1	381.8	42.6	23.7	477.0	2323.4	4277.6
4	103.4	3023.0	1.579.5	895.8	387.7	46.2	20.3	483.5	2090.9	4748.6
5	110.1	3019.2	1.690.6	762.6	396.8	38.2	22.9	511.5	2220.3	4333.4

8. FEASIBILITY ANALYSIS : FINANCIAL APPRAISAL

Analysis of the financial aspects of the investments has a different aim from the economic evaluation. The feasibility of the project and the choice of the best alternative are an economic problem. "real (or economic) values" are dealt with, the purpose being to help judge whether the investment is worth carrying out as compared with alternative investments and to study the project's contribution to the economy as a whole.

The financial evaluation of the project, on the other hand, is directed to testing the practical applicability of the economic choices in terms of current (market) values, and in terms of current financial practices in banking, taxation etc. with the aim of establishing whether the latter are appropriate for ensuring a sound financial basis to both the industry and its beneficiaries.

In this chapter the financial position of the chosen alternative III will be analysed, and a comparison will also be made with the mechanical rice-processing mill (Alternaltve I) and a mechanical mill integrated with a bran-oil extraction plant (Alternative II).

8.1 Assumptions

Following the desire expressed by the Thai authorities, the rice-processing mill is to be carried out without recourse to direct Government finance or International Financing Institutes. The

14. CULTIVATED AREA BY REGIONS EXPRESS IN PERCENTAGE TOTAL GLUT. E TOTAL NON GLUT.

YEAR	CENTRAL PLAIN		NORTHEASTERN		NORTHERN		SOUTHERN	
	Non glut.	Glutin.	Non glut.	Glutin.	Non glut.	Glutin.	Non glut.	Glutin.
1955	71.3	4.3	16.6	78.3	0.7	16.3	11.4	1.1
6	70.1	4.3	17.6	79.5	0.8	14.9	11.5	1.3
7	75.6	5.4	10.6	74.2	1.4	19.4	12.4	1.0
8	69.0	4.8	17.6	78.7	1.5	17.3	11.9	1.0
9	69.4	4.0	18.3	78.5	0.9	16.6	11.4	0.9
60	70.6	4.1	17.2	77.0	0.8	17.8	11.4	1.1
1	67.5	4.4	20.3	77.0	0.9	17.6	11.3	1.0
2	66.2	4.0	21.6	79.9	0.8	15.4	11.4	0.9
3	67.0	4.1	20.9	78.4	1.0	16.5	11.1	1.0
4	68.0	4.9	20.1	75.6	1.1	18.5	10.9	1.0
5	69.7	5.9	17.6	76.1	0.9	17.9	11.8	1.0

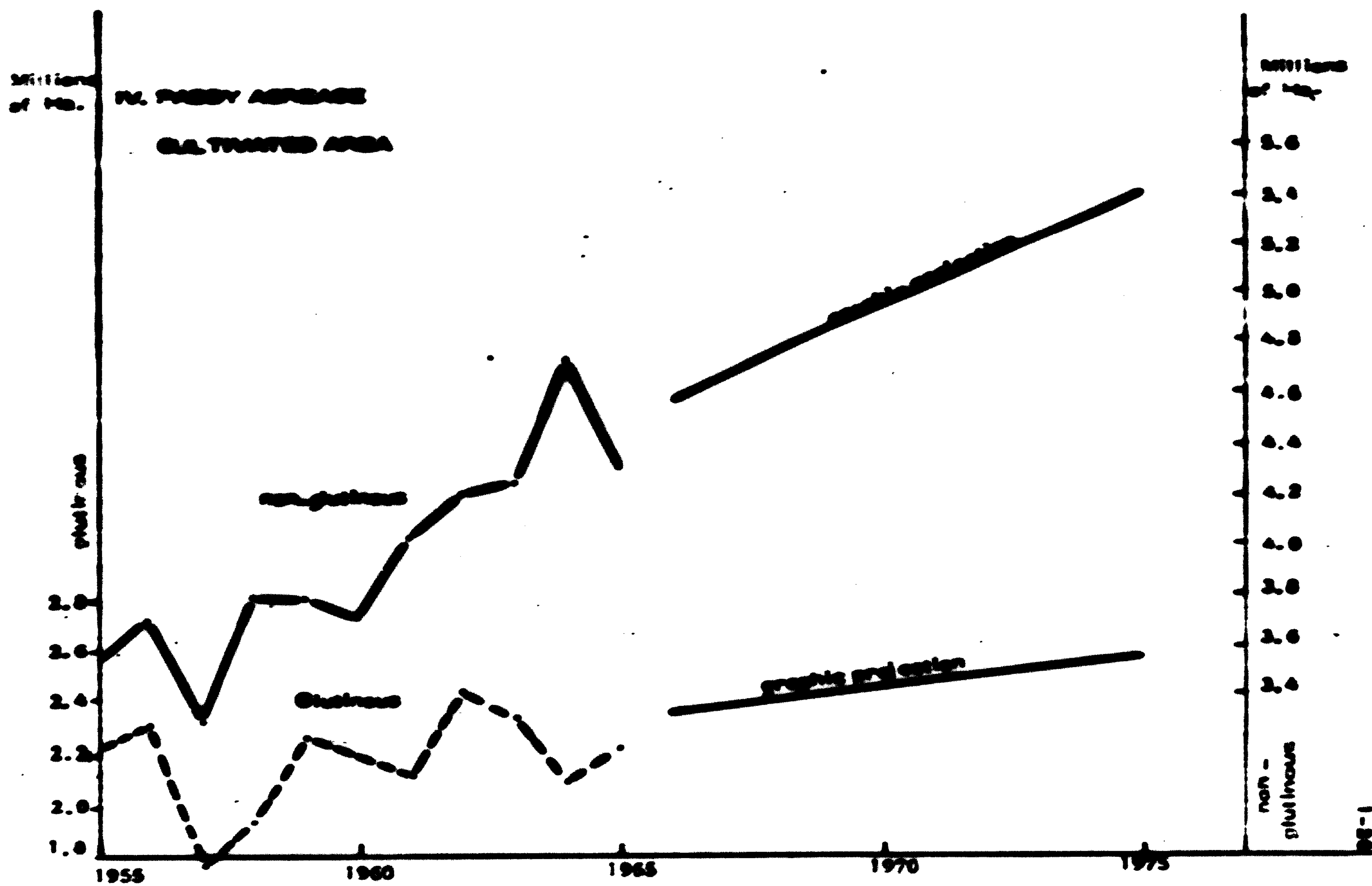
up to 1965. By means of a diagram showing the existing data, it may be roughly estimated that the increase in cultivation in the years 1968 - 1975 is as follows (see also Diagram IV):

Year	Non-glutinous	Glutinous
	1000 hec.	
1966	4,600	2,350
1967	4,660	2,370
1968	4,770	2,400
1969	4,860	2,420
1970	4,960	2,440
1971	5,060	2,470
1972	5,140	2,500
1973	5,240	2,520
1974	5,330	2,540
1975	5,420	2,570

Rice in Thailand is cultivated mainly during the monsoon season, i.e. when rain floods the land. The temperature and light conditions would permit the production of paddy in other periods of the year as well, but the lack of irrigation and canalisation excludes such cultivation outside the rainy season.

The paddy crops harvested out of season amount to almost negligible surface areas varying from 10,000 to 20,000 hectares per year (Table 15.), i.e. about 0.20% of the total area.

The method of cultivation adopted for rice-growing is almost exclusively that of transplanting; in fact 75-80% of the surface area cultivated each year is transplanted, and only 20-25% sown (Table 16).



Millions of Ha.
glutinous
1.8
2.0
2.2
2.4
2.6
2.8
non-glutinous
Glutinous
graphic projection
1955
1960
1965
1970
1975
Millions of Ha.
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
non - glutinous

15. TOTAL HARVESTED AREAS AND PADDY PRODUCTION OF OFF SEASON

Year	Ha	% of totalharvested	Metric ton
1965	10.773	0.35	31.222
6	11.040	0.18	17.290
7	12.161	0.28	23.244
8	10.799	0.21	16.867
9	6.062	0.12	10.674
00	10.137	0.17	17.191
1	11.105	0.19	18.532
2	11.372	0.18	19.974
3	13.005	0.20	22.016
4	18.799	0.31	36.394
5	22.352	0.37	45.337
6	33.853	0.48	63.843

16. BROADCAST AND TRANSPLANTED AREAS IN %

YEAR	Broadcasted	Transplanted
1965	20.0	80.0
6	20.5	79.5
7	26.3	73.5
8	25.1	74.9
9	23.2	76.8
00	24.9	75.1
1	22.7	77.3
2	21.7	78.3
3	23.8	76.2
4	23.2	76.8
5	23.8	76.2

III. Production

The total yearly production of paddy in Thailand was 5,570,110 tons in 1955 and 11,845,522 tons in 1966, and is expected to reach 13,410,000 tons in 1969 (Table 17.).

The annual variation in the quantities of paddy available is considerable, depending on the area under cultivation, and the climatic conditions of that particular year.

Between 1956 and 1960 the yearly average increase in production amounted to 100,000 tons, equal to 1.35% as compared with 1955. In the following five years 1961-1965 this increase rose to 373,000 tons per year, or 3.48% as compared with 1960. In the four-year period 1966-1969, however, on the basis of extremely approximate estimates of production, the yearly average increase was equal to 1,050,000 tons per year, i.e. 11.41% as compared with the 1965 production. Thus, in the last 14 years, from 1955 to 1969, the total production of paddy has risen by an average of 5.69% per year.

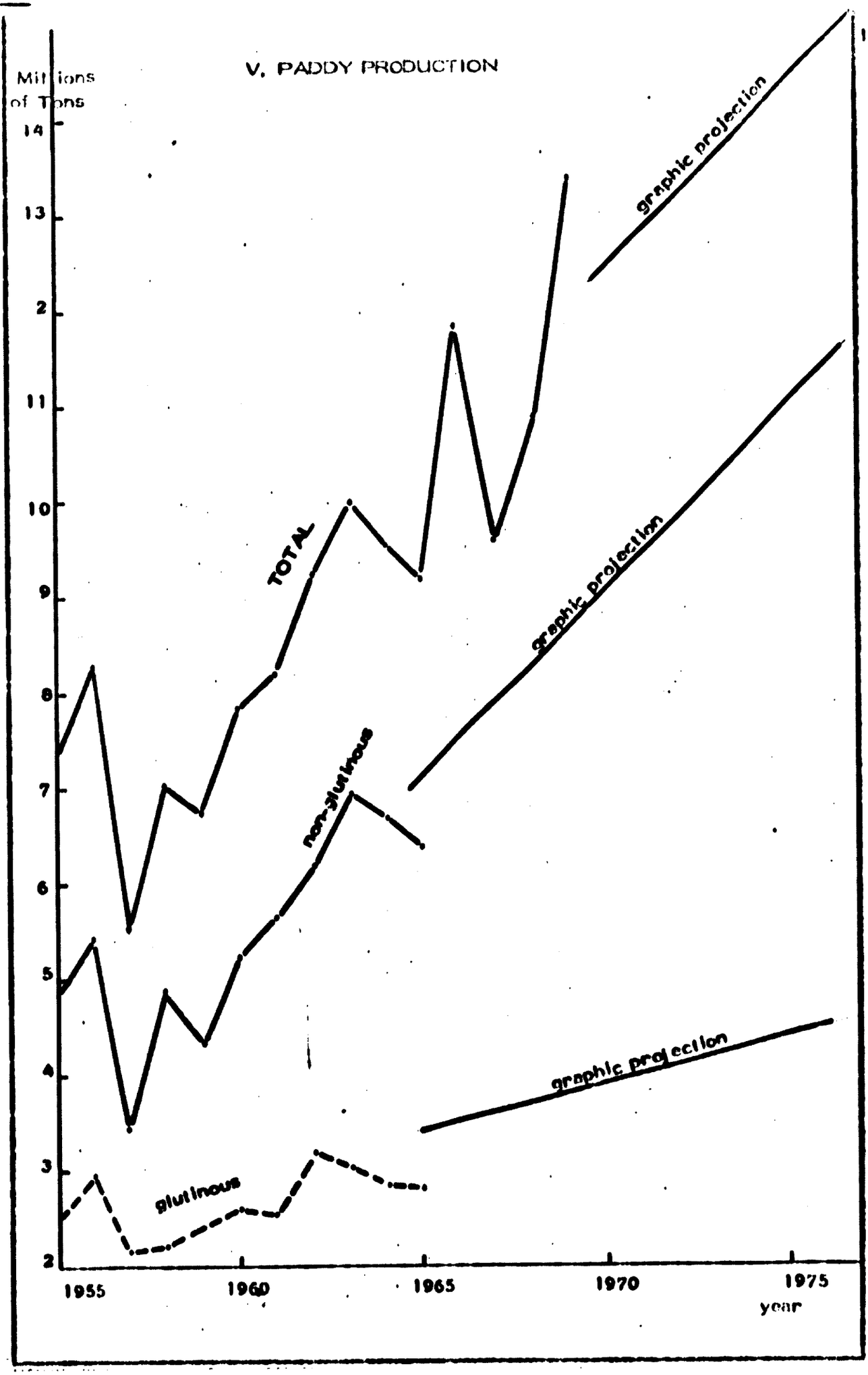
Without considering the last two years, i.e. 1968 and 1969, for which the data are absolutely unreliable, the average yearly increase in production between 1955 and 1967 would fall to 2.56%, and from 1961 to 1967 to 3.21 (Table 17. and Diagram V).

In the same periods considered, the production of paddy per hectare has also risen and, more particularly, from 1961 to 1967 the yearly increase in unitary production was equal to 0.29% (Ta-

17. PADDY PRODUCTION

Year	Cultivated area Ha x 1000	Total production Metric Tons	Average yield Tons/Ha
1955	5,770	7,333,611	1.36
6	5,927	8,296,782	1.44
7	5,075	5,570,110	1.30
8	5,758	7,053,185	1.36
9	6,065	6,769,766	1.29
60	5,921	7,834,506	1.38
1	6,179	8,179,626	1.44
2	6,659	9,279,478	1.50
3	6,601	10,028,882	1.58
4	6,539	9,558,170	1.60
5	6,553	9,218,000	1.54
6	7,306	11,845,522	1.73
Est.7	6,410	9,594,854	1.71
Est.8	6,485	10,895,000	1.92
Est.9	7,580	13,410,000	-

V. PADDY PRODUCTION



ble 18 and Diagram VI.)

Having considered and appraised the various parameters which determine the sum-total of paddy production (increase in surface area and possible technical progress), a constant average rate of increase in production equal to 8.0% per year may be estimated as from 1967. On the basis of this increase, the production up to 1975 may be predicted as follows, in millions of tons:

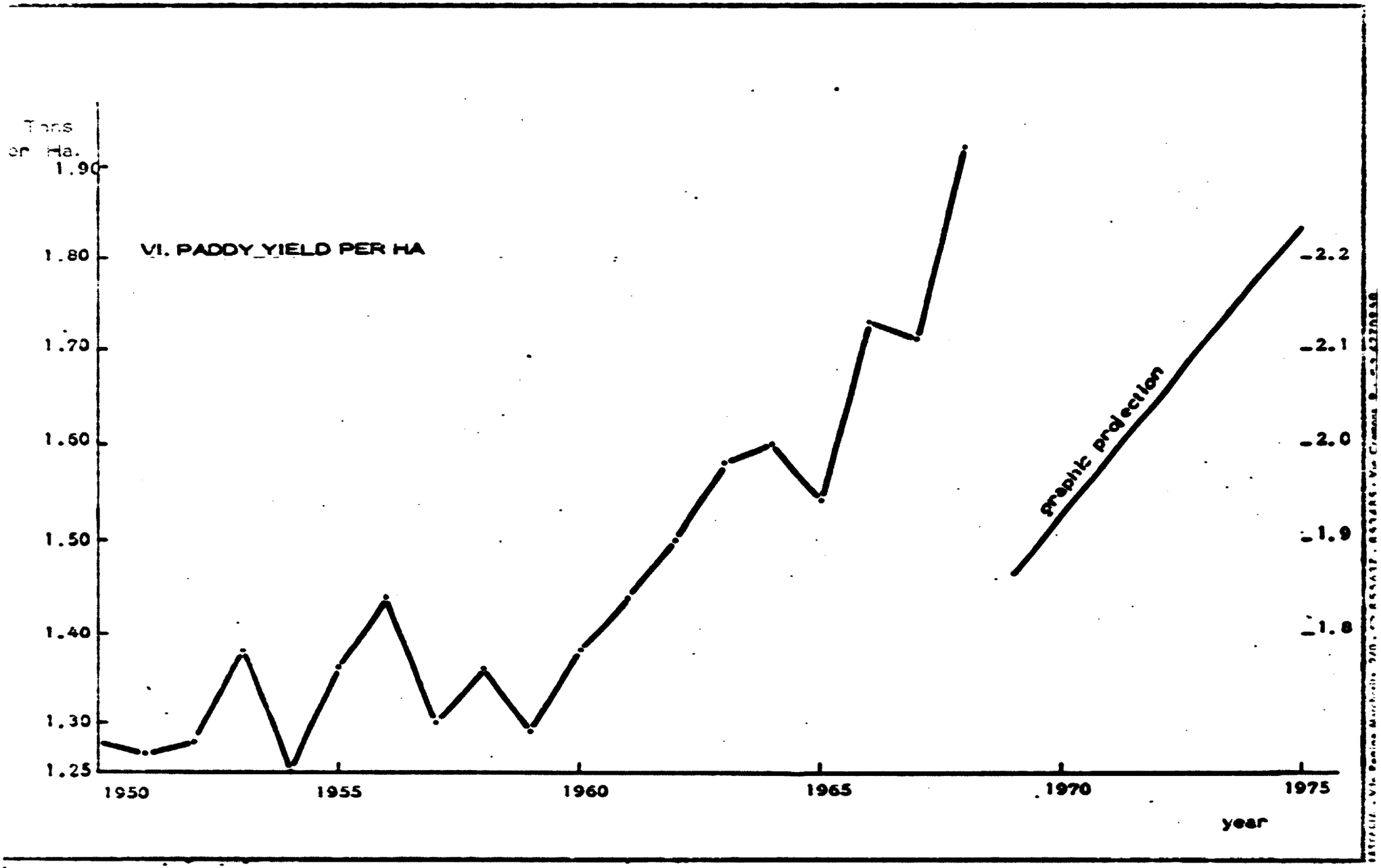
Year	Production in million tons	Increase over previous year
1968	10,636	0.768
1969	11,192	0.829
1970	12,087	0.895
1971	13,054	0.967
1972	14,098	1.044
1973	15,226	1.128
1974	16,444	1.218
1975	17,759	1.315

The ratio of the quantity of paddy produced of the non-glutinous and glutinous types over the last few years was 70% non-glutinous, and 30% glutinous (Table 19).

Assuming the above proportions, as a fixed constant for the medium-term forecasts, the production of the two types of paddy could be as follows, in millions of tons:

18. TREND OF PADDY YIELD TON/HA

YEAR	YIELD	INDEX
1907-16	1.74	110
1917-26	1.79	110
1927-36	1.63	100
1937	1.54	95
38	1.44	88
39	1.48	91
40	1.52	93
41	1.41	86
42	1.33	82
43	1.45	89
44	1.29	79
45	1.25	77
46	1.26	78
47	1.28	79
48	1.38	85
49	1.34	83
50	1.28	79
51	1.27	78
52	1.28	79
53	1.38	85
54	1.25	77
55	1.36	84
56	1.44	88
57	1.30	80
58	1.36	84
59	1.29	79
60	1.38	85
61	1.44	89
62	1.50	92
63	1.58	97
64	1.60	98
65	1.54	96
66	1.73	106
Est. 67	1.71	105
Est. 68	1.92	118


Tons
per Ha.
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.25
VI. PADDY YIELD PER HA
graphic prediction
2.2
2.1
2.0
1.9
1.8
1950
1955
1960
1965
1970
1975
year

financing of the project should thus be considered as coming from exclusively national sources, using suppliers' credit. It has been assumed that 30% of the total investment costs will be supplied out of their own funds by the owners of the plant; the remainder is to be provided as a loan from the suppliers, carrying an interest rate of 8%, with a three-year period of grace (1) and a ten-year repayment period.

The investment schedule is shown in Tables 17, 18 and 19.

The revenues include sales of milled rice and all by-products. Yearly and total revenues are shown in the income statements given in Tables 14, 15 and 16.

The processing costs include maintenance expenditure, personnel expenditure, operating expenses (fuel and solvents), plus 10% for overheads and 10% for contingencies.

Depreciation has been taken over a period of 35 years, considered as the economic life of the plant.

Amortization of the debt is considered in 10 years, carrying an interest rate of 8%.

The loan for Alternative I totals $ 2,009,000, including interest during the three-year period of grace (see Table 17) and $ 2,533,800 for Alternative II (see Table 18).

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(1) During the three-year period of grace, interest is charged, being added to the original loan.

19. TOTAL PRODUCTION GLUTINOUS AND NON GLUTINOUS RICE -AND PER CENT

Year	Total production 1000 ton	Increm.	Glutinous 1000 ton	increm.	Non glutinous 1000 ton	increm.	% of glutinous of total	increm.	% of non Glutinous of total	increm.
1955	7334	+ 963	2495		4839		34.02		65.98	
6	8297	+ 963	2879	+ 384	5418	+ 579	34.69	+ 0.67	65.31	- 0.67
7	5570	- 2727	2149	- 730	3421	- 1997	38.59	+ 3.90	61.41	- 3.90
8	7053	+ 1483	2164	+ 15	4889	+1468	30.68	- 7.91	69.32	+ 7.91
9	6770	- 283	2376	+ 212	4394	- 495	35.09	+ 4.41	64.91	- 4.41
60	7835	+ 1065	2614	+ 238	5220	+ 826	33.37	- 1.72	66.63	+ 1.72
1	8177	+ 342	2553	- 61	5624	+ 404	31.22	- 2.15	68.78	+ 2.15
2	9279	+ 1102	3095	+ 542	6184	+ 560	33.35	+ 2.13	66.65	- 2.13
3	10029	+ 750	3065	- 30	6964	+ 780	30.56	- 2.79	69.44	+ 2.79
4	9558	- 471	2823	- 242	6735	- 229	29.53	- 1.03	70.47	+ 1.03
5	9199	- 359	2810	- 13	6389	- 346	30.55	+ 1.02	69.45	- 1.02
6	11846	+ 2647								
7	9595	- 2251								
Est. 8	10895	+ 1300								
Est. 9	13410	+ 2505								

Year	Non-glutinous	Glutinous	Total
1968	7,254	3,109	10,363
1969	7,834	3,358	11,192
1970	8,461	3,626	12,087
1971	9,138	3,916	13,054
1972	9,869	4,229	14,098
1973	10,658	4,568	15,226
1974	11,511	4,933	16,444
1975	12,431	5,328	17,759

It will be noted that, as compared with the production of paddy obtained in past years, the rate of increase of production of other crops is far higher and - as mentioned earlier with relation to cultivated areas - the rate of production for maize and fibre products is particularly high (Tables 20, 21 and 22).

The total paddy production, subdivided according to each of the agrarian regions, has been updated only as far as 1965, while for later years it has been possible to collect certain of the estimated values (Table 23).

As in the case of the surface areas, the greatest production is to be found in the Central Plain Region and in the North-Eastern Region. The highest average production per hectare is achieved constantly in the Northern Region, where, however, the type of rice produced and consumed is essentially glutinous, as also in the North-Eastern Region.

20. MAIZE PRODUCTION

	Year	Tons
	1948-52	31,000
	1952-56	68,000
	1957	-
	8	-
	9	-
	60	543,900
	1	598,300
	2	665,400
	3	857,700
	4	935,100
	5	1,021,300
	6	1,250,300
Prelim.	7	1,000,000
Est.	8	1,550,000
"	9	1,705,000

21. INDEX OF PRODUCTION OF PRINCIPAL CROPS (1950-53 = 100)

Year	Rice	Maize	Upland	Oil	Fibre	All crops except rice
1955	101	165	194	151	91	181
56	115	279	282	165	131	252
7	77	332	306	179	152	328
8	97	451	322	164	169	337
9	93	768	393	149	230	403
60	108	1319	440	177	584	470
1	113	1450	361	152	976	431
2	128	1622	319	166	209	387
3	139	2093	527	175	670	575
4	132	2280	458	166	899	518
1965	127	2490	421	170	1496	534

22. INDEX OF AGRICULTURAL PRODUCTION (1953 = 100)

Year	Paddy	Maize	Kenaf and Jute	Cassava
1958	91.06	364.41	206.56	171.46
1959	62.17	620.34	343.44	381.56
1960	95.08	1063.69	1205.49	430.62
61	112. 62	1170.14	2255.74	608.06
62	112. 62	1301.30	900.82	731.60
63	121.72	1677.44	1405.74	743.65
64	116.01	1828.81	1995.08	548.47
65	111.88	1997.26	3549.18	775.07
66	145.30	2194.30	4014.80	1574.80
Prel 67	116.50	2444.60	1668.00	1557.80
Est. 68	139.60	2640.20	1170.50	1662.90

23. VARIATION OF PADDY PRODUCTION BY REGIONS (1000 tons)

Year	Northern	Ton/ha	Northeastern	Ton/ha	Central Plain	Ton/ha	Southern	Ton/ha
1955	745.5	1.97	2149.5	1.20	3768.7	1.53	669.9	1.62
6	798.6	2.16	2613.4	1.13	4223.5	1.59	661.2	1.54
7	822.1	2.16	1572.4	1.04	2653.6	1.30	522.1	1.48
8	719.5	1.89	1978.0	1.00	3731.3	1.56	624.4	1.42
9	795.6	1.93	2019.8	0.93	3307.4	1.46	646.8	1.51
60	781.6	1.93	2294.5	1.03	4118.9	1.59	639.4	1.48
1	873.7	2.13	2322.9	1.03	4273.1	1.69	706.9	1.51
2	854.9	2.96	3082.1	1.17	4599.9	1.72	742.6	1.53
3	915.8	2.09	3043.6	1.18	5284.8	1.84	784.7	1.66
4	1006.3	2.32	2777.9	1.22	5183.6	1.82	590.4	1.41
5	1068.4	2.47	2291.3	1.09	5091.4	1.73	747.8	1.53
Est. 6	3334.6	-	3795.5	-	4011.2	-	805.8	
Est. 7	2755.4	-	2177.2	1.12	3932.6	1.98	729.6	-
8	-	-	-	-	-	-	-	-
Est. 9	3040.0	2.39	4580.0	1.42	4010.0	1.87	980.0	1.65

The region of greatest interest for the production of high-quality non-glutinous paddy rice remain almost exclusively the Central Plain. Considering that the Central Plain is the area of cultivation most concerned with rice export, both on account of the type of rice produced and because the areas of production are closest to the points of shipment, it may be interesting to analyse the potential production of the region, as far as the non-glutinous type of rice is concerned (Table 24).

In the period 1955-1965, between 71 % and 76% of the non-glutinous paddy harvested throughout the country was produced in the Central Plain. In the first five years the average annual increase was 3.97%, as compared with 1955; in the second five-year period this increase rose to 4.64%, as compared with 1960.

Considering that in the two-year period 1964-65 the production of non-glutinous paddy of the Central Plain was equal to approximately 75% of all the paddy of this type produced by Thailand, it would appear reasonable to assume this percentage as a fixed constant for the forecasts of production of non-glutinous rice in the area.

On the basis of this forecast, the production of non-glutinous rice in the region of the Central Plain alone should reach the following values in the next few years:

20. [illegible] AND NON-GLUTINOUS RICE BY REGIONS

YEAR	NORTHERN 1000 tons	% non glut.	% total	NORTHEASTERN 1000 tons	% non glut.	% total	CENTRAL PLAIN 1000 tons	% non glut.	% total	SOUTHERN 1000 tons	% non glut.	% total
NON GLUTINOUS												
1985	90.9	1.1	0.60	562.3	11.6	7.67	3601.0	74.4	49.10	624.7	12.9	8.52
6	90.5	1.2	0.73	695.6	12.8	6.38	4031.9	74.4	48.59	625.6	11.6	7.54
7	102.8	3.0	1.84	286.1	8.6	5.32	2523.2	73.8	45.30	493.5	14.6	8.95
8	111.3	2.3	1.15	686.9	12.4	8.59	3582.0	73.3	50.79	589.5	12.0	8.36
9	70.6	1.6	1.04	538.9	12.3	7.96	3178.2	72.1	46.83	614.6	14.0	9.08
80	68.6	1.3	0.88	508.6	11.2	7.26	3957.1	75.8	50.50	607.7	11.7	7.76
1	80.1	1.4	0.98	768.0	13.7	9.39	4099.4	72.9	50.13	673.9	12.0	8.27
2	76.3	1.2	0.82	975.0	15.8	10.51	4420.3	71.5	47.64	712.9	11.5	7.68
3	94.4	1.4	0.94	1033.9	14.8	10.31	5063.4	73.0	50.69	752.1	10.8	7.50
4	110.4	1.6	1.16	1068.8	15.9	11.16	4987.8	74.1	52.18	568.4	8.4	5.95
5	97.5	1.5	1.06	696.7	10.9	7.56	4874.5	76.3	52.88	720.4	11.3	7.82
GLUTINOUS		% Glut.			% Glut.			% Glut.			% Glut.	
1985	994.6	27.9	9.67	1867.2	63.6	21.64	187.6	6.7	2.28	45.2	1.8	0.62
6	733.6	25.2	8.84	1917.8	66.6	23.11	191.6	6.7	2.31	35.5	1.2	0.43
7	719.2	33.5	12.91	1276.8	59.4	22.91	130.4	6.0	2.34	23.6	1.1	0.42
8	608.2	28.1	8.62	1372.1	63.4	19.45	149.3	6.9	2.12	34.9	1.6	0.49
9	725.2	30.5	10.71	1480.9	62.3	21.87	137.2	5.8	2.02	32.2	1.4	0.48
80	713.0	27.3	9.10	1707.9	65.3	21.80	161.8	6.2	2.06	31.8	1.2	0.41
1	973.5	31.1	11.90	1554.9	60.9	19.01	173.7	6.8	2.12	13.1	1.2	0.16
2	778.7	25.2	8.39	2107.0	68.1	22.71	179.6	5.6	1.94	29.6	0.9	0.32
3	821.4	26.8	8.19	2009.7	65.6	20.04	201.4	6.6	2.01	32.6	1.0	0.32
4	895.9	31.7	9.37	1709.1	60.6	17.88	195.8	6.9	2.05	22.0	0.8	0.23
5	970.9	34.6	10.53	1504.6	56.7	17.30	216.9	7.7	2.35	27.4	1.0	0.30

Year	Production in millions of tons	Increase over previous year
(1970)	(6,346)	470,000)
1971	6,854	508,000
1972	7,402	548,000
1973	7,994	592,000
1974	8,633	639,000
1975	9,323	690,000

Tables 25-28 give data and figures taken from official documents. In Diagram VII, the values indicated are recorded, as well as a graph showing the possible development of the production and home consumption of rice.

25. ESTIMATED AMOUNT OF RICE AVAILABLE FOR DOMESTIC CONSUMPTION

Year	Paddy produced in thousands of tons	Edible rice recovered in thousands of tons	5% reduction in tons (a)	Amount exported in thousands of tons	Available for domestic consumption	Estimated per-capite consumption in Kg./yr.
1955	7,334	4,767	238,350	1,265	3,254	146
6	8,297	5,393	269,650	1,570	3,553	154
7	5,570	3,630	181,020	1,133	2,316	98
8	7,053	4,585	229,220	1,092	3,263	133
9	6,770	4,401	220,020	1,203	2,978	118
60	7,835	5,120	256,000	1,576	3,289	127
1	8,177	5,397	269,840	1,271	3,856	144
2	9,279	6,124	305,380	1,418	4,401	160
3	10,029	6,619	330,950	1,420	4,868	168
4	9.558	6,308	315,400	1,896	4,097	137
5	9,218	6,084	304,200	1,895	4,885	159
Est. 6	11,846	7,818	390,900	1,510	5,917	187
Est. 7	9,595	6,333	316,650	1,490	4,526	139
Est. 8	10,895	7,191	359,535	1,020	5,811	171
Est. 9	13,400	8,184	409,200			

(a) The yield of edible rice from paddy is taken as 65% up to 1960 and 66% from 1961 onwards. The 5% reduction is rice used as seed and wastage.

26. PRO-CAPITE CONSUMPTION OF RICE ACCORDING TO VARIOUS SOURCES

I Survey : Interdepartmental committee on Nutrition for National Defence, Oct-Dec. 1960:

400.0 gr./day

II Survey : Anderson - FAO Nutrition adviser to Thailand Nov-Feb. 1962:

524.6 gr./day

III FAO : 1957-1960:

126 Kg./year

IV FAO : Projection for 1970:

149 Kg./year

		Rice consumption gr./day	Rice consumption Kg./year	Population in millions	Total consumption in 1000 tons	Production of edible rice in 1000 tons
I	1960	400.0	146.0	26.4	3,854	5,120
II	1961	524.6	191.5	27.2	5,198	5,397
III	1957-59	-	av. 126.0	24.9	3,137	av. 4,205
IV	1970	-	est. 149.0	36.0	5,364	-

For Alternative III the total loan is $ 2,980,700, including interest (see Table 19) in the three-year period of grace, with a yearly capital recovery of $ 444,200.

8.2 Results

Tables 14, 15 and 16 give the income statements and Tables 17, 18 and 19 give the statements of sources and application of funds (Cash Flow) for the investor. Not before Year 2 would it be possible to earn a net profit. Between Years 4 and 13 the debt will be serviced, and a consistent yearly cash surplus (net of depreciation) will remain. From Year 14 to Year 35 the cash surplus increases substantially, having by now repaid the debts. The financial rate of return on own funds over cash surplus works out at 19.8% for Alternative I and at 23% for Alternative II, whilst it is 32.5% for Alternative III over the 35 Years of the economic life of the plant. (1)

All in all, the financial position is very satisfactory when viewed in the context of agricultural processing industries elsewhere in the developing coutries.

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(1) Benefit/cost ratio (i.e. cash surplus over own funds) at a 14% interest rate is : 1.7 for Alternaitve I; 2.8 for Alternaitve III.

27. ESTIMATED PRO-CAPITE RICE CONSUMPTION

Year	Quantity available for domestic consumption in 1000 t.	Population in thousands	Kg. per head per year	Annual variation
1955	3,264	22,762	145.6	
6	3,553	23,445	153.8	+ 8,2
7	2,316	24,148	97.5	-56,3
8	3,263	28,873	133.3	+35,8
9	2,978	25,619	117.9	-15,4
60	3,289	26,338	126.5	+ 8.8
1	3,856	27,180	144.2	+17,7
2	4,401	27,995	159.7	+15,5

28. POPULATION - PRODUCTION - CONSUMPTION - EXPORT

Year	Population million	Rice milled production (*) ton x1000	5% reduction (**) ton x 1000	Export ton x 1000	Available domestic consumption 1000 ton	Consump. pro capite Kg/year
1955	22.762	4,767	238.3	1,265	3,264	146
6	23.445	5,393	269.6	1,570	3,553	154
7	24.148	3,630	181.0	1,133	2,316	98
8	24.873	4,584	229.2	1,092	3,263	133
9	25.619	4,401	220.0	1,203	2,978	118
60	26.388	5,120	256.0	1,576	3,289	127
1	27.180	5,397	269.8	1,271	3,856	144
2	27.995	6,124	305.4	1,418	4,401	160
3	28.9	6,619	330.9	1,420	4,868	168
4	29.8	6,308	315.4	1,896	4,097	137
5	30.7	6,084	304.2	1,895	4,885	159
6	31.7	7,818	390.9	1,510	5,917	187
7	32.7	6,333	316.6	1,490	4,526	139
8	33.8	7,191	409.5	1,020	5,811	171
9	34.8	8,851	442.5			

(*) Paddy converted into milled rice at a yield of 65% up to 1960, 66% from 1961 onwards

(**) Reduction for seed, wastage and damages during storage

VII.

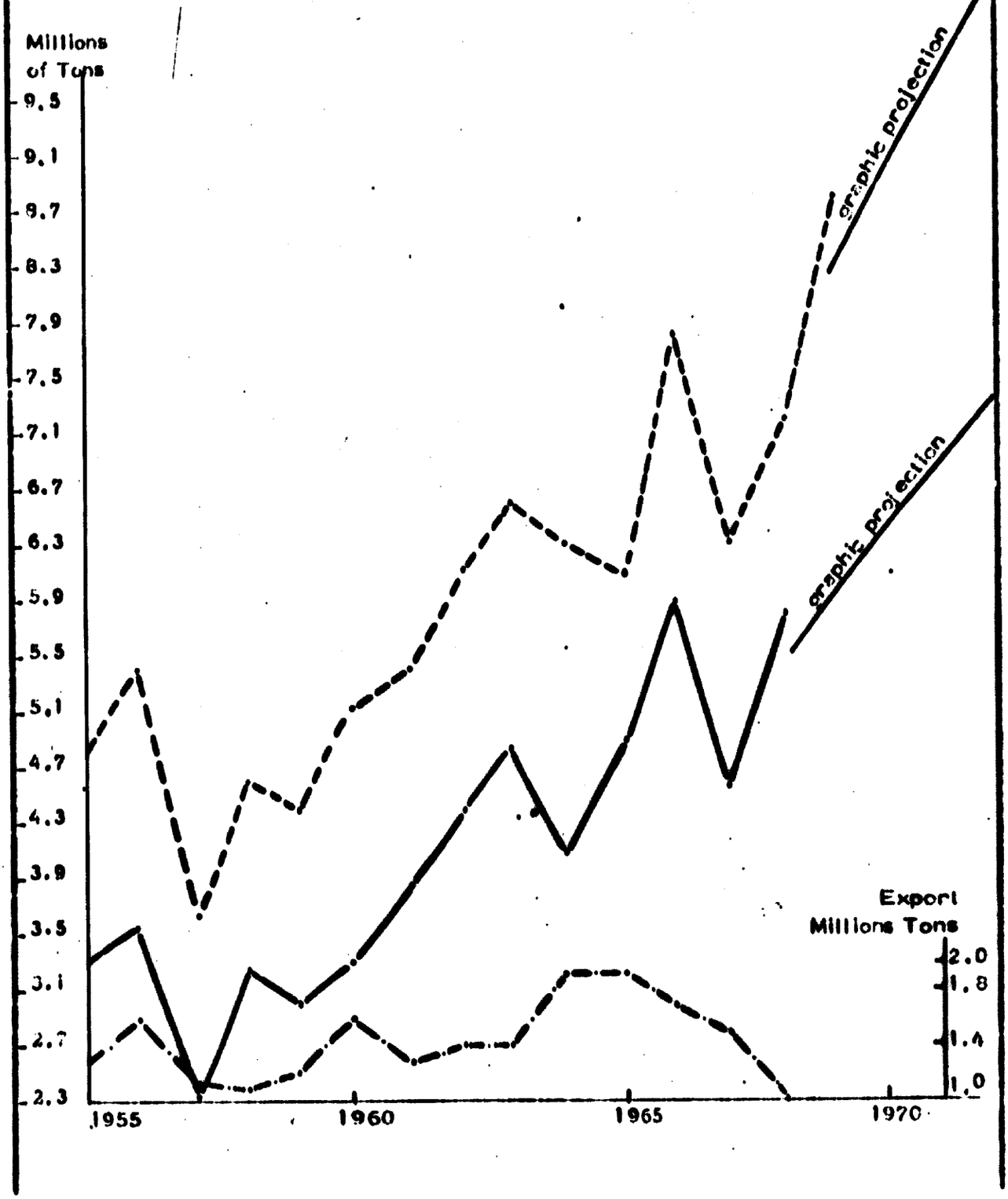
PADDY PRODUCTION

RICE CONSUMPTION

RICE EXPORT

CONVERSION RATE

100 Kilos paddy = 66 Kilos Milled Rice



IV. Paddy grades

The qualitative characteristics of paddy are established on the basis of the agronomical variety, the percentage of breakage occurring during milling and the percentage of damaged grains, such as red grains or grain with red streaks, chalky-textured or discoloured grains.

A typical characteristic of Thai rice is the shape of the grain, which may be classified as long and slender, and the type of texture, which is waxy and translucent.

Accordingly, the varieties with these characteristics are those with the greatest commercial value.

Under a law which came into force on May 20, 1957, the Thai Ministry of Economic Affairs laid down standards governing the types of rice to be exported. These are based essentially on eight grades of milled rice. The composition of each grade is established in terms of whole and broken grains of varying sizes. Each grade is, moreover, classified as regards the length of the grain and also the proportion of chalky and discoloured grains.

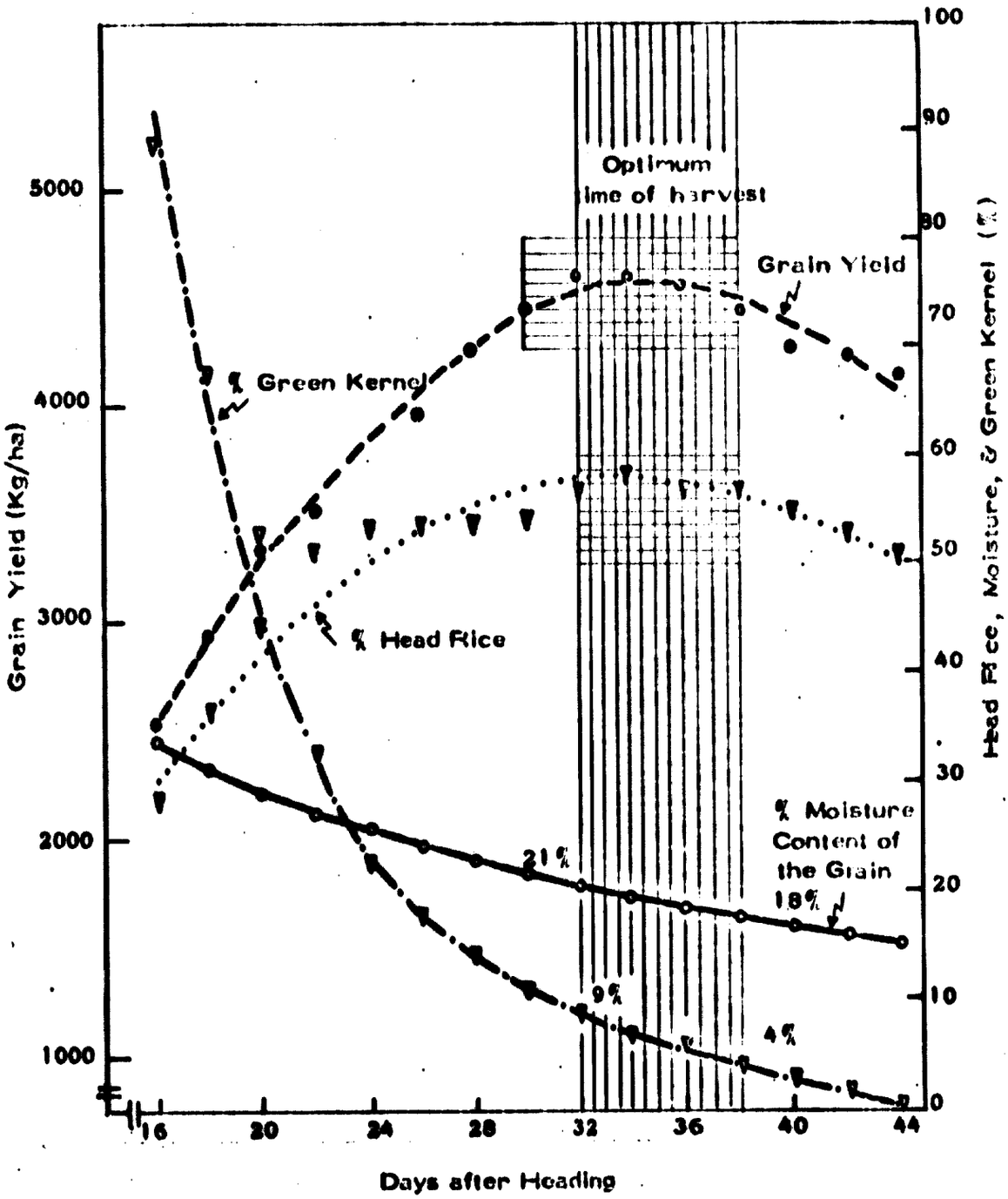
The classification of paddy rice is directly influenced by the quality of the milled product obtained; however, it has not been possible to work out a well-defined and precise classification of the threshed cereal. In the transactions taking place between producers and middlemen, and between the latter and the millers, the quality and value of the product are usually determined on the basis of visual examination.

To ascertain the yield on processing, as well as the appearance of the processed grains and any possible defects, a sample of the rough rice is shelled in a very rudimentary way, using a level surface consisting of an abrasive hard compound on which the rice is placed and rubbed with a wooden cylinder.

Thus judgement as to the quality and consequent commercial value of the product is in practice left to the subjective evaluation of the parties involved, without any determination based on a precise calculation of the components of its commercial value.

VIII.

Optimum time of harvest on the basis of maximum grain yield and high percentages of head rice as indicated by percentage moisture of grain at harvest and percentage green kernels



Source: International Rice Research Institute, Los Banos, Laguna Philippines

APPENDIX II

THE MARKET OF WHOLE GRAIN AND BROKEN RICE (STATISTICAL DATA)

29. OUTPUT OF PADDY AND MILLED RICE

Year	Paddy in thousands of tons	Milled-Rice - 65% - in thousands of tons	Milled-Rice - 60% - in thousands of tons
1960/61	7,834	5,092	4,700
1961/62	8,177	5,315	4,906
1962/63	9,279	6,031	5,567
1963/64	10,029	6,518	6,017
1964/65	9,558	6,212	5,734
1965/66	9,218	5,991	5,530
1966/67	11,900	7,735	7,140
1967/68	9,600	6,240	5,760

(a) Source: "Economic Progress of Thailand - General Indicators" - Office of National Economic Development Board - October 1968

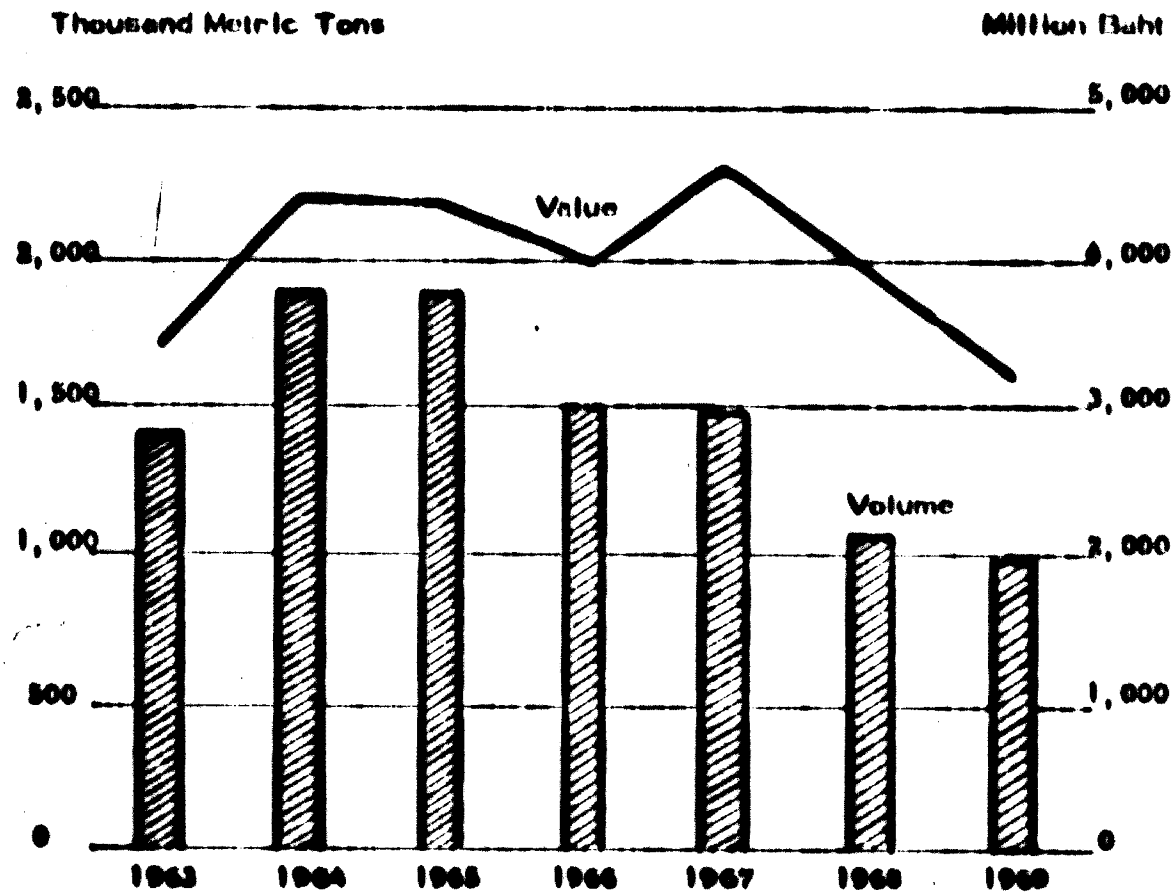
(1) Estimated

30. TOTAL VALUE OF EXPORTS AND TOTAL MILLED RICE EXPORTS (1960 - 1968)

Year	Total value exports (FOB) (U. S. dollars)	Total milled rice exports (Tons)	Total Value of milled rice exports (U. S. dollars)
1960	430, 715, 559	1, 202, 772	138, 490, 905
1961	499, 849, 166	1, 575, 998	179, 909, 205
1962	476, 458, 529	1, 271, 023	161, 993, 361
1963	483, 815, 058	1, 417, 673	171, 196, 064
1964	616, 960, 893	1, 896, 258	819, 427, 488
1965	647, 040, 598	1, 895, 223	216, 718, 668
1966	715, 495, 856	1, 507, 550	200, 055, 143
1967	708, 308, 900	1, 462, 272	232, 657, 248
1968	683, 954, 675	1, 068, 185	180, 741, 517

(a) Source: Annual Statement of Foreign trade of Thailand
Department of Customs - 1968

IX. RICE EXPORTS



Source: Department of Customs

Table 14 - Income Statement: Alternative I
(U.S. $)

Description	Year 1	Year 2	Year 3	From year 4 to year 35
Revenues	-	1,944,000	3,240,000	6,480,000
- White head rice	-	1,701,300	2,835,600	5,667,600
- White broken rice	-	172,800	288,000	576,000
- Raw bran	-	70,000	116,400	232,800
Costs	5,300	1,874,600	3,170,500	6,171,200
- Raw material inputs (paddy)	-	1,687,500	2,812,500	5,625,000
- Operation and maintenance	4,000	58,000	73,300	133,200
- Petrol and water	100	1,100	1,100	2,100
- Overheads and contingencies	-	12,000	15,000	25,000
- Interests on working capital	600	115,000	170,000	285,000
- Depreciation of fixed assets	-	-	109,600	109,600
Net Profit (before taxes)	- 5,300	69,400	58,000	309,200

[redacted]

Year	Total of rice exports		White rice				Glutinous rice			
			Husked		Husked, others		Broken		Husked		Broken	
	Tons	Mill. units of Dollars	Tons	Mill. units of Dollars	Tons	Mill. units of Dollars	Tons	Mill. units of Dollars	Tons	Mill. units of Dollars	Tons	Mill. units of Dollars
[redacted]	1,[redacted],772	120.4	[redacted],400	21.2	[redacted],[redacted]	28.9	[redacted],[redacted]	21.3	42,[redacted]	5.4	22,[redacted]	2.0
[redacted]	1,[redacted],[redacted]	170.9	[redacted],[redacted]	32.8	677,[redacted]	71.3	[redacted],[redacted]	28.9	[redacted],[redacted]	5.7	[redacted],[redacted]	2.0
[redacted]	1,[redacted],[redacted]	161.9	[redacted],[redacted]	35.5	[redacted],[redacted]	42.0	[redacted],[redacted]	29.3	[redacted],[redacted]	5.9	37,[redacted]	3.2
[redacted]	1,417,[redacted]	171.1	[redacted],[redacted]	34.9	477,[redacted]	51.6	[redacted],[redacted]	25.8	104,[redacted]	12.6	[redacted],[redacted]	3.1
[redacted]	1,[redacted],[redacted]	230.4	415,[redacted]	32.6	[redacted],[redacted]	77.8	[redacted],[redacted]	36.8	[redacted],[redacted]	10.2	[redacted],[redacted]	2.6
[redacted]	1,[redacted],[redacted]	216.7	[redacted],[redacted]	29.7	[redacted],[redacted]	51.8	[redacted],[redacted]	28.1	[redacted],[redacted]	8.6	14,[redacted]	1.5

Source: Department of Customs, [redacted]

Table 31 continued.

Years	Rice cargo		Parboiled		Rice n. e. s.		White rice flour		Glutinous rice flour		Vermicelli	
	Tons	Millions of dollars	Tons	Millions of dollars	Tons	Millions of dollars	Tons	Millions of dollars	Tons	Millions of dollars	Tons	Millions of dollars
1960	9,337	0.8	177,842	18.9	—	—	24	0.001	501	0.06	9,743	1.23
1961	13,529	1.3	147,467	17.6	1,467	0.1	3	0.0009	2,566	0.23	9,723	1.35
1962	21,226	2.5	161,242	22.5	771	0.07	10	0.001	3,752	0.42	9,422	1.45
1963	14,635	1.4	175,726	22.6	643	0.07	3	0.0003	2,969	0.33	9,249	1.39
1964	44,889	4.1	254,351	29.7	467	0.05	53	0,005	4,836	0.51	9,613	1.34
1965	102,831	10.1	492,889	54.9	224	0.02	4	0.0006	4,746	0.49	6,237	0.82

(a) Source: Agricultural statistics of Thailand – 1965 – Division of Agricultural Economics Office of the Under – Secretary of State Ministry of Agriculture Bangkok.

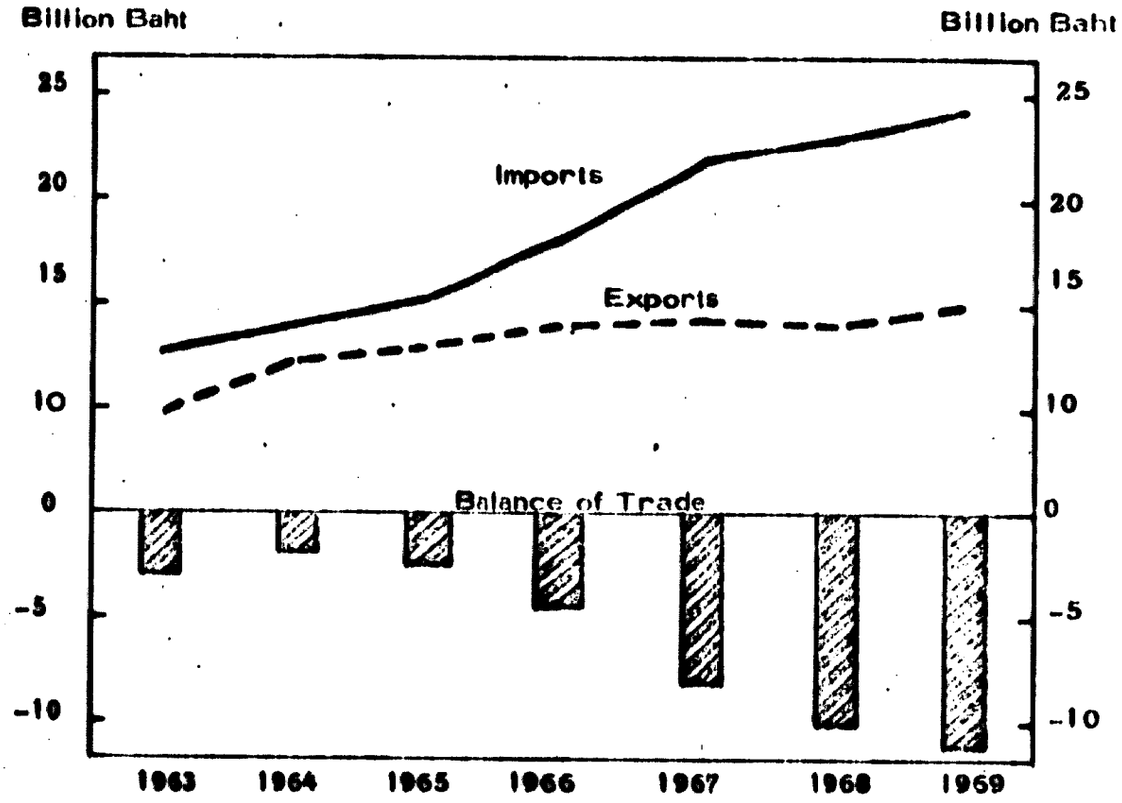
32. INDIGENOUS EXPORTS OF MILLED RICE, PRINCIPAL COUNTRIES AND WORLD TOTAL, 1969, AND COMPARATIVE DATA

(in thousands of tons, milled equivalent)

Region/country	(a) 1961-63 average	1964 (a)	1965 (a)	1966 (b)	1967 (b)	1968 (b)	(b) 1969 (provisional)
Far East							
Burma	1,661	1,394	1,348	1,128	540	346	450 (1)
Cambodia	244	487	469	168	223	247	103
China (Taiwan)	79	128	257	178	122	68	44 (1)
Japan	-	-	-	-	-	-	328
Korea, Rep. of	23	13	19	44	-	-	-
Pakistan	123	135	149	187	122	73	130 (1)
Philippines	-	-	-	-	-	41	-
Thailand	1,419	1,998	1,851	1,510	1,480	974	986
Vietnam, Rep. of	187	49	-	-	-	-	-
Others (2)	26	25	30	25	70	73	80 (1)
TOTAL	3,762	4,129	4,123	3,240	2,557	1,822	2,121
MainlandChina (3)	519	807	739	1,202 (1)	1,192 (1)	928 (1)	730 (1)
N. Korea (3)	13	5	44	72 (1)	125 (1)	60 (1)	60 (1)
N. Vietnam (3)	9	11	18	13 (1)	3 (1)	1 (1)	20 (1)
Rest of the world;	1,909	2,313	2,607	2,587	3,090	3,583	3,407
World Total	6,212	7,265	7,523	7,114	6,967	6,394	6,338

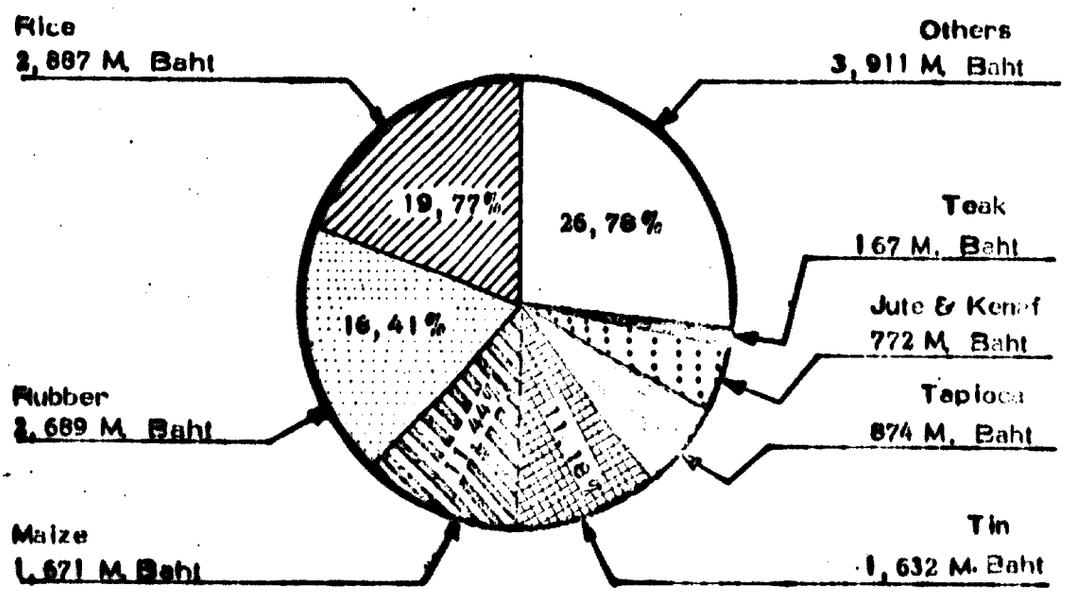
(1) Un official estimates
(2) Excludes China (Mainland), North Korea and North Vietnam
(3) Based on returns from importing countries
(a) Source: FAO - Rice Trade Intelligence - n. 3, June 20, 1968
(b) Source: FAO - Rice Trade Intelligence - n. 3, June 10, 1970

X. FOREIGN TRADE



V.I. 1969 EXPORTS CLASSIFIED BY COMMODITIES

Total 14, 603 Million Baht



Source : Department of Customs

33. EXPORTS OF MILLED RICE IN 1963 BY COUNTRIES OF DESTINATION

(In thousands of tons, milled equivalent)

Country	Milled	Brokens	Husked	Others	Total
Malaysia	328.9	93.3	9.7	90.3	422.3
Indonesia	347.9	-	-	-	347.9
Hong Kong	114.7	61.7	1.2	13.1	190.6
Japan	5.5	75.9	-	12.8	94.2
Saudi Arabia	4.7	-	-	62.9	67.6
Ceylon	36.4	-	-	-	36.4
Aden	-	-	-	26.7	26.7
Denmark	13.8	6.4	0.8	8.3	23.3
United Kingdom	3.8	7.7	0.6	4.7	16.9
Senegal	-	13.0	-	-	13.0
Ryu-Kyu Isl.	3.2	3.2	-	4.0	0.4
Somaliland	0.6	-	-	7.5	8.1
Brunei	6.1	-	-	0.4	6.5
Mauritius	1.5	-	-	4.5	6.0
Netherlands	4.7	-	1.1	0.1	5.9
South Africa	1.3	0.1	-	2.1	3.5
Persian Gulf	1.0	0.1	-	1.7	2.8
Rhodesia	0.7	0.4	-	-	1.1
Lebanon	0.9	-	-	0.1	1.0
Kenya	0.8	-	-	0.1	0.9
New Zealand	0.3	-	-	-	0.3
Germany, F.R.	0.1	-	-	-	0.1
Others	14.0	13.0	1.7	4.7	33.2
	899.0	299.6	15.1	284.0	1,398.7

(a) Source: FAO - Rice - Exchange of Economic Information - n. 2, March 4, 1964

34. EXPORTS OF MILLED RICE IN 1964 BY COUNTRIES OF DESTINATION

(In thousands of tons, milled equivalent)

Country	Milled	Brokens	Husked	Others (1)	Total
Malaysia	262.5	133.0	25.4	84.6	505.5
Indonesia^	444.1	1.0	-	-	445.1
Hong Kong	120.8	67.9	3.6	12.2	204.7
Philippines	115.1	-	-	-	115.1
Japan	15.4	88.1	-	10.9	114.4
Saudi Arabia	1.2	-	-	46.8	48.0
Aden	-	-	0.1	40.3	40.4
Denmark	6.0	16.4	3.3	10.7	36.4
Senegal	-	34.0	-	-	34.0
Netherlands	26.7	2.5	2.1	1.5	32.8
Somaliland	1.1	-	-	29.5	30.6
Ceylon	13.6	5.0	1.2	9.3	29.9
China(Taiwan)	19.0	-	-	2.0	21.0
Persian Gulf	2.1	0.9	-	16.0	19.0
Mauritius	1.0	-	-	18.0	19.0
United Kingdom	3.0	10.6	0.3	4.3	18.0
Iraq	12.7	-	-	-	12.7
South Africa, Rep. of	7.5	-	0.1	2.1	9.7
Ryu-Kyu Isl.	1.5	4.3	-	3.5	9.3
Brunei	7.0	-	-	0.4	8.3
Lebanon	1.3	-	-	-	1.3
Rhodesia	1.2	0.1	-	-	1.3
New Zealand	0.3	-	-	-	0.3
Others	20.4	7.0	0.3	30.1	78.8
	1,066.1	378.2	48.6	301.0	1,693.0

(a) Source: FAO - Rice Exchange of Economic Information - n. 1, February 18, 1965

(1) Including boiled and glutinous rice

35. EXPORTS OF MILLED RICE IN 1965 BY COUNTRIES OF DESTINATION

(In thousands of tons, milled equivalent)

Country	Milled	Brokens	Husked	Others (1)	Total
Aden	-	-	-	24.1	24.1
Brunei	0.3	-	-	0.5	0.8
Ceylon	25.7	-	-	155.7	181.4
Denmark	4.9	3.2	10.3	5.4	23.8 (2)
Hong Kong	101.5	90.2	5.0	8.7	205.4
India	0.4	82.4	-	130.3	213.1
Indonesia	88.5	10.5	-	-	99.0
Iran	10.0	-	-	-	10.0
Japan	38.7	94.4	-	7.0	144.9
Madagascar	22.1	9.5	-	-	31.6
Malaysia	338.1	68.2	38.9	85.4	424.6
Mauritius	1.5	-	-	34.8	36.3
Netherlands	1.0	1.6	7.1	7.3	17.0
Persian Gulf	0.9	-	-	1.6	2.5
Philippines	91.0	39.6	-	-	130.6
Reunion	1.1	-	-	-	1.1
Rhodesia	1.0	-	-	0.3	2.1
Ryu-Kyu Isl.	0.5	5.0	-	3.9	9.3
Saudi Arabia	0.4	-	-	78.0	78.3
Senegal	-	48.0	-	-	48.0
Somaliland	0.3	-	-	0.7	0.9
United Kingdom	3.0	0.9	5.3	3.4	21.5
West Irian	1.0	-	-	-	1.0
Others	21.0	10.3	20.9	11.0	135.7
	708.3	488.3	85.3	801.0	1,881.0

(a) Source: FAO - Rice - Exchange of Economic Information - n. 2, April 5, 1966

(1) Including boiled and glutinous rice

(2) Of which only 1,270 tons remained in Denmark

36. EXPORTS OF MILLED RICE IN 1966 BY COUNTRIES OF DESTINATION

(in thousands of tons, milled equivalent)

Country	Milled	Brokens	Husked	Others (1)	Total
Aden	0.1	0.1	-	22.7	22.9
Bahrain	0.9	-	-	0.7	1.6
Brunei	6.7	-	-	0.1	6.8
Ceylon	-	10.9	-	103.0	113.9
China(Taiwan)	-	-	-	2.0	2.0
Czechoslovakia	13.5	-	-	-	13.5
Denmark	6.5	0.2	4.5	0.5	11.7
Ethiopia	-	-	-	1.3	1.3
France	4.1	-	1.8	0.4	6.3
Germany, F.R.	0.1	-	0.9	-	1.0
Hong Kong	80.5	116.5	2.9	9.4	211.3
India	6.0	42.2	-	131.5	179.7
Indonesia	120.7	37.7	-	-	167.4
Japan	0.2	84.4	-	0.8	85.2
Jordan	1.0	-	-	-	1.0
Kenya	1.7	0.1	-	-	1.8
Malaysia*	68.9	16.1	0.5	61.8	146.3
Maldive Isl.	0.1	-	-	0.9	1.0
Mauritius	1.5	-	0.9	10.4	12.8
Mozambique	1.1	-	-	-	1.1
Netherlands	1.4	-	20.6	0.1	22.1
Oman	0.4	-	-	2.2	2.6
Pakistan	-	10.0	-	0.0	10.0
Philippines	-	40.6	-	-	40.6
Reunion	3.0	7.3	-	-	10.3
Rhodesia	1.4	-	-	-	1.4

Table 36 continued

Country	Milled	Brokens	Husked	(1) Others	Total
Ryu-Kyu Isl.	-	3.8	-	2.6	6.4
Saudi Arabia	0.5	-	-	46.0	46.5
Senegal	-	46.0	-	-	46.0
Singapore	107.9	11.6	6.9	18.3	144.7
Somalia, Rep. of	0.5	-	-	7.7	8.2
Somaliland (Br)	-	-	-	1.4	1.5
Somaliland (Fr)	0.1	-	-	2.4	2.5
South Africa, Rep. of	0.7	-	0.1	1.9	2.7
Tanzania	12.8	-	-	-	12.8
Tunisia	1.0	-	-	-	1.0
United Kingdom	2.1	4.9	3.7	1.5	12.3
Vietnam, Rep. of	56.6	-	-	19.3	75.9
Others	1.0	-	3.3	1.3	6.5
	510.9	443.4	46.1	460.0	1,460.4

(a) Source: FAO - Rice - Exchange of Economic Information - n. 2, March, 10, 1967

(1) Including boiled and glutineus rice

Table 15 - Income Statement : Alternative II

Description	Year 1	Year 2	Year 3	Year 4	From year 5 to 9
[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	-	1,655,300	2,[illegible],800	[illegible]	[illegible]
White [illegible] broken rice	-	173,000	288,600	579,[illegible]	[illegible]
[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] oil	-	-	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] ingredients	-	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] materials	4,000	[illegible]	[illegible]	[illegible]	[illegible]
Solvents and fuel	-	-	13,500	31,500	[illegible]
Petrol and water	100	1,100	1,100	2,100	2,100
Overheads and contingencies	-	14,000	26,600	37,600	[illegible]
Interests on working capital	600	[illegible]	174,000	288,000	[illegible]
Depreciation of fixed assets	-	-	114,130	159,800	159,800
Net Profit (before taxes)	-5,300	56,780	95,290	339,490	478,050

37. EXPORTS OF RICE IN 1967 BY COUNTRIES OF DESTINATION

(In thousands of tons, milled equivalent)

Country	(1) Milled	Brokens	(2) Husked	(3) Others	Total
Aden	0.1	-	-	26.9	27.0
Bahrain	-	-	-	1.1	1.1
Belgium	-	0.1	-	1.4	1.5
Brunei	8.9	-	-	0.4	9.3
Ceylon	-	-	-	97.7	97.7
China(Taiwan)	-	-	-	6.0	6.0
Denmark	0.2	3.5	-	7.9	11.6
France	1.0	0.4	0.1	0.1	1.6
French Terr. of the Afars & the Issas	-	-	-	2.4	2.4
Hong Kong	106.2	97.1	1.1	9.9	216.3
India	-	119.6	-	64.3	183.9
Indonesia	73.3	101.5	-	-	174.8
Israel	1.0	-	-	-	1.0
Japan	-	105.3	-	21.6	126.9
Malaysia	54.5	56.4	0.4	66.5	177.8
Mauritius	0.5	-	-	20.4	20.9
Netherlands	0.2	-	0.2	0.7	1.1
Okinawa	-	4.9	-	3.3	8.2
Oman-Muscat	-	-	-	2.6	2.6
Penang	1.3	1.7	0.1	13.2	16.3
Philippines	-	100.0	-	-	100.0
Reunion	1.6	-	-	-	1.6
Saudi Arabia	-	-	-	24.1	24.1

Table 37 continued

Country	(1) Milled	Brokens	(2) Husked	(3) Others	Total
Singapore	92.8	19.5	2.8	14.3	119.4
Somalia	-	-	-	6.0	6.0
South Africa	0.8	-	-	1.2	2.0
United Kingdom	0.3	4.0	0.1	2.3	6.7
Vietnam, rep. of	60.0	-	-	-	60.0
Others	2.2	0.2	1.0	1.3	4.7
	396.9	614.2	5.8	425.6	1,442.5

(1) Including parboiled and glutinous rice

(2) i.e. brown, cargo, and loonzain rice

(3) Including paddy

(a) Source: FAO - Rice Trade Intelligence - n. 2, April 20, 1968

38. EXPORTS OF RICE IN 1968 BY COUNTRIES OF DESTINATION

(in thousands of tons, milled equivalent)

Country	Milled	Brokens	(1) Husked	(2) Others	Total
Aden	0.3	-	-	14.6	14.9
Bahrain	1.7	-	-	1.9	3.6
Brunei	10.5	-	-	0.3	10.8
Ceylon	-	-	-	55.8	55.8
Denmark	0.7	0.2	1.5	0.8	3.2
France	1.0	-	0.1	-	1.1
Germany, F. R.	-	-	1.8	-	1.8
Hong Kong	70.6	47.5	1.0	8.9	129.0
India	0.2	154.4	-	52.6	207.2
Indonesia	32.5	5.8	-	-	38.3
Japan	-	64.2	-	25.5	89.7
Kuwait	2.7	-	-	0.4	3.1
Netherlands	0.3	-	3.1	0.5	3.9
Malaysia	48.8	59.0	0.1	45.2	154.1
Mauritius	0.4	-	-	9.9	10.3
North Borneo	12.7	4.5	-	8.4	26.6
Okinawa	-	5.4	-	2.3	7.7
Oman	0.6	0.5	-	4.5	5.6
Saudi Arabia	0.9	0.1	-	67.9	68.9
Seychelles	-	1.8	-	-	1.8
Singapore	76.7	34.6	1.8	15.7	128.8
Somalia	0.2	-	-	2.3	2.5
South Africa, Rep. of	0.1	2.8	-	1.1	3.2
Tunisia	2.8	-	-	-	2.8
United Kingdom	1.2	-	-	0.8	2.8

Table 38 continued

Country	Milled	Brokens	(1) Husked	(2) Others	Total
Vietnam, Rep. of	40.0	-	-	-	40.0
Others	3.3	0.1	-	4.0	7.3
	300.3	370.3	0.4	335.4	1,008.4

(1) i.e. brown, cargo, and leonzain rice

(2) including parboiled, glutinous rice and paddy

(a) Source: FAO - Rice Trade Intelligence - n. 3, June 10, 1969

30. EXPORTS OF RICE IN 1968 BY COUNTRIES OF DESTINATION

(In thousands of tons, milled equivalent)

Country	Milled	Brokens	(a) Husked	(b) Others	Total
Aden	0.1	0.2	-	20.0	20.3
Brunei	11.0	0.1	-	0.4	12.3
Ceylon	-	-	-	20.7	20.7
China(Taiwan)	-	-	-	7.0	7.0
Denmark	3.5	0.7	1.0	1.5	5.7
France	1.6	-	0.1	-	1.7
Hong Kong	100.0	60.6	1.6	0.0	172.0
India	-	11.0	-	101.3	112.3
Indonesia	77.0	5.0	-	-	82.0
Japan	0.1	0.2	-	20.7	20.0
Korea, Rep. of	-	-	-	2.0	2.0
Malaysia	20.0	60.6	-	20.2	131.0
Malawi	2.0	-	-	-	2.0
Mauritius	1.0	0.2	-	20.0	20.1
Mozambique	1.6	-	-	-	1.0
Netherlands	0.3	-	1.0	0.2	1.5
Okinawa	-	5.0	-	2.5	0.1
Oman	0.2	-	-	1.0	2.1
Penang	0.1	1.1	-	0.0	7.2
Reunion	1.4	-	-	-	1.4
Saudi Arabia	0.1	-	-	20.2	20.3
Senegal	0.5	60.0	-	-	60.5
Singapore	20.7	60.6	1.7	17.2	120.2
Somalia	-	-	-	1.6	1.6

Table 9 continued

Country	Milled	Brokens	(1) Husked	(2) Others	Total
South Africa, Rep. of	0.3	3.3	-	1.4	5.0
United Kingdom	3.5	3.4	-	1.5	8.4
Others	3.6	0.3	0.3	3.0	7.0
	200.0	220.7	5.7	420.9	906.3

(a) Source: FAO - Rice Trade Intelligence - n. 2, April 20, 1970

(1) i.e. brown, cargo and loonzain rice

(2) Including parboiled, glutinous rice and paddy

10. EXPORT PRICES OF MILLED RICE IN BURMA AND THAILAND

(in U.S. cents/kg.)

Year	COUNTRIES		
	Burma (1)		Thailand (2)
	I	II	
1960	9.0	-	12.5
1961	9.3	11.3	12.7
1962	9.3	11.3	12.3
1963	9.5	12.0	14.4
1964	10.1	12.5	12.7
1965	10.4	12.7	12.7
1966	10.4	12.7	14.6
1967	12.0	12.1 (3)	22.2
1968	14.0	17.4	20.3

(a) Source: FAO - Production Yearbook 1968, vol. 22

(1) Contract prices FOB Rangoon, under bilateral trade agreements:

I - With Ceylon: Ngasein small mills specials; throng dec. 1968 40% brokens; from January 1968, fully boiled.

II - With Japan: Ngasein, 15% brokens, in small lots; 1966, Sinebyu and Ngasein

(2) Contract with Pakistan

(3) White, 5-7% brokens, government standard, FOB Bangkok

Table 42

Exports of milled rice and rice products by selected countries of destination in 1968.

Type of rice	Ceylon quantity (m. tons)	Ceylon value Fob (US $)	Hong Kong quantity (m. tons)	Hong Kong value Fob (US $)	India quantity (m. tons)	India value Fob (US $)
Cargo 100%						
Cargo 5%						
Cargo 10%				4		
Cargo 15%						
Cargo n. e. s.						
Cargo broken			3358	215169		
White 100%			65044	1884834		31
White 5%			8853	1281526	1	136
White 10%			1010	150220	10	953
White 15%			4635	743910	3	519
White 20%						
White 25%			100	16000	6200	782540
White 35%					141	15602
White 45%			200	32604		
White coated						
White n. e. s.	11500	1705006			42826	5147235
Broken A1 super			100016	12733647		
Broken A1 special			12	1431		
Broken C1 super			455	58591		
Broken C1 special			170	20042		
Broken C1 ordinary						
Broken C3 special			28	3170		
Broken A1 extra-super			16097	2782657		
Broken n. e. s.						
Glutinous 10%			8045	1121073		126
Glutinous broken			3234	422154		
Hulled dried			25	2756		
Parboiled	901000	11200035			130004	13009016
Ship stores	1	82	32	3000	25	4000
White rice flour						
Glutinous rice flour			12000	22000		
White rice meal						
Vermicelli made from rice			20000	81360		

Table 4I continued

Type of rice	Indonesia quantity (m. tons)	Indonesia value Fob (US $)	Japan quantity (m. tons)	Japan value Fob (US $)	Korea Rep. quantity (m. tons)	Korea Rep. value Fob (US $)
Cargo 100%						
Cargo 5%						
Cargo 10%						
Cargo 15%						
Cargo n. e. s.						
Cargo broken						
White 100%	20	2879	1	280		
White 5%	995	150835	20	3326		
White 10%	87	11050				
White 15%	13	1979				
White 20%	1357	221598				
White 25%	330	45645				
White 35%	112000	12765502				
White 45%	12115	1477744	174	20810		
White coated						
White n. e. s.	37500	4027401	47	7063		
Broken AI super	10000	1243451	42304	5465000		
Broken AI special	310	36586	42404	5407401		
Broken CI super						
Broken CI special			2003	272586		
Broken CI ordinary						
Broken CJ special						
Broken AI extra-super						
Broken n. e. s.						
Glutinous 10%			2000	455014		
Glutinous broken	50	6016	504	77310		
Boiled dried	1168	139792				
Parboiled						
Ship stores	7	799	26	3701		
White rice flour						
Glutinous rice flour			4000310	604000		
White rice meal						
Vermicelli made from rice			10000	2040		

Table 43 continued

Type of rice	Malaysia quantity (M. tons)	Malaysia value Fob(US $)	Pakistan quantity (m. tons)	Pakistan value Fob(US $)	Philippines quantity (m. tons)	Philippines value Fob(US $)
Cargo 100%	38	3878				
Cargo 5%	30	4899				
Cargo 10%						
Cargo 15%	17	2413				
Cargo n. e. s.						
Cargo broken	206	26510				
White 100%	49533	7545268	18	677	1	365
White 5%	13700	2134201			1	62
White 10%	26	4157		18		
White 15%	28	58301				
White 20%						
White 25%	30	4900				
White 35%						
White 45%						
White coated						
White n. e. s.			9000	1449878	24065	3376031
Broken A1 super	14007	1737317			20001	2863212
Broken A1 special	24	3977				
Broken C1 super	3	400				
Broken C1 special	143	15304				
Broken C1 ordinary	24	3304				
Broken C3 special	97	9007				
Broken A1 extra-super	10	1330				
Broken n. e. s.	12003	2201900				39
Glutinous 10%	3071	650061				
Glutinous broken	31	10031				
Boiled dried	45912	6057150				
Parboiled	9008	1258440				
Ship stores	14	2140			4	565
White rice flour	(1)					
Glutinous rice flour	201000	40400				
White rice meal						
Vermicelli made from rice	(1) 1454040	192245	(1) 26	18		

Table 16 - Income Statement: Alternative III
(US $)

Description	Year 1	Year 2	Year 3	From year 4 to year 35
Revenues	-	2,834,800	5,669,600	7,086,000
- White beer price	-	2,430,000	4,860,000	6,075,000
- White bread price	-	174,600	349,200	437,000
- Defatted bran	-	71,400	142,700	178,000
- Coffee oil	-	138,800	277,200	346,000
Costs	5,300	2,610,900	5,121,700	6,410,000
- Raw materials and (power)	-	2,250,000	4,500,000	5,625,000
- Operation and maintenance	4,600	84,200	140,000	156,000
- Solvent and fuel	-	72,600	104,000	121,000
- Petrol and water	100	1,100	1,100	2,000
- Overheads and contingencies	-	32,000	50,000	56,000
- Interests on working capital	600	148,000	272,000	296,000
- Depreciation of fixed assets	-	-	207,300	207,300
Net Profit (before taxes)	- 5,300	223,900	347,200	573,300

Table 8 continued

Type of rice	Singapore quantity (m. tons)	Singapore value - Fob(US $)	Vietnam Rep. quantity (m. tons)	Vietnam Rep. value Fob(US $)
Cargo 100%	10	1633		
Cargo 5%	205	24068		
Cargo 10%				
Cargo 15%	20	4400		
Cargo n. e. s.	1	75		
Cargo broken	6813	653191		
White 100%	65400	10690793		
White 5%	29120	4744001		
White 10%	11086	1613130		
White 15%				
White 20%				
White 25%			78065	8903866
White 35%			900	103615
White 45%				
White coated	3	2276		
White n. e. s.			400	40372
Broken A1 super	11520	1282140		
Broken A1 special	20	4140		
Broken C1 super				
Broken C1 special				
Broken C1 ordinary				
Broken C3 special				
Broken A1 extra-super			18	1200
Broken n. e. s.	5106	904100		
Glutinous 10%	2000	301400		
Glutinous broken	3	491		
Boiled dried				
Parboiled	9112	1251722	200	28560
Ship stores	2	207	2	200
White rice flour	1200 (1)	204		
Glutinous rice flour	200000 (1)	28000	(1)	
White rice meal			10095	1172
Vermicelli made from rice	(1) 201000	72000		

(a) Source: Annual Statement of Foreign Trade of Thailand - Department of Customs - 1966 (pag. 252)

(1) quantity in Kilogramme

Table 42

Export of milled rice and rice products by selected countries of destination in 1967

Type of rice	Ceylon		Hong Kong		India	
	quantity (m. tons)	value Fob (US $)	quantity (m. tons)	value Fob (US $)	quantity (m. tons)	value Fob (US $)
Cargo 100%						
Cargo 5%						
Cargo 10%						
Cargo 15%						
Cargo 35%						
Cargo broken			1046	126206		
White 100%		66	65020	10799226		66
White 5%			4016	500646		52
White 10%			2526	299151		
White 15%			15355	2018037		
White 20%						
White 25%			100	10502		
White 35%						
White coated						
White n. e. s.			100	15797	59791	7360234
Broken Al super			69516	10504474	59366	9440393
Broken Al special					7063	1198243
Broken Al ordinary			200	20065		
Broken Cl super						
Broken Cl special			51	6066		
Broken Cl ordinary			700	69166		
Broken C3 special			204	40018		
Broken Al extra-super	200	26216	700	70497		
Glutinous 10%			22330	3019370		
Glutinous 15%			5041	604704	40	7976
Glutinous 25%			100	10000		
Glutinous broken						
Boiled dried			4050	516300		
Parboiled	27450	1512000	10	2626		
Ship stores	1	100	823	111700	64056	8000004
Glutinous rice flour			50	6000	7	1004
White rice meal			100000(1)	31004		
Vermicelli made from rice			10000(1)	1000		
White rice flour			204000(1)	58430		
			60000	10052		

Table 42 continued

Type of rice	Indonesia quantity (m. tons)	Indonesia value Fob(US$)	Japan quantity (m. tons)	Japan value Fob(US $)	Korea Rep. quantity (m. tons)	Korea Rep. value Fob(US
Cargo 100%						
Cargo 5%						
Cargo 10%						
Cargo 15%						
Cargo 35%						
Cargo broken						
White 100%	1	300	3	700		
White 5%			40	6940		
White 10%				60		
White 15%						
White 20%	2046	420417				
White 25%	114	17650				
White 35%	72817	9400075				
White coated						
White n. e. s.	70000	12775563	901	148196		
Broken AI super	31100	2077267	50004	7410897		
Broken AI special			50012	7233858		
Broken AI ordinary						
Broken CI super						
Broken CI special			4335	530630		
Broken CI ordinary			600	78441		
Broken CJ special						
Broken AI extra-super						
Glutinous 10%		50	21004	3000630		
Glutinous 15%						
Glutinous 35%						
Glutinous broken			2004	312430		
Boiled dried						
Parboiled	14	10001	400	60000		
Ship stores	0	1150	(0) 23	3072		
Glutinous rice flour			4000670	707356		
White rice meal			(0)			
Vermicelli made			20000	3000		
Gram rice						
White rice flour						

Table 4a continued

Type of rice	Malaysia quantity (m. tons)	Malaysia value Fob (US $)	Pakistan quantity (m. tons)	Pakistan value Fob (US $)	Philippines quantity (m. tons)	Philippines value Fob (US $)
Cargo 100%	26	4804				
Cargo 5%	5	1713				
Cargo 10%	10	1461				
Cargo 15%	31	4500				
Cargo 35%						
Cargo broken	417	80012				
White 100%	41983	8170191			1	204
White 5%	7383	1388273				70
White 10%	104	24430			250	37030
White 15%	864	177773				
White 20%	5	887				
White 25%	10	1650				
White 35%						
White coated						
White n. e. s.	680	128841			99610	13529040
Broken A1 super	84670	8368801				
Broken A1 special	17	2798				
Broken A1 ordinary						
Broken C1 super						
Broken C1 special	277	30801				
Broken C1 ordinary	10	2437				
Broken C3 special	212	48713				
Broken A1 extra-super						
Glutinous 10%	16437	3728801				
Glutinous 15%	5	630				
Glutinous 25%	26	3841				
Glutinous broken	8752	880743				
Boiled dried	106	24880				
Parboiled	84015	9148701				
Ship stores	22	2863			5	240
Glutinous rice flour (1)	380680	48875				
White rice meal	-					
Vermicelli made from rice (1)	1838970	288468				
White rice flour						

Table 42 continued

Type of rice	Singapore quantity (m. tons)	Singapore value Fob(US $)	Vietnam Rep. quantity (m. tons)	Vietnam Rep. value Fob(US $)
Cargo 100%		20		
Cargo 5%	385	66353		
Cargo 10%	818	30566		
Cargo 15%	20	6763		
Cargo 35%	25	3366		
Cargo broken	3100	272310		
White 100%	55330	11007988		150
White 5%	14082	2850184		
White 10%	14043	2366344		
White 15%				
White 20%				
White 25%			20025	2833982
White 35%				
White coated	6	4758		
White n. e. s.	1004	204004	100	18455
Broken A1 super	10005	2455402	150	21222
Broken A1 special	100	12063		
Broken A1 ordinary	150	22576		
Broken C1 super				
Broken C1 special	1022	134357		
Broken C1 ordinary	175	25005		
Broken C3 special				
Broken A1 extra-super				
Glutinous 10%	2000	350720		
Glutinous 15%				
Glutinous 25%				
Glutinous broken	2977	400613		
Boiled dried	65	10000		
Parboiled	7104	1207004		
Ship stores	5	001	4	001
Glutinous rice flour (1)	210000	31707		
White rice meal	(1)			
Vermicelli made from rice	870000	130705		
White rice flour (1)	04000	10145		

Table 43

Exports of milled rice and rice products by selected countries of destination in 1966

Type of rice	Ceylon quantity (m. tons)	Ceylon value Fob(US $)	Hong Kong quantity (m. tons)	Hong Kong value FOB(US $)	India quantity (m. tons)	India value Fob(US $)
Cargo 100%						
Cargo 5%						
Cargo 10%						
Cargo n. e. s.			100	17294		
Cargo broken			762	99046		
White 100%		84	64434	13653025	15	5943
White 5%			1350	235499		52
White 10%			10	8736		
White 15%			6002	1157092	5	843
White 25%						
White 35%						
White n. e. s.					154397	25224034
Broken A1 super			33475	5827553		
Broken A1 special			250	44993		
Broken C1 super			530	81637		
Broken C1 special			1200	173727		
Broken C1 ordinary						
Broken C3 special						
Broken A1 extra-super			12271	2249339		
Glutinous 10%		24	6792	1263946		61
Glutinous broken			2619	463219		
Boiled brief			36	9172		
Parboiled	88011	16881819			88000	8 21374
Ship stores	37	4040	53	6833	15	1959
White rice flour			(1) 914500	128682		
Glutinous rice flour			(1) 270270	42868		
Vermicelli made from rice			(1) 407000	70136		

Table 43 continued

Type of rice	Indonesia quantity (m. tons)	Indonesia value Fob(US$)	Japan quantity (m. tons)	Japan value Fob(US$)	Korea quantity (m. tons)
Cargo 100%					
Cargo 5%					
Cargo 10%					
Cargo n. e. s.					
Cargo broken					
White 100%	8	717	1	371	1
White 5%			43	7218	
White 10%					
White 15%	94	17486			
White 25%		3630010			
White 35%	30857	1163261			
White n. e. s.	3461		481	782582	
Broken A1 super			38389	5771907	
Broken A1 special	400	71735	38175	5892996	
Broken C1 super					
Broken C1 special			5171	739276	
Broken C1 ordinary					
Broken C3 special					
Broken A1 extra-super					
Glutinous 10%			31965	4329591	
Glutinous broken			7 6269	939850	
Boiled bried					
Parboiled					
Ship stores	3	313	28	3494	
White rice flour					
Glutinous rice flour		(0)	4065169	603216	
Vermicelli made from rice		(0)	29000	4135	

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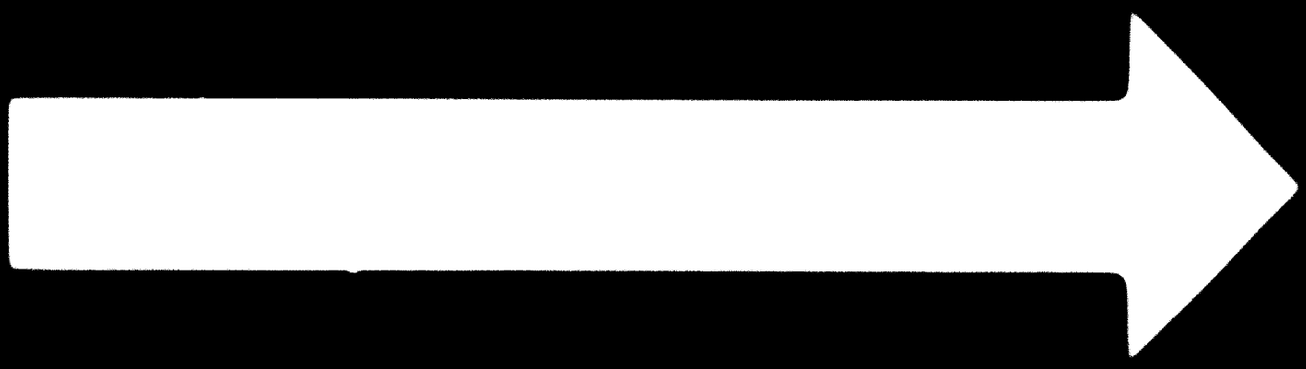

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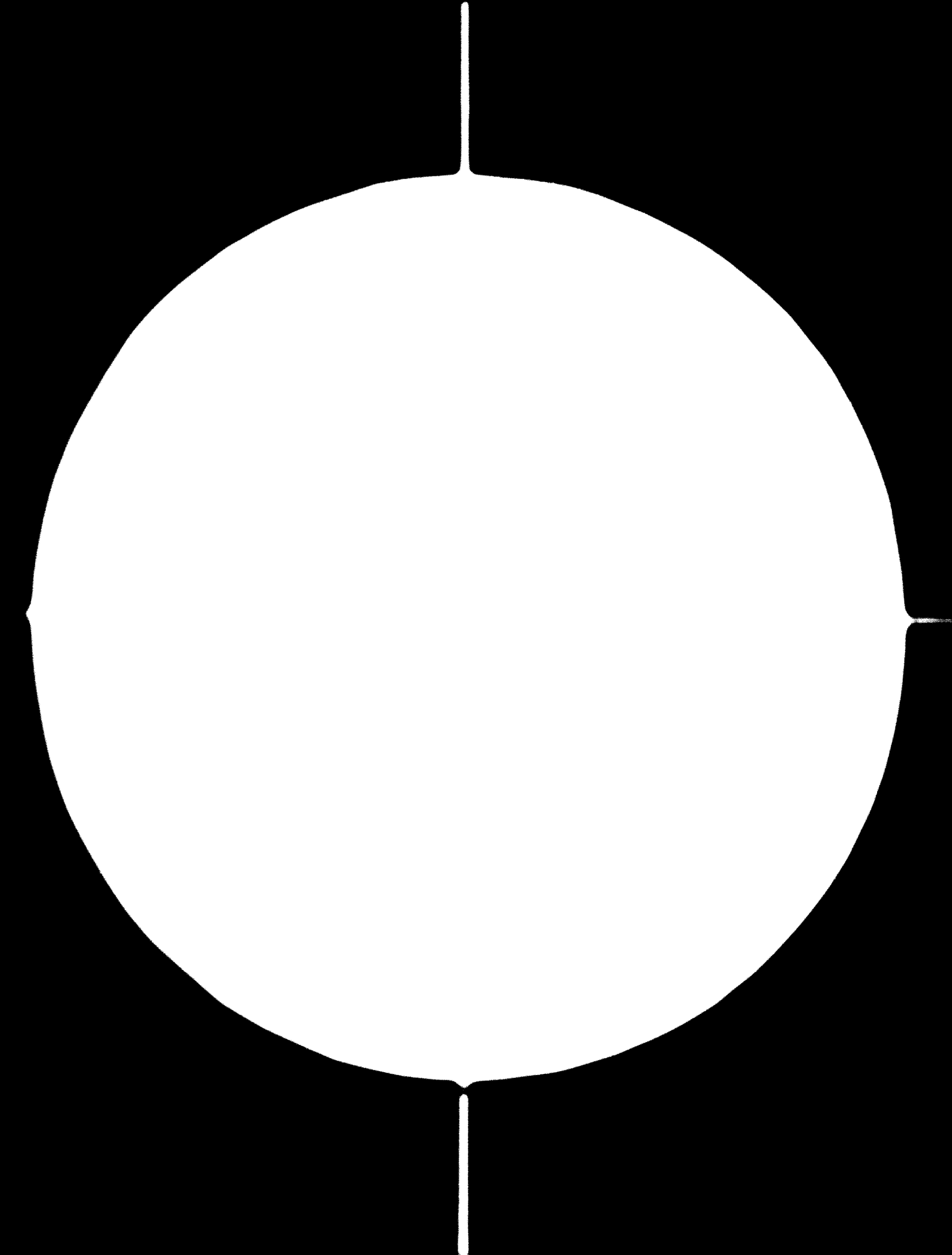


Basically, the Thai farmer produces rice for home consumption. It is estimated that, on average, only 40% of the rice produced is marketed in the country. Table 49 gives a general idea of the value of the produce sold and that consumed on the rice farm, for different purposes. The sale prices undergo considerable fluctuations over a period of time; moreover, the price varies in accordance with the type or quality of the product sold.

The present prices of paddy to the wholesale market of Bangkok market and on the markets of other cities from 1955 to 1968 for paddy rice of various qualities.

In April 1970 the wholesale prices in Bangkok were as follows:

- grade A : 63 dollars/ton
- grade B : 60.5 dollars/ton
- grade C : 55.3 dollars/ton

Tables 53 and 54 give indications concerning the value of paddy produced in the recent past.

The evolution of prices is basically connected with the quantity of product harvested and with exports, these being the only elastic factors involved in marketing the product.

Very approximately, it may be estimated that in the next few years

69. VALUE OF PADDY FOR SALE AND HOME CONSUMPTION (1953)

(US DOLLARS)

	sale		home consumption		total	
	value	%	value	%	value	%
Northern	388	38.7	619	61.3	847	100
Northeastern	140	19.7	695	80.3	754	100
Central plain	796	56.6	609	43.4	1.405	100
Southern	451	44.4	564	55.6	1.016	100
Southeastern	164	26.4	458	73.6	622	100
Southwestern	81	17.1	395	82.9	477	100
Country total	419	42.1	575	57.9	994	100

90. AVERAGE WHOLESALE PRICES ON SELECTED MARKETS

(in U.S. $ per ton)

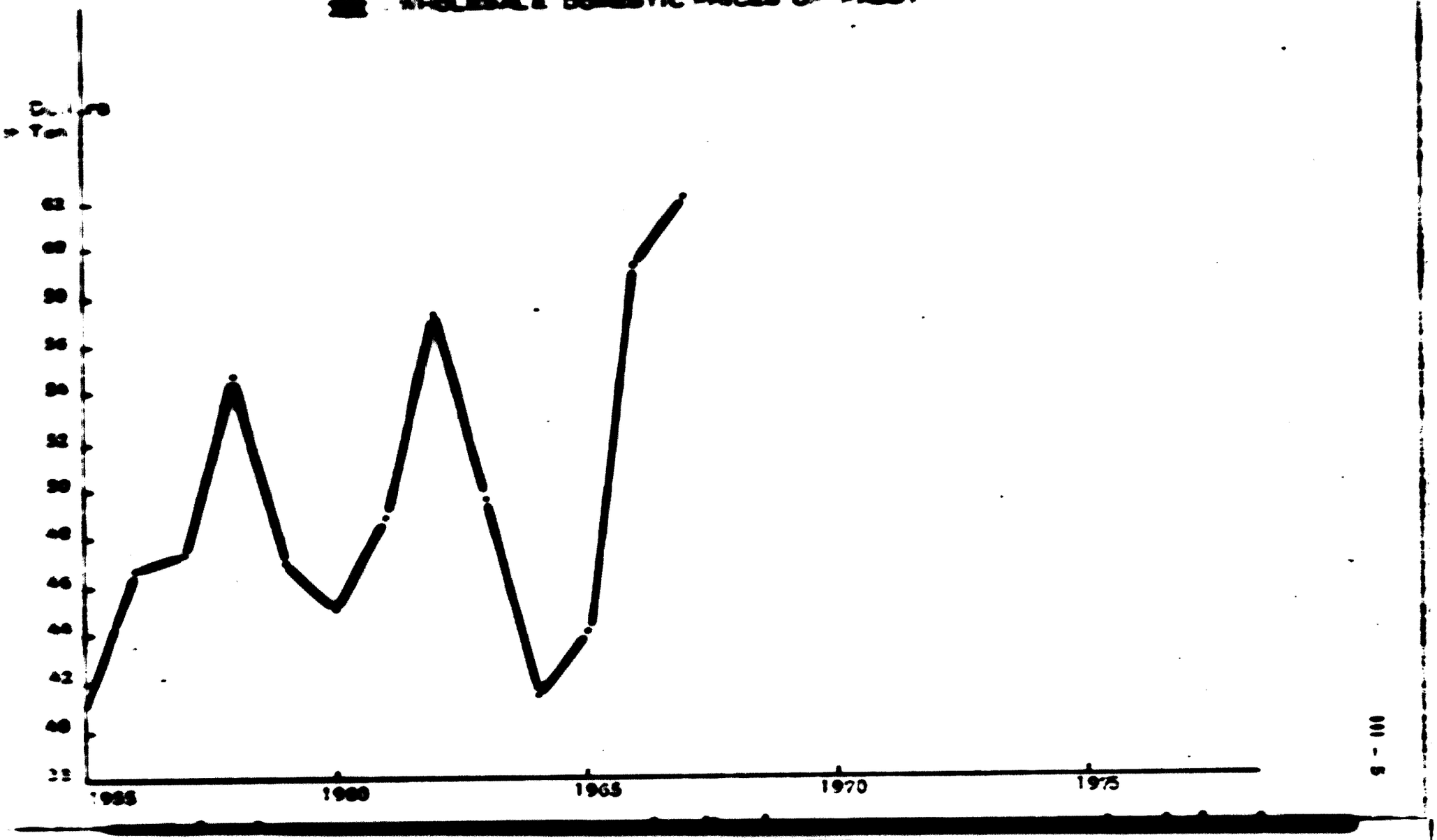
YEAR	NORTHERN		NORTHEASTERN		CENTRAL PLAIN		SOUTHERN	
	Chienmai	Sampang	Makorn rajsima	Uhobraja thani	Bangkok	Nakorn Sawan	Patalung	Nakorn sithamraj
1955	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	33.78	31.40	40.13	35.61	51.09	42.50	42.80	47.15
8	41.36	34.16	46.22	39.90	41.53	46.21	47.86	41.91
9	48.78	36.31	41.15	41.21	42.55	39.37	40.29	40.50
60	65.99	28.15	35.56	32.83	45.60	28.51	32.50	31.29
1	41.40	33.35	41.87	37.98	54.82	38.87	32.25	36.27
2	49.62	41.81	51.54	49.55	47.71	52.50	44.89	36.76
3	42.28	35.88	44.22	39.41	38.50	44.46	48.75	43.74
4	37.75	33.18	38.83	35.47	41.59	34.53	31.61	32.34
5	43.00	33.13	36.92	33.55	60.30	43.88	-	39.10

52. AVERAGE WHOLESALE PRICES OF PADDY

Year	Paddy n° 1 U. S. $/ton	Paddy n° 2 U. S. $/ton	Paddy n° 3 U. S. $/ton
1960	44.90	42.25	40.40
1	49.25	45.25	43.45
2	50.60	54.00	53.05
3	51.55	47.70	46.55
4	53.70	50.10	50.05
5	45.00	41.70	40.05
6	64.10	59.00	58.05
7	67.15	61.75	60.15
8	63.45	59.00	57.55

53. WHOLESALE PRICE OF PADDY N° 1 (NA SUAN) DELIVERED ALONGSIDE MILL IN BANGKOK

Year	Price in U. S. $/ton
1955	45
6	45
7	45
8	50
9	45
60	43
1	47
2	55
3	45
4	40
5	45
6	50
7	60


WHOLESALE DOMESTIC PRICES OF PADDY
1965
1970
1975

35. PRODUCTION AND VALUE OF PADDY

Year	Planted area Ha x 1000	Harvested area Ha x 1000	Average yield T/Ha	Production ton x 1000	Wholesale $/ ton.	Value $ million
1986	5,770	5,576	1.36	7,334	43.1	316.58
6	5,287	5,702	1.44	8,297	43.0	356.48
7	5,075	4,317	1.30	5,570	51.1	284.61
8	5,736	5,100	1.36	7,053	41.5	292.97
9	6,006	5,363	1.29	6,770	42.5	288.09
90	5,921	5,643	1.38	7,835	45.6	357.24
1	6,179	5,656	1.44	8,180	54.8	448.33
2	6,680	6,191	1.50	9,279	47.7	442.15
3	6,991	6,354	1.58	10,029	38.6	386.14
4	6,330	5,971	1.60	9,558	41.6	397.51
5	6,479	5,925	1.54	9,218	60.3	555.90

36. PRODUCTION VALUE OF RICE AND OTHER PRINCIPAL CROPS

(Index 1950 - 1953 = 100)

Year	Rice million of $	Index	Other crops million of $	Index	Of total value production
1955	311.085	119	198.820	139	509.905
6	356.490	134	203.865	143	560.355
7	284.515	107	271.390	191	555.905
8	292.970	110	273.800	193	566.770
9	288.050	108	351.490	247	639.540
60	367.245	134	444.605	313	801.850
1	448.835	168	445.505	314	894.340
2	441.940	166	390.045	275	831.985

the price of paddy rice will remain more or less constant at its present level, with a slight tendency to rise as regards the better qualities of product, unless the methods of grading are modified.

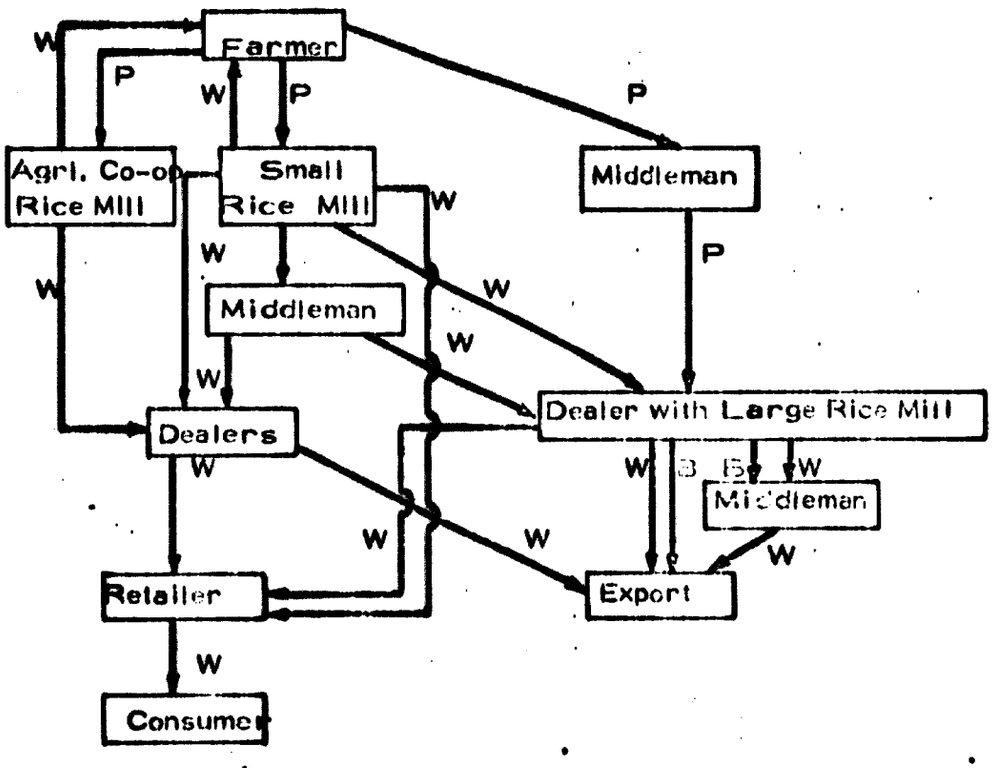
The values quoted here for paddy rice should be taken as those paid by the millers to the middlemen. The real values or prices paid to the producer vary, depending not only on factors of quality, but also on the obligations contracted by the producer towards the middlemen.

The middleman is typical and characteristic of the Thai rice industry. He represents the entire infrastructure connecting production and milling, and even at times distribution for consumption and export. The middleman renders the most widely varying services in the whole rice market. Each group is responsible for one or more marketing aspects. (See Diagram XIII).

He is in close contact with the producer, to whom he offers services such as the purchase of the product and its sale (when the amount stored for domestic consumption has run out); he acts as money-lender and also purchases the products necessary for agriculture. He is often himself the owner of land which he rents out to the farmer; he acts as tradesman and transportation company for third parties, and is associated with the industrialist or else is a rice industrialist himself. The product he buys is resold to other middlemen or directly to the miller. Very often he mills the rice himself and then offers it on the consumer market of to exporters.

The Government has intervened and is still intervening in an

XIII. DISTRIBUTION AND MARKETING ROUTE OF RICE IN THAILAND



P = PADDY

W = MILLED RICE

B = BROWN RICE

effort to control the operations of the middlemen and to replace them, by buying up and storing the paddy. A programme of buying up unmilled rice directly from the farmer at a guaranteed minimum price of 50 dollars per ton has in fact been introduced in the country (see table below).

Thailand guaranteed price for new crop 70/71 : (US dollars per ton)

Type of rice	Price
- Special n. 1 grade	65.-
- special n. 2 grade	60.-
- special n. 3 grade	57.5
- first grade	55.-
- second grade	52.5
- third grade	50.-

The product should be handed over to the State storehouses and, following evaluation, is paid for at the fixed price.

In 1969 the Government organisation for procuring rice from the producer at the guaranteed minimum price purchased 70,000 tons of product by means of collection and storage centres throughout the various areas, especially in the central plain region.

However, the Government action has not had the expected success, since numerous problems have arisen as regards its programme. These include the necessity of taking the place of the middlemen not only for one part of their function but for the entire programme of

Table 43 continued

Type of rice	Malaysia quantity (m. tons)	Malaysia value Fob(US $)	Pakistan quantity (m. tons)	Pakistan value Fob(US $)	Philippines quantity (m. tons)	Philippines value Fob(US $)
Cargo 100%						
Cargo 5%						
Cargo 10%						
Cargo n. e. s.						
Cargo broken	107	14587				
White 100%	38319	5797704	93		1	278
White 5%	632	137700			1	78
White 10%	80	15954				
White 15%	39756	5274677				
White 25%						
White 35%	395	71876				
White n. e. s.						
Broken A1 super	58960	9584158				
Broken A1 special	28	4853				
Broken C1 super	179	26952				
Broken C1 special	50	7238				
Broken C1 ordinary	5	661				
Broken C3 special	7	926				
Broken A1 extra-super						
Glutinous 10%	8964	1501516				
Glutinous broken	3983	503985				
Boiled bried	37	8109				
Parboiled	43745	7645129				
Ship stores	19	2535				
White rice flour	683000 (1)	69260				730
Glutinous rice flour	330150 (1)	53475				
Vermicelli made from rice	1760560 (1)	254180				

assistance to the farmer. In fact, the middleman - who is not peculiar to Thailand, but typical of the numerous rice-producing countries of Asia - provides two-way assistance, supplying all the input required by the farmer (financing, seed, products, transportation, etc.), while at the same time absorbing a large part of the output consisting of the crop harvested.

Accordingly, in order to take his place, it is necessary to set up and set in motion not only the infrastructures dependent on production but also those on which production depends, consisting above all of various forms of direct or indirect financing of the producer, not to mention human relations involved.

Transportation of the product to the storage, processing and consumer distribution centres takes place in Thailand by water, railway or road. Rice is generally transported in the loose state, and only rarely in containers such as sacks.

The most economical form of transportation is still by water. However, road transport is beginning to be more widely adopted with the development of the road network in Thailand and the larger number of motorised vehicles available.

The paddy rice is usually stored in bulk, whether by the producer, middleman, Government storehouse or rice-processing industry.

When the rice is purchased, collected and stored by the middleman, little attention is paid to segregating the different batches of

different varieties; there's a general tendency to mix different varieties of rice. Usually the subdivision is only maintained between long grained varieties and medium- or short-grained ones.

The tendency makes a considerable difference to milling, since the damage caused by the product to the milling machines is largely due to the difference in the biometric axes of the grain. The paddy is stored by the farmer for different lengths of time. Usually, once the harvest is over, the farmer stores up the quantity of cereal he considers necessary for home consumption and sells part of the remainder in order to meet the debts he has contracted. Subsequently, on one or two occasions, he sells any rice he finds to be superfluous. The time of storage varies, depending on the decision taken by the farmer, who tries to obtain the highest market price. It has been estimated that in 1970 seven million tons of paddy rice were held back by the farmers. In fact, 60% of the producers waited to sell their surplus in September, when they calculated that the price paid would be the highest of the year. The authorities consider this fact extremely significant as regards the economic situation of the producer, who was not forced to sell earlier because of financial difficulties. Furthermore, it is estimated that 80% of the product harvested in the central region was sold at a higher price than the minimum guaranteed by the Government. On the other hand, it would appear that in the North and North-Eastern regions only 40% of the harvest has been sold at a price above the guaranteed Government minimum.

The amount of cereal which the middlemen and the rice-proces-

sing industry is able to store is nevertheless insufficient, especially in view of the future increase in production.

In the absence of a recent census on the storage facilities available in Thailand, Table 55 has been drawn up on the basis of the 1956 census.

Current prices for renting storage facilities are declared as averaging of 0.50 dollars per ton of product per year or season. As a general rule, in Thailand rice is stored in wooden buildings with walls of bamboo matting. The building has no concrete flooring but consists of beaten earth once more covered with matting and paddy husk. Storage conditions are primitive in the extreme, with the result that there are high losses caused by insects, rodents or birds.

For statistical purposes the competent national offices calculate a loss of product equal to 7.5% of production in terms of paddy rice (or of 5.0% in terms of milled rice) for direct utilisation by the producer as seed. This percentage should also include the hidden losses of product as a result of destruction by parasites, etc. during storage.

55. NUMBER AND CAPACITY OF PADDY STORAGE BY ZONES (1956)

	10 - 15 tons		51 - 100 tons		100 tons over		Total	
	N.	Capacity	N.	Capacity	N.	Capacity	N.	Capacity
NORTHERN	2,499	34,685	36	3,230	70	69,247	2,614	107,162
NORTHEASTERN	2,233	42,897	251	21,491	435	247,487	2,919	311,875
CENTRAL PLAIN	21,743	438,216	1,369	105,971	1,198	545,948	24,310	1,090,135
SOUTHERN	102	2,463	22	1,940	48	20,343	172	24,746
KINGDOM	26,577	518,261	1,678	132,632	1,760	883,025	30,015	1,533,918

APPENDIX IV

SURVEY ON EXISTING RICE MILLS IN THAILAND

IV. 1. The recent development of the rice industry in Thailand

Immediately after the Second World War, the system of milling in Thailand was changed by a technical innovation: the huller.

The huller is worked by an internal combustion engine, and mills the rice in a single operation, carrying out shelling and whitening at the same time.

It is an American invention, derived from a similar machine used for processing coffee beans; in fact, the best-known North American manufacturer, whose name has become synonymous with that of the machine, produces machinery to process both coffee and rice.

Before the Second World War, the large North American mills used hullers to whiten the rice, instead of whitening cones.

In the colonial period between the Wars, American, British and German manufacturers distributed the huller in Central and South America, Africa and the Orient, not as a whitening machine for shelled rice but as a machine capable of carrying out the entire milling process in a single operation. The revolution in mechanical milling consisted in having concentrated the process, which in the large mills was carried out in at least two stages, into one stage only.

In Thailand, the hullers were imported, and later manufactured locally, with great success, and before long the entire milling sys-

tem changed completely, with very important consequences and serious repercussions, as we shall show.

The huller and explosion engine gradually replaced home pounding, and the production areas became studded with small mechanical mills which processed the paddy, even in small quantities (50-100 Kg.). The first result of the introduction of the huller was thus the almost complete disappearance of home pounding, freeing men (or women) from the labour involved in manual milling.

But the effects of the huller did not stop there. Not only did it replace manual processing by mechanical milling at the level of producer-consumer and local consumption, but also had repercussions on the industry which was already well-established in the country; small mills equipped with hullers absorbed a large proportion of the rice which should have gone to large or medium-sized mills, and put the processed rice onto the market in competition with the industrial product.

The huller plants are generally to be found in the production areas. They have a very limited capacity (less than 5 tons/day), and can be purchased and installed at low cost, since all that is necessary is a shed to house them. Processing is usually carried out on a service basis, i.e. the operator does not buy the paddy, but only processes it, returning the milled rice to the owner.

For the first fifteen years after the war, until recently, the rice industry in Thailand was disintegrating at an alarming rate.

The big mills along the river Chao Phya gradually ceased to operate as their supply of rice was ever-increasingly absorbed by hundreds of small or medium-sized plants scattered throughout the production areas.(see Table 96).

The huller, which changed the milling system in Thailand, must also be held responsible for various negative aspects of the present rice industry in Thailand. These may be summarized as follows:

1) The reduction in the food value of the product, which is processed to a high degree of milling to give an invitingly white appearance. It loses part of the substances contained in the specks of bran left on the kernel by the imperfect manual milling.

2) The considerable reduction in the quantity of edible rice produced by the hullers in comparison with larger mills.

3) The inferior quality of the edible rice, on account of the high proportion of broken or mechanically damaged grains.

4) The production of a single by-product, consisting in a mixture of powdered husks, bran, polish and small fragments of grain, instead of separate, distinct by-products.

The changes in the Thai rice industry provoked by the introduction of the hullers cannot be denied, and have, in fact, been widely recognized.

It must not be forgotten, however, that a second important

26. [illegible] OF PADDY MILLED IN RICE MILLS IN BANGKOK (1981-1984) in tons

Month	1981 Quantity	1981 %	1982 Quantity	1982 %	1983 Quantity	1983 %	1984 Quantity	1984 %
January	113,266	15.06	55,020	13.96	46,717	13.61	27,201	13.52
February	76,797	10.21	73,062	12.96	31,041	9.27	17,656	8.75
March	95,580	12.71	37,020	6.16	46,037	13.41	24,691	12.33
April	47,201	6.30	47,730	7.76	37,643	10.96	17,023	8.43
May	48,333	6.76	46,604	7.91	26,334	7.30	5,804	2.91
June	39,419	5.24	46,563	6.59	24,139	7.03	7,304	3.65
July	51,207	6.82	43,007	7.13	27,405	8.01	11,709	5.82
August	66,560	8.30	46,201	7.66	26,664	7.76	18,979	9.65
September	55,666	7.43	46,507	7.57	20,418	5.96	27,500	13.65
October	46,600	6.70	46,066	7.66	12,200	3.57	22,960	11.39
November	36,000	5.17	36,070	6.23	16,730	4.87	14,406	7.14
December	82,960	11.06	36,406	5.96	29,076	8.10	5,190	2.57
Total	752,001	100.00	615,406	100.00	343,345	100.00	201,620	100.00

Table 96 continued

Month	1986 Quantity	1986 %	1988 Quantity	1988 %	1987 Quantity	1987 %	1988 Quantity	1988 %
January	18,762	13.23	20,006	13.03	20,462	12.70	8,201	19.01
February	23,633	16.60	16,388	10.66	23,804	14.70	8,161	17.40
March	26,036	18.30	18,513	12.01	23,463	14.56	10,319	22.00
April	17,610	12.43	6,342	4.12	16,232	10.08	6,231	13.28
May	5,334	3.70	8,511	5.52	14,341	8.90	3,113	6.64
June	8,475	5.90	8,465	5.49	11,371	7.06	4,573	9.75
July	11,488	8.11	10,029	6.51	19,761	12.27	2,822	6.01
August	6,941	4.90	11,210	7.18	10,654	6.61	1,365	2.91
September	3,469	2.46	11,614	7.54	6,017	3.74	1,034	2.20
October	4,696	2.80	15,988	10.38	5,165	3.21	-	-
November	1,439	1.02	10,936	7.10	3,946	2.45	-	-
December	14,200	10.00	16,084	10.42	5,993	3.72	-	-
Total	141,602	100.00	154,086	100.00	161,088	100.00	46,988	100.00

Source: Ministry of Economic Affairs

Table 43 continued

Type of rice		Singapore quantity (m. tons)	Singapore value Fob(US $)	Vietnam Rep. quantity (m. tons)	Vietnam Rep. value Fob(US $)
Cargo 100%					
Cargo 5%		80	14224		
Cargo 10%		465	86758		
Cargo n. e. s.					
Cargo broken		1260	164850		
White 100%		64533	14010575	2	520
White 5%		10065	2014721		100
White 10%		225	45358		
White 15%		4032	752558		
White 25%		30	6065	40011	6308552
White 35%					
White n. e. s.					
Broken A1 super		34054	5244397		
Broken A1 special					
Broken C1 super		25	3884		
Broken C1 special		330	41124		
Broken C1 ordinary					
Broken C3 special					
Broken A1 extra-super					
Glutinous 10%		4006	763348		20
Glutinous broken		2741	360777		
Boiled bried		12	2658		
Parboiled		8799	1493358		
Ship stores		10	1436	5	648
White rice flour	(1)	454970	72246		
Glutinous rice flour	(1)	246000	40038		
Vermicelli made from rice	(1)	1015200	173806		

consequence of this development was the increase in the number of medium-sized or "standard" mills alongside the huller plants. (See point 5. 2 of the Final Report).

After the Second World War, the local mechanical workshops rapidly developed their production of rice-processing machinery, similar to that imported from Europe but of smaller dimensions and capacity.

It is therefore not only due to the huller that the big mills in the neighbourhood of Bangkok and Dhonburi were forced to close, but but also because medium-sized plants began to be manufactured locally for installation in or near the various production areas.

The hullers and standard mills are largely responsible for the spread of rice-rpocessing on a service basis, i. e. milling for payment without the purchase and sale of the rice.

This practice was almost unknown to the big mills, and today constitutes one of the most important problems to be solved in modernizing, rationalizing and improving the economic yield of the rice industry.

IV. 2 The various types of rice mill in Thailand

In 1960 a study was carried out on the Thai rice industry. This classified the number, type and characteristics of the mills as follows:

IV. 2. 1 Small mills: Plants with a capacity of 1-5 tons/day. They generally consist of one or more hullers, which carry out the entire milling process in one operation. At the end of 1956 there were 3518 of these plants, 16% of them in the Central Region. Their total capacity amounted to 7,960 tons, i.e. 11% of the overall milling capacity of the Thai rice industry.(see Table 57).

These plants were most common in the Northern and Southern Regions; in the North-Eastern Region they represented 13.7% of the capacity of the industry, while in the Central Region they represented only 3.2%.

The small mills or hulling plants were especially numerous in areas where communications and transport were difficult, and in the neighbourhood of the production areas, where they processed rice for local consumption.

IV. 2. 2 Medium-sized or standard mills: Plants with a capacity of 5-30 tons/day. They generally consist of several machines, each executing one phase of the milling (multi-stage milling). The product is transported in continuation from one machine to another by means of mechanical conveyors.

97. CAPACITY OF SMALL MILLS COMPARED WITH TOTAL CAPACITY OF ALL RICE MILLS IN THE DIFFERENT REGIONS (1956)

Region	Daily Total capacity in tons	Daily Capacity of small mills in tons	%
Central plain	44,761	1,429	3.2
North-Eastern	11,113	1,528	13.7
Northern	7,342	2,802	38.2
Southern	8,161	2,201	27.0
Whole country	71,377	7,960	11.1

Origin : Rice Department, Ministry of Agriculture

At the end of 1956 there were 2,179 standard mills in Thailand, with a total capacity of 26,341 tons/day. The Central Region possessed 1244 of them, i.e. 57% of the national total, with a production of 17,736 tons/day, forming 67% of the total production of the medium-sized mills (see Table 58).

IV. 2. 3. Large mills: Plants with a capacity of over 30 tons/day. Besides being equipped with a large number of processing machines, they also have fully-mechanized conveyor systems to transport the product from one part of the mill to another.

In 1956 the number of large mills in Thailand totalled 370, with a total productive capacity of 36,986 tons/day (see Table 59). The largest of these mills were concentrated in the Bangkok and Dhonburi regions (40) and in Ayudhya (34). Of the national total, 227 were in the Central Region, i.e. 61.35%, with a productive capacity of 25,596 tons/day, equal to 69.20%.

There were 41 mills with a capacity of more than 100 tons/day.

Of the 6067 rice mills in Thailand in 1956, by 1970 many had disappeared, but many more new plants had been erected. The most recent official statistics give the total number of rice mills as 24,638, of which 85 have a productive capacity of over 50 tons/day, and the remainder of 5-50 tons.

In fourteen years almost all the large mills have closed, es-

38. NUMBER OF STANDARD RICE MILLS (5-30 TONS/DAY) AND CAPACITY BY CHANGWADS, CENTRAL REGION 1956

Changwad	Number of mills	Total Daily Capacity in tons	% (Cap.)
Karnchanaburi	11	164	0.92
Kampangphet	8	111	0.63
Chantaburi	26	254	1.43
Chaseungsao	46	763	4.30
Cholburi	32	584	3.29
Chainart	20	316	1.78
Traad	4	50	0.28
Taag	10	185	1.04
Dhonburi	16	273	1.54
Nakorn-nayok	23	470	2.65
Nakornpathom	72	1,000	5.64
Nakornswan	82	1,207	6.81
Nontaburi	27	583	3.29
Pathmthani	42	770	4.34
Prachuabkirikan	-	-	-
Pracheenburi	19	286	1.61
Bangkok	47	845	4.76
Ayudhya	79	1,239	6.99
Pijit	46	669	3.77
Bhisnulok	40	405	2.28
Petchburi	36	376	2.12
Petchaboon	8	156	0.88

Table 58 continued

Changwad	Number of mills	Total Daily capacity in tons	%(Cap.)
Rayong	15	135	0.76
Rajburi	64	836	4.71
Lopburi	71	887	5.00
Smutprakarn	45	886	5.00
Smutsongkram	14	157	0.89
Saraburi	30	336	1.89
Singburi	26	361	2.04
Sukhodhai	63	626	3.53
Supanburi	59	982	5.54
Ang-tong	45	705	3.98
Utradit	7	568	3.20
Uthaithani	14	271	1.53
Smutsakorn	17	280	1.58
Total	1,244	17,736	100.00

Note: The figures were calculated from the statistics of the rice Department, Ministry of Agriculture

59. NUMBER OF LARGE RICE MILLS OVER 30 TONS/DAY AND CAPACITY IN THE DIFFERENT REGIONS (1956)

Region	No.	Total cap. in tons/day	No.	Total cap. in tons/day	No.	Total cap. in tons/day	No.	Total cap. in tons/day
Central	162	7,143	37	3,475	28	14,978	227	25,596
North-Eastern	69	3,209	12	956	4	1,500	85	5,665
Northern	24	1,168	6	500	3	649	33	2,317
Southern	18	878	1	80	6	2,450	25	3,408
Whole country	273	12,398	56	5,001	41	19,577	370	36,986

Origin : Rice Department, Ministry of Agriculture

pecially in the areas of Bangkok, Dhonburi and Ayudhya, while the small mills or hulling plants have increased from 3518 to 18,642: an increase of almost 500%. On the other hand, according to the data collected, the standard mills, i.e. the mills with a capacity of 5-50 tons/day, but using a processing system different from that of the hullers, have increased from 2,179 to 5,911, almost 250%.

IV.3. The yield of the various types of mill

As already mentioned, the hulling plants give a yield 2-8% lower than that of the standard and large mills; the lower the quality of the paddy, the higher the percentage lost. If the rice kernels are fragile, the yield is bound to be lower.

No data is available concerning the quality of the milled rice produced by the hulling plants. For the standard and large mills, the average overall yield is 55% whole kernels, 11% brokens, giving a total of 66%. When high-quality paddy is used, the yield is 64% whole kernels, 3% brokens, totalling 67%.

In general, the standard mills give a higher yield than the large ones, mainly because they are more modern, equipped with newer machinery, and are under constant maintenance and repair.

As regards the percentage of brokens, however, the large mills are more efficient, giving 51% of whole kernels as compared with 47% from the standard mills (see Tables 60 and 61 and Diagram XIV).

The overall yield in terms of edible rice (whole grains plus brokens) varies by only 0.1% : 65.9% in the standard and 66% in the large mills.

However, the average yields, whether overall (whole rice and brokens) or qualitative (percentage of brokens) are not to be taken alone, as they depend on varied and numerous factors, ranging from the quality of the paddy to the layout of the mill, the efficiency of the machinery and the skill of the labour force.

60.. PRODUCTS FROM MILLING - GOVERNMENT EXPERIMENT (1958)

	Head Rice (kg.)	Broken rice (kg.)	Fine & coarse bran (kg)	Husks (kg.)	Deficit (kg.)
Luengrahang	475	193	112	218	2
Puangnak 26	443	243	95	218	1
Nangmol 3, 4	469	211	101	217	2
Luengorn 29	431	291	93	184	1
Luengorn 23	506	173	96	224	1
Muangpye	535	155	87	222	1
Luengyai 34	561	127	84	228	-

Origin: The Government Experiment Rice Mill, Rice Department, Ministry of Agriculture

Note: All kinds of broken rice are included

44. TOTAL EXPORTS WITH REGARD TO THOSE OF RICE AND MAIZE

Years	Total Value Exports(FOB) Millions of dollars	Exports Quantity millions of tons	Rice Value Millions of doll.	% Total Value Exports(1)	Exports Quantity Millions of tons	Maize Value millions of doll.	% Total Value Exports(
1960	430.5	1.30	138.5	30.8	0.514	37.5	8.3
1961	500.0	1.56	180.0	36.0	0.567	30.0	6.0
1962	476.5	1.37	168.0	33.9	0.472	25.0	5.2
1963	483.5	1.42	171.0	35.3	0.744	41.5	8.5
1964	617.0	1.90	219.5	35.5	1.115	67.5	10.9
1965	647.0	1.89	216.5	33.4	0.804	48.5	7.4
1966	691.0	1.51	200.0	28.9	1.218	76.0	10.9
1967	694.0	1.48	233.0	33.5	1.093	68.0	9.7
1968(1)	648.0	1.02	184.0	28.3	1.380	88.0	13.5
1969(1)	794.0	1.83	293.5	36.9	1.530	99.0	12.4

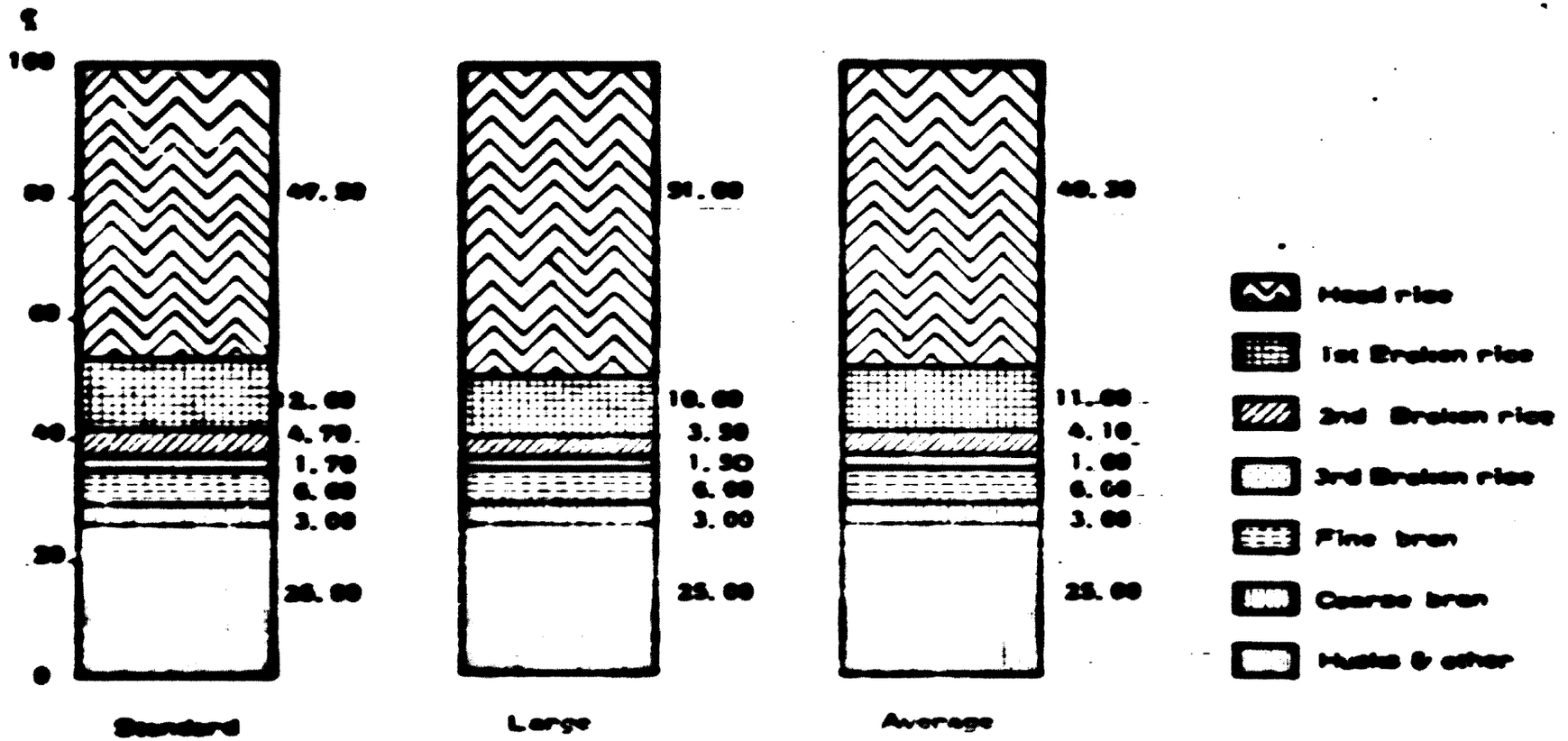
(a) Source: "Economic Progress of Thailand - general indicators" - Office of National Economic Development Board - October 1968

(1) Estimated

67. AVERAGE YIELDS FROM 1 TON OF PADDY IN LARGE AND MEDIUM SIZED RICE MILLS IN THE CENTRAL REGION 1958

	Head Rice (kg.)	%	1st broken (kg.)	%	2nd broken (kg.)	%	3rd broken (kg.)	%	Total rice (kg.)	%	Fine Bran (kg.)	%	Coarse Bran (kg.)	%	Husks etc. (kg.)	%
Standard (5–30 tons/day)	475	47.50	120	12.00	47	4.70	17	1.70	659	65.90	60	6.00	30	3.00	251	25.1
Large (over 30 tons/day)	510	51.00	100	10.00	35	3.50	15	1.50	660	66.00	60	6.00	30	3.00	250	25.00
Average	488	48.30	110	11.00	41	4.10	16	1.60	659	65.90	60	6.00	30	3.00	250	25.00

XIII. Average % recovery of products and by-products from 1000 Kg. of paddy in different types of mill during 1958.



IV 4. [illegible]

The large mills cost 10% less to operate than the standard mills (US $ 3 per ton as against 3.30 per ton) (see Table 63). In making this estimate, however, the determining factor is the quantity of rice processed, which has a very considerable effect on the overheads.

It has been calculated that labour costs represent 46-60% of the operating cost of a mill. Repair and maintenance come second in order of importance, making up 7-10%. Amortization and depreciation of the plants are negligible, as most of the plants were constructed a long time ago (see Table 63).

The custom of dubbing the processing cost in the case of milling on a service basis is of great importance. As mentioned above, the hulling plants usually mill the rice, without buying and selling it, on behalf of the producer or trader who owns it. The cost of this service is paid partly in money and partly in kind, i.e. the edible rice is restored to the owner and the by-products from milling (husks, bran, polish and small brokens, less than a quarter the size of the grain) are kept by the operator.

Although some of the standard mills purchase the rice they mill, many of these too process rice on a service basis, in competition with the hulling plants.

The cost of processing in standard mills is higher than in hulling plants, but on the other hand the rice they produce is of

superior quality, containing a smaller percentage of brokens.

A survey carried out in 1967 showed that 50% of the standard mills operated both by purchasing and selling the rice and on a service basis.

When rice is milled on a service basis, it may be paid for in several ways:

a) About 18% charge 0.50-1.50 US $ per ton of paddy. The highest price is charged at the beginning of the season, immediately after the harvest, when there is a lot of rice to be milled and the market price of the by-products is very low. As the quantity of rice available diminishes and the market price of the by-products rises, the charge for milling is lowered, the operator being satisfied with the sum he obtains from the sale of the by-products.

b) About 78% of the mills charge nothing for milling, considering that their services are sufficiently compensated by the value of the by-products which they retain.

c) The remaining 4%, not only make no charge for milling, but actually pay the producer or trader 1.25-1.50 US $/ton. The value of the by-products makes it possible to cover the cost of milling and to pay the owner of the product.

63. AVERAGE RUNNING COSTS IN MILLING 1 TON OF PADDY IN THE RICE MILLS OF THE CENTRAL REGION (1958)

Size of mill	Management Costs		Mill costs		Total cost	
	Baht	$	Baht	$	Baht	$
Large (more than 30 tons/day)	14.12	0.70	46.72	2.34	60.84	3.04
Medium (from 5 to 30 tons/day)	18.13	0.90	48.53	2.42	66.66	3.33
Average	16.13	0.80	47.63	2.38	63.75	3.18

Source: Rice Department - Ministry of Agriculture

Note: The motor power in a medium-size rice mill is, as a rule, less than that necessary for a large rice mill, in so far as processing equipment of medium capacity calls for a proportionally smaller consumption of power (this has a restraining influence). It should also be noted that the large rice mills are usually equipped with parboiling units. Furthermore, the fact that labour costs in a large rice mill should only be 10% less than in a medium size one, is explained by the lack of mecanization in the handling of the product in transit to an from the warehouse. We have had to accept the cost data exactly as given to us.

63. RUNNING COSTS IN MILLING 1 TON OF PADDY IN RICE MILLS OF THE CENTRAL REGION (1958)

List	Large Mills		Medium-sized Mills	
	Baht	%	Baht	%
Cost of gringing gear	8.84	18.92	5.02	10.34
Cost of labour	25.43	45.43	28.75	59.24
Cost of lubricating oil	3.20	6.85	5.00	10.30
Cost of repairs to grinding equipment	3.65	7.81	4.46	9.20
Cost of fuel	5.60	11.99	5.30	10.92
Other	-	-	-	-
Total	46.72	100.00	48.53	100.00

MILLING YIELD AND VALUE OF THAI PADDY CALCULATED ON AN EXPERIMENTAL BASIS IN A STANDARD MILL

	1975kg	%	Value	1857kg	%	Value	1887kg	%	Value
Paddy:									
Thai Rice 100%	1084	54.78	1386.80	1039	55.95	1426.73	1025	54.32	1385.16
Br. A1	214	10.81	183.77	180	10.18(A2)	173.06	198	10.49	178.33
Br. C1	35.5	1.79	21.48	33.5	1.80	21.60	34	1.80	21.60
Br. C3	7.5	0.38	4.37	7	0.38	4.37	7	0.37	4.44
Bran 1st Cone	71	3.59		59	3.18		107	5.67	
2nd "	46.5	2.35		63	3.39		47	2.49	
3rd "	36	1.82		29	1.56				
	153.5	7.76	77.69	151	8.13	81.30	154	8.16	81.69
Coarse Br.									
Asp. (splits)	11.5	0.58	4.06	6	0.32	2.24	5	0.27	1.89
Normal	21	1.06	8.30	35	1.88	9.40	31.5	1.67	8.35
	32.5			41			36.5		
Samples	10	0.51	10.20	3	0.16	3.20	2.5	0.13	2.50
			1706.58			1721.90			1683.97
Off fall									
Paddy trieur 6	0.8	0.04		0.5	0.03(2)		1	0.05	
43/4	0.8	0.04		0.5	0.03(3)		1.5	0.08	
Losses & Husk	440.4	22.25		392.5	21.14		427.5	22.66	
Total		100.00			100.00			100.00	

A survey carried out in 1957 showed that 50% of the standard mills operated both by purchasing and selling the rice and on a service basis.

When rice is milled on a service basis, it may be paid for in several ways:

a) About 18% charge 0.50-1.50 US $ per ton of paddy. The highest price is charged at the beginning of the season, immediately after the harvest, when there is a lot of rice to be milled and the market price of the by-products is very low. As the quantity of rice available diminishes and the market price of the by-products rises, the charge for milling is lowered, the operator being satisfied with the sum he obtains from the sale of the by-products.

b) About 78% of the mills charge nothing for milling, considering that their services are sufficiently compensated by the value of the by-products which tey retain.

c) The remaining 4% not only make no charge for milling, but actually pay the producer or trader 1.25-1.50 US $/ton. The value of the by-products makes it possible to cover the cost of milling and to pay the owner of the product.

Milling on a service basis makes difficult any improvement in the yield of whole grain rice, since the miller is interested, to a certain extent, in increasing the quantity of brokens and bran which are kept as payment for the milling service.

APPENDIX V

MODERN RICE PROCESSING METHODS

At present, rice-processing can be divided into the following categories, according to the methods adopted:

- entirely mechanical milling;
- mechanical milling assisted by organic solvents.

V. 1 Mechanical milling may in turn be divided into:

- single-stage milling, using only one machine to produce edible rice from paddy (as in the case of the hullers);
- multi-stage milling, in two or more operations, using several machines which each carry out one stage of the milling process (shelling, whitening, polishing etc.).

Multi-stage milling is carried out by two distinct methods, taking their names from their countries of origin: the European (or "traditional") method and the Japanese method.

Thailand is at present at the point where these two systems meet, or perhaps conflict.

The European method was introduced into the country with the rice mills. It is based on the use of disc shellers, whiteners with an inverted vertical cone and polishers or brushers with a vertical cone or cylinder.

The Japanese system, which began to spread in Asia and other parts of the world only after the War, uses shellers with rubber rollers, whiteners of two different types (friction or emery) and hori-

48. TOTAL VALUES OF THE PRINCIPAL EXPORTS

(U.S. DOLLARS)

Year	Rice	Rubber	Tin	Teak
1960	128,490,905	128,967,628	26,830,783	17,806,610
1961	179,909,905	106,502,348	30,846,941	12,607,779
1962	161,993,361	105,532,382	24,257,059	8,505,031
1963	191,196,064	95,161,805	37,046,317	6,833,749
1964	219,427,488	102,994,718	48,072,662	8,938,815
1965	216,718,668	99,944,414	38,337,901	10,041,206
1966	200,055,143	93,034,876	1,264,443	12,147,822
1967	232,657,248	78,686,289	93,808	9,683,060
1968	188,741,517	90,796,564	-	8,447,838

(a) Source: Annual statement of Foreign Trade of Thailand

Department of Customs - 1968

zontal cylindrical polishers.

There is also a difference in the methods adopted to separate the shelled rice from the paddy. The traditional or European system uses an oscillating tray divided into compartments, while the Japanese method consists of a tilted steel-mesh tray, which is stationary for small plants or vibrating for large mills.

As mentioned above, a precise comparative study of the results obtained from the use of each individual machine, whether of Japanese or European make, would decide the technical and economic advantages should it be adopted by the Thai rice-processing industry.

Mechanical processing, whether by the traditional European system, the Japanese system or a mixture of the two, must however be considered from a rather different point of view than in the past. While technological progress has changed very little the principles on which the various machines operate, it has made considerable advances as regards the flow chart, by introducing new auxiliary machines.

In the last few years, excellent results, from the point of view of both quantitative and qualitative milling yield, have been produced by the so-called 'fragmented' processing system. Since every machine processes the grains of rice in a certain position, and the efficiency of the operation depends on one or more biometrical axes of the grain, it can be seen that uniformity in the biometric dimensions is of the utmost importance. For example, in the case of the sheller

with abrasive horizontal discs, shelling is carried out by pressing the ends of the grain when it is in a vertical position. The space between the two discs must be such as to allow all the grains to be husked if they are all of the same size. If there are longer grains, they are bound to be broken or damaged, while grains shorter than average will not be husked at all. In the case of the roller sheller, on the other hand, the grains are husked lying in a horizontal position. Those thinner than the space at which the rollers have been set cannot be shelled, while grains which are too large are liable to be broken.

The same is true of all the other processing machines. If the rice were divided into batches of grains with perfectly uniform length or thickness, they could be processed on a rational basis, giving the highest possible yield. Especially in Thailand, where the paddy to be milled is usually a mixture of different agronomic varieties, pregrading, and also grading of the milled rice would certainly constitute a step forward.

After milling, the different batches of pregraded rice, processed separately, would be kept apart. The separation of brokens from whole grains, from the different products milled, could be carried out in a perfectly rational way, and the brokens, subdivided according to size, and kernels of two or more sizes could be collected separately at the end of the milling process.

By controlling the proportion in which whole grains and brokens of various sizes are mixed, it would be possible to produce absolute-

uniform batches of rice, answering to the precise norms laid down in the standards for milled rice.

The grading of the product on the basis of size could also be combined with that according to specific gravity, removing grains or brokens of a chalky texture; these could then be mixed with the saleable product, again in accordance with the percentages laid down in the official rice standards.

The Thai economy would benefit considerably from this, especially as regards rice exports, as batches of rice corresponding perfectly to the conditions of the sale contract, as regards quality, could be exported. At present, it is not rare for batches of rice bound for export to contain a percentage of brokens lower than the permitted proportion, in order to avoid any protest or rejection on the part of the buyer.

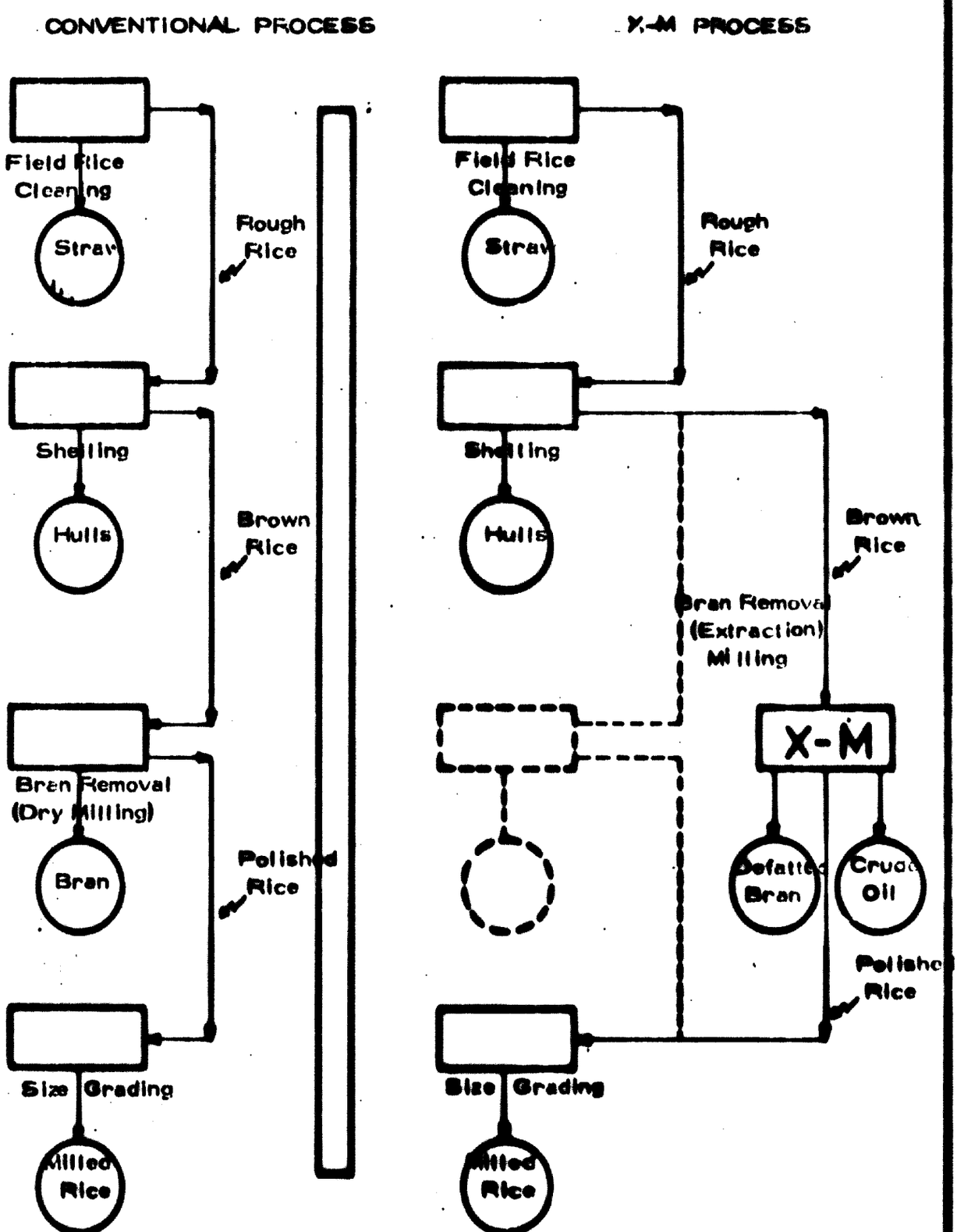
This obviously harms the economy of the country, since, by substituting whole rice for brokens, the real value of a batch of rice becomes considerably higher than the price charged. One of the main objectives of the Thai rice industry must be to install plants designed on the basis of a flow chart which includes the pregrading of paddy, processing in separate batches of graded paddy, separate storage of milled rice and by-products and accurate mixing of the various products to achieve the correct qualitative composition.

V. 2 Mechanical milling with the help of organic solvents is the latest technological development in modern rice-processing. We

shall deal with this subject in greater detail in the following pages.

The method is used only for the whitening process; shelling, grading etc. remain unchanged and must be carried out by the normal mechanical methods. In other words, processing by means of organic solvents takes the place of normal whitening, between shelling and grading of the milled rice. Pregrading of the paddy and dosed mixing of the different types of milled rice and brokens cannot be replaced by the use of organic solvents, but on the contrary should be combined with this method in order to obtain the best results.

V. MODERN MILLING FLOW CHART



66. RICE MILLING OPERATIONS

Section	Processing system	Products	By-products
Reception Pre-cleaning Storage	Mechanical	Clean paddy	Impurities
Grading	Mechanical	Paddy of different sizes	
Shelling	Mechanical	Shelled or brown rice	Husks Stone bran
Whitening and Polishing	Mechanical --- XM process	Milled rice of different milling degrees	Raw bran & polish --- Defatted bran, crude oil and vegetable wax
Grading	Mechanical	Head rice, brokens of different sizes	Brokens
Blending	Mechanical	Rice of different classes & grades	
Bagging & conditioning	Mechanical	Bagged and packaged rice	

V.3. The solvent extracting milling process (XM process)

V.3.1. This process constitutes one of the most recent achievements in rice-processing technology. As mentioned above, it takes the place of mechanical whitening, all other operations (precleaning, shelling, grading etc.) being carried out in the traditional way.

The advantages of this method over mechanical whitening are as follows:

- greater overall yield of edible rice;
- smaller percentage of brokens;
- smoother, whiter appearance of processed rice;
- lower oil content of processed rice, and therefore improved storage properties;
- possibility of totally removing the layers of the endosperm (bran and pollish, without leaving traces of striation or floury residues, consisting of fragments of bran; it also reduces the partial removal of the starch cells of the endosperm;
- extraction of crude oil, during the actual milling process, from the bran, germ and starchy endosperm.

The XM process also resolves the problems of acidity, FFA and starch cells (flour) in extracting crude oil from the bran.

The crude oil obtained by the XM process can be refined and rendered edible with the minimum loss, as the acidity is very low. More-

ever, the crude oil is already free from vegetable waxes, and there is therefore no need for a special process to extract these during refining.

The defatted bran obtained as a by-product is resistant to flavour degradation and can consequently be stored for long periods; it can also be used as raw material for the extraction of protein (which is contained in a higher concentration), or used directly for the preparation of many different foods.

The technical and economic advantages of this process are beyond question, and in addition, for an exporting country such as Thailand, there is a further benefit of an economic nature which is extremely important.

Since Thailand exports rice not only to markets which require a highly-milled product but also to markets which, because of the lower price, accept undermilled rice, the XM process would be an excellent way of satisfying the latter demand; it makes it possible to produce undermilled rice, leaving a high percentage of completely defatted bran on the grain, giving the product an excellent colour and very good storage properties.

For Thailand, as an exporting country, and for many other African and Asian countries which consume rice, either produced locally or imported, the XM process offers the ideal solution to the much-discussed problem of the consumption of undermilled rice: the dieticians affirmed that it was important to consume rice undermilled, whereas the processing industry rightly pointed out that the fatty particles left

on the grain became rancid during storage and ruined the flavour, rendering the product unsaleable. The new process, by extracting the oil from the bran left on the grain, has finally solved this problem, since it is no longer possible for the odour or flavour to deteriorate. In other words, the problem of food value which arose when mechanical milling on a commercial scale replaced home pounding in a mortar has at last been solved by the XM process.

The Thai rice-processing industry could increase the overall yield of milled rice for export to certain markets by reducing the quantity of bran removed, to provide a product as good, if not better, as regards nutritive value, appearance and flavour, which could be stored indefinitely.

Undermilled rice has a tendency to become floury after a time, as the particles of bran left on the grain dry out and rub off. This could be prevented by glazing, using a glucose and water solution and talc. Until now, this process could not be applied to undermilled rice because of the fatty particles, which did not allow the water to be absorbed, but when the product has been completely defatted by the XM process, glazing should be possible.

V.4. The XM process is a North American invention which has been developed in the last ten years; the initial studies and research began about 1960.

A large number of patents have been taken out, in the United States and in other countries, to protect the invention. The patent

issued in the name of Truman B. Wayne has led to the first, plant erected by Riviana Foods Inc. at Abbeville in Louisiana alongside a previously-constructed rice mill using conventional methods to process rice mechanically.

Food Engineering International, Inc., a subsidiary of Riviana Foods Inc., holds the world-wide exclusive patents license and has the power to issue licenses for the X-M process to other parties.

V.5 As mentioned above, the new process replaces mechanical whitening in the milling process (see Diagram XVI).

After threshing and drying, the paddy is cleaned if necessary and shelled. The shelled rice is then moistened with oil (usually crude bran oil) and left for a certain length of time in tanks, to soften the layers of the caryopsis; this makes it very easy to remove these layers by peeling rather than abrusion or mechanical cutting.

From the softening tanks the product passes to the whitening machines, in which the bran is completely separated from the starchy endosperm. The machine used for this process is a huller-type whitening machine, similar to Japanese design, which has been duly modified; it is based on the principle of friction. Inside the machine, the rice meets a spray of organic solvent, of the type normally used in food

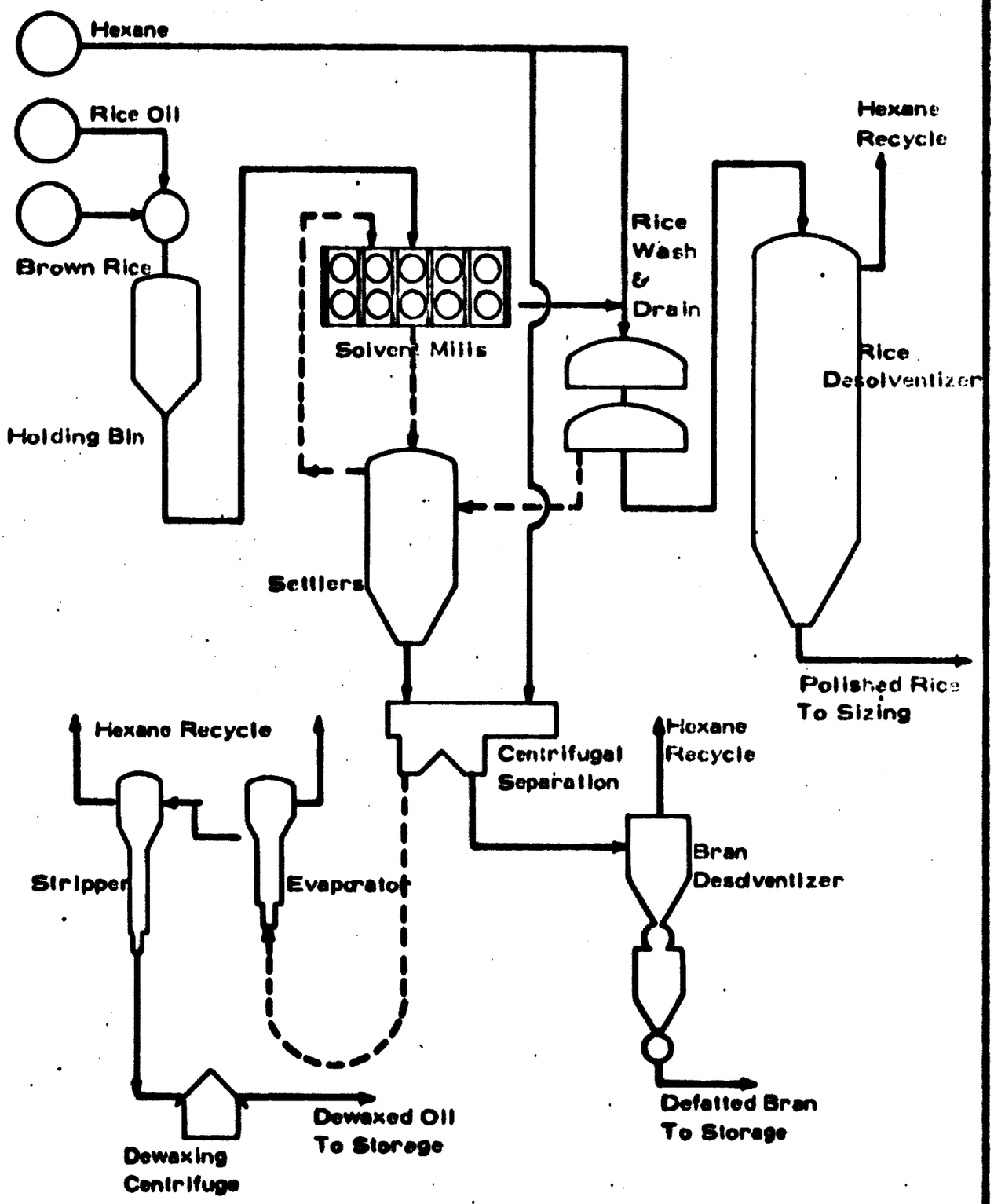
46. AVERAGE WHOLESALE PRICES FOR MILLED RICE AND MAIZE IN THAILAND

(U.S. dollars per Ton)

Year	100%	5%	10%	15%	20%	25%	Broken A1 super	Maize
1960	88.05	79.30	86.95	84.60	59.30	56.20	47.80	55.47
1961	86.55	81.65	77.95	76.60	72.30	69.85	61.85	55.40
1962	90.50	84.65	81.40	80.45	-	68.60	72.05	49.44
1963	89.95	84.10	81.05	77.50	-	71.30	66.20	51.34
1964	84.00	77.20	73.50	70.15	67.45	61.05	50.40	52.08
1965	88.45	76.80	74.10	71.55	69.80	65.65	53.40	60.15
1966	109.45	104.30	101.35	97.85	94.10	92.45	88.40	56.27
1967	126.60	119.90	116.15	109.65	106.00	104.05	83.50	56.73

(a) Source: "Economic Progress of Thailand" - General Indicators - Office of National Economic Development Board - October 1968

XVI. XM RICE MILLING PROCESS FLOWSHEET



processing. This solvent is sprayed onto the rice throughout the process of separating the bran from the caryopsis, fulfilling three functions:

- it helps to remove the bran and separate it from the product, taking with it even the smallest particles which would otherwise have to be removed from the surface of the grain by brushing;
- it dissolves the fats contained not only in the bran but also in the starchy endosperm;
- it disperses the heat which tends to develop as a result of the friction of the rice, keeping the product cool and thus avoiding the possibility of cracks in the grain due to the rise in temperature.

When the bran has been removed from the grain, they are then separated by screening, during which the product is subjected to a continuous flow of warm solvent. At this point, the rice, which has been whitened but is still wet with solvent, follows a different direction from that of the bran in Diagram XVI.

The cereal is passed through a machine which evaporates the solvent (rice desolventizer). It is then graded to remove any broken or damaged grains present in the edible product.

The bran, carried in the flow of solvent, goes through a complicated process to remove the oil it contains and to retrieve the solvent, which can then be re-used.

The bran which remains when the oil and solvent have been removed gives a by-product which is almost completely free from fat.

V.6.2. The defatted bran obtained from the XM process is very light in colour; it has very little odour and may be stored for a long time without deteriorating, as it contains almost no fat which might go rancid.

When analysed, it is shown to have a protein content higher than bran derived from rice processed mechanically (17-20% as against 12%).

The properties of this by-product are such that it may even be used as an ingredient in foods for human consumption.

It should be noted that both the edible rice and the bran obtained from the XM process are relatively resistant to insect contamination because contact with the solvent tends to destroy parasitic life in the product.

V.6.3. The bran oil is light in colour, and does not contain wax. (The average proportion of vegetable wax contained in rice bran oil is 3-5%; the percentage in oil from the XM process is usually lower than 0.15%).

An important characteristic of the oil is its low content of FFA. Since the oil is extracted from the bran actually during the whitening process, the lipase is completely inactivated and cannot separate the fatty particles, as usually happens in the period of time between production of the bran by mechanical processing and its use in the oil-extraction plant. It is estimated that, on average, the percentage of FFA which forms during the first hours of storage of the bran by mechanical processing is of the order of 1% per hour.

The FFA content of the crude oil determines the yield in terms of edible oil obtained in refining, as shown in Table 66).

V. 6. 4 . Vegetable wax, for which a profitable industrial use has not yet been found, may be returned to the defatted bran, increasing its weight without notably decreasing its value.

V. 6. 5. The economic evaluation of the XM process is based exclusively on comparative data obtained from the only industrial plant of this kind in the world.

Since this plant operates under the particular conditions of Southern Louisiana, and processes rice with the typical characteristics of that grown in the South of the United States, the evaluation given below must be taken as extremely approximate and liable to considerable variation.

This depends on:

- the characteristics of the paddy to be processed, particularly with regard to the agronomic variety, the purity of the strain, the harvesting conditions, the methods of drying and the storage conditions. If the raw paddy contains grains which have been physically or mechanically broken, before it is processed, or if it is of an especially fragile type, this will obviously have an adverse effect on the yield in terms of head rice and percentage of brokens;
- the moisture content of the cereal to be processed may cause the machines to function imperfectly, and above all may influence the

6. VARIATION OF RECOVERIES OF EDIBLE OIL ETC. DEPENDING ON F. F. A. (%) IN CRUDE OIL

Process	Article	Expected recovery(%)	F. F. A. (%) ≦ 5	10	15	20
	Crude oil	-	1,000 kg.	1,000kg.	1,000kg.	1,000kg.
Dewaxing	Dewaxed oil	96.5	965	965	965	965
	crude wax	10.0	100	100	100	100
Neutrali-zing	Neutralized-oil	Y=97-FFA	752	665	590	493
	Soda-foots	100-Y	113	200	285	372
Bleaching	Bleached oil	96.5	727	642	560	475
Deodoring	deodored oil	97.3	707	625	545	462
	scum oil	1.5	11	9.6	8.4	7.1
Wintering	edible oil	86.0	600	532	463	394
	solid edible-oil	15.0	107	93	82	68

Notes:

1) The calculation is based on method No. 1 wich is introduced in the quotation from a booklet by M/s Base Oil & Fat Co., Ltd.

2) Expected recovery (%) expresses recovery rate against the material in each stage of refining

3) Solid edible oil is also called SOFT OIL %

quality of the oil extracted;

- the local environmental conditions, which may influence the processing operations, reducing the yield in terms of products and by-products and causing high losses of solvent, with the consequent increase in processing costs.

The factors which may influence the process, its results and consequently its profitability are numerous and varied; it would therefore be advisable to carry out laboratory investigations in order to check the results and economic benefits of the process under the particular conditions of Thailand, before taking any decision as to the erection of a large, commercial plant.

It should also be remembered that any economic evaluation does not take into account the royalties of the patent or licence to be issued by Food Engineering International, Inc.

Since the XM process must be considered as part of the whole milling process, including reception of the paddy, cleaning, shelling etc. right through to bagging (see Diagram XV it was first necessary to determine the present cost of processing rice mechanically in a large rice mill in Thailand.

The cost of the whitening process alone, by means of an organic solvent, was then added to the amount estimated.

The cost of milling rice mechanically, as at present estimated in Thailand, should include depreciation not only of the mechanical pro-

cessing machines but also of all the auxiliary services connected with the plant, for storage of the paddy, milled rice and by-products until their use or dispatch.

It should also be remembered that traditional mechanical milling is of a seasonal nature, whereas a processing system including the XM method is a truly industrial operation. For obvious technical and economic reasons, the use of organic solvents in processing the rice requires that the plant operate non-stop 24 hours/day and 7 days/week, for at least 300-320 days per year.

In the case of Thailand, where there is only one rice harvest, this means that a very large quantity of paddy must be bought and stored, in order to feed the plant continuously with raw material. The storage of such a large quantity of cereal obviously requires extensive capital, of which the cost or interest must be added to the cost of mechanical processing and that of whitening by the XM process.

APPENDIX VI

SPECIFICATIONS OF MACHINERY, EQUIPMENT AND BUILDINGS FOR THE THREE ALTERNATIVES OF THE MILLING PLANT

General

The cost of the different components of the milling plants which have been considered in the feasibility study has been recovered from similar mills which have been sold by various manufacturers during the last three years, since the costs differ considerably, depending on the different sources of import (U.S.A., Europe, Japan, etc.). For some equipment the prices are worked out according to European quotations, and for other equipment according to the cost of similar plants installed in some Asian countries. For rice-processing machinery no customs duty exists in Thailand but for other machinery a duty varying from 15 to 20 % of the C.I.F. cost has to be allowed.

Alternative I

A. Offices, watchman's lodgings, auxiliary buildings and equipment: the following building area has been calculated for:

- watchman's lodging	60	sq.m.
- offices	120	" "
- labourers'lavatory & locker room	200	" "
- garage for 4 vehicles	80	" "
Total	460	" "

Taking as an average price U.S. $ 30 per square metre of an imported, all-steel building with a height of 6 m., there results a total cost of 13,000 dollars for the buildings. The cost includes internal partitions, fixtures, windows, etc.

The cost of furniture for the watchmen's lodgings, offices and locker room to be provided locally has been estimated at U.S. $ 3,000. The plumbing to be provided locally has been calculated at U.S. $ 2,000.

B. The building for the rice mill. A total covered area of 1,000 sq. m. has been estimated. The building, having a height of 12 m., has been calculated at U.S. $ 30-40 per sq. m. of covered area, including 40% for sea-freight, import duty, inland transport and erection.

C. Silos and by-products godowns. A total of 10,000 sq. m. of covered area has been calculated as necessary for storing rice and brokens produced during at least 45 days of continuous operation, and for the production of raw or defatted bran during 3-4 months of continuous operation. The height of the godowns has been calculated at about 6 m. An average cost of $ 25 per sq. m. brings the total cost to $ 250,000 for godowns erected on site.

47. EXPORT MARKET PRICES (FOB) OF MILLED RICE (a)

(in U. S. $ per ton)

Item	1965	1966	1967	1968	1969(1)	April 1969	April 1970(1)
Government to Government contracts:							
- White rice 35% brokens	102.2	123.6	120.0	147.2	136.3	134.5	112.5
- White rice 10% brokens	-	128.0	140.5	190.5	173.4	178.6(2)	165.6(3)
Private trade:							
- White rice 5% brokens	137.5	166.0	223.7	203.3	185.5	193.2	130.2
- Husked rice 100%	125.4	155.6	220.6	207.1	180.0	181.2	144.0
- Brokens A1 super	96.9	126.1	150.5	151.5	104.7	108.0	89.4

(a) Source: FAO - Rice Trade Intelligence
(1) Provisional
(2) January
(3) July 1969

Item	1969 Jan.	1969 March	1969 June	1969 Sept.	1970 Jan.	1970 March	Change in March 1970 over March 1969 (%)
Long grain:							
- White rice 100% 1st grade	190	202	214	202	166	150	26
- White rice 5%	176	187	190	187	154	137	27
Brokens:							
- White brokens 01 ordinary	100	100	91	89	92	73	27

(a) Source: FAO - Committee on Commodity Problems - Study Group on Rice
14th Session - 6 April 1970

D. [redacted]. The paddy silos chosen are of the "in bin" drying system type. This kind of silo can be of varying construction and equipped with different aeration systems. To store 36,000 M.T. of paddy of different varieties and moisture content, 36 bins with a capacity of 1,000 tons each are considered necessary. These bins, of flat-bottomed bolted steel construction, with an aeration system obtained by blowing air onto the bottom of the bin, will be supplied with external insulation and a roof suitable for tropical climatic conditions. The aeration system can also be used for the evacuation of the paddy remaining at the bottom of the bin. The cost F.O.B. European port for the complete storing plant may be calculated at U.S. $ 720,000; 40% for sea-freight, inland transport, duty and erection has been calculated on top of the F.O.B. price.

E. [redacted]. The paddy will be delivered to the mill either by barges or by trucks. Reception capacity has been calculated for an output of 100 tons. Two movable elevators, with an hourly capacity of 50 tons each, supported by a cantilever system, provide for the unloading of the product transported in bulk by barges. Four dumping pits with a capacity of 6 tons each, equipped with elevators with a capacity of 50 tons per hour, provide the necessary unloading facilities for rice delivered by truck in

bags or bulk state. Paddy delivered by truck is weighed by two weigh-bridges with a capacity of 15 tons load each. Paddy delivered by barges will be weighed by continuous weighing machines after scalping. The equipment will be composed of the following elements:

- 8 elevators, with a capacity of 50 tons per hour, maximum height 15 m.
- 4 scalping machines of a capacity of 50 tons each
- 2 continuous weighing scales, equipped with a recording device
- 8 horizontal conveyors, with a capacity of 50 tons each for a total length of 150 m.
- 2 weigh-bridge scales, for 15 tons each
- supporting frames for the elevators, scalping machines, weighing apparatus, including corrugated steel sheets for roof and walls, gangways and stairs, electric motors, wiring, switchboards, etc.

A total cost of $ 97,500 for the equipment installed has been calculated free of duty and auxiliary equipment for a rice mill.

F. Mechanical handling and internal transport equipment. The equipment includes all the necessary conveyors for :

1 moving the paddy from the receiving section to the storage section;

ii handling the paddy in the storage section ;

iii transporting the paddy from the storage section to the mill;

iv transporting clean rice and brokens from the mill to the storage godowns;

v transporting the bran from the mill to the bran storage godown;

vi blowing the husk from the mill to the silos attached to the boiler.

The cost has been calculated as follows;

F.O.B. European port: for items i and iii (including bag handling equipment) U.S. $ 15,000; for item ii, U.S. $ 105,000; for item iv, U.S. $ 32,000; for items v and vi, U.S. $ 15,000. The total cost of $ 167,000 has been increased by 40% to cover freight, inland transport, duty and erection expenses.

8. Rice breeding laboratory. The building for the laboratory, of a steel structure with 2 partitions, having a total covered area of 120 sq.m., has been calculated at U.S. $ 30 per sq.m. installed. The furniture, to be provided locally, has been calculated at U.S. $ 000.

The laboratory equipment consists of:

- 2 sample dividers
- 2 moisture testers
- 2 miniature shelling and polishing cones

- 3 laboratory paddy cleaners
- 3 sets of paddy grading sieves
- 3 sets of clean rice grading sieves
- miscellaneous equipment for taking, handling and examining the samples, including thermometers, portable hygrometers, etc.

The total cost of the above equipment, delivered F. O. B. Bangkok, duty-free as ancillary milling equipment, is U. S. $ 19,000.

M. Rice milling machinery. The milling machinery and ancillary equipment for an average production of 15 tons of paddy per hour include:

- 2 feeding bins, in steel construction, with a capacity of 150 tons of paddy each;
- 1 continuous paddy-weighing scale;
- 4 cleaners of 4-ton paddy capacity each;
- 20 paddy-grading cylinders, of the steel-wire type, for grading paddy by thickness, 3 different grades;
- 8 rubber-roller shellers, with a 2-ton capacity each, to be used as first shelling break;
- 3 rubber-roller shellers, with 2-ton capacity (one to be left idle as a spare machine);
- 4 husk seperators, equipped with vibrating sieves, aspirators and cyclones;

- 8 compartment separators, with 48 compartments each, with variable speed devices;
- 12 pearling cones, diameter 1,250 mm., equipped with 12 rubber brakes: capacity of each cone 4 tons per hour in terms of paddy (3 polishing breaks, 4 plane sifters for separating small brokens from milled rice);
- 4 vibroscreens, for separating small brokens from bran;
- 16 trieurs cylinders, for grading clean rice and for sizing the different classes of broken rice;
- 4 continuous weighing scales, for weighing head rice and different sized brokens;
- 10 holding bins, for rice and brokens, equipped with volumetric metering devices for the exact mixing or blending of milled rice and different kinds of brokens, total holding capacity of the bins: 250 tons;
- 3 automatic weighing and bagging machines, equipped with top holding bins, bagging capacity 350 bags/hr.
- 2 weighing and bagging machines for the bran (to be installed in the bran godown);
- 4 bag sewing-machines;
- bucket elevators;
- horizontal conveyors;
- suction fans;
- cyclones, air ducts, air filter etc. for handling the

products through the machines and aspirating the dust, meanwhile cooling the products and avoiding moisture condensation;

- machinery supporting steel frames and feeding bins for the compartment separators and polishing cones.

The total cost of the equipment, including electric motors, reduction gears, belting, electric wiring, switchboard, F.O.B. European port, is US$ 178,000. Transport and erection charges, excluding customs duty amount to US $36,500.

I. Electricals, workshop and spare parts have been calculated on the basis of the cost given for similar mills by the manufacturers. The costs have been increased by 40% for transport, duty and erection. The electricals include the distribution wiring from the power station to the different utilization sections of the plant; switchboards for each section are not included, nor is the wiring, as these have been calculated in the total cost of each section. Workshop and spare parts include the workshop facilities (welding equipment, metal working machines and other special equipment or tools required by the mill repairs). The cost of the spare parts includes only mechanical and electrical components; spare parts for the mill, e.g. rubber rollers, emery and carborundum, are calculated under separate items.

J. Boilers, steam engines and generators, husk and ashes silos and power generators.

By calculating 65 tons of husk production per day, the total steam production in 24 hrs amounts to 160 tons or 6,500 Kg/hr. From this steam, about 1,300 H.P. can be produced. Two boilers, each producing 3,000-3,500 Kg of steam, will cost approximately $ 80,000 installed, including the smoke-stack, aspirators and steel components for the husk furnace.
Two steam engines, one as a reserve, coupled with two generators (approximately 400 kW per hour) can be considered for a cost of 60,000 $ F.O.B. European port or 95,200 $ installed, duty-paid. The necessary building for the boilers and the power station requires a covered area of 300 sq.m., which will cost approximately 6,000 dollars installed (no walls are required). The husk storage for 120 tons of husks requires 1,200 cu.m. capacity, in a steel construction; it can be calculated at 40,000 $ F.O.B. or 67,200 $ installed. For the ashes, which represent 20% in terms of volume of the burnt husks, the storage facilities will cost approximately $ 13,200 installed. A water softener and a pneumatic conveyer for husks and ashes may be calculated at a cost of $ 7,100 installed. Motors, belting, reduction gears, wiring and switchboards are all included in the cost.

Alternative II

The extraction facilities for recovering the oil from the bran have been considered as imported from Japan. The plant, of the batch type, has a total investment cost, including boiler, buildings and additional power generating equipment, given by the manufacturers.

The costs given by the manufacturers have been up-dated and transport, duty and erection have been added. The specifications of the plant chosen are as follows:

- raw material input: 20,000 Kg
- crude oil output (16.5%): 4,000 Kg
- defatted bran output (80%): 16,000 Kg
- steam consumption: 1,000 Kg/ton (2,000 Kg/hr)
- power consumption: 70 kWh/ton (100 kW/hr installed)
- water consumption: 20,000 Kg/ton (delivery at the plant side 20 cu. m. per hour)
- solvent losses: 1%, based on raw rice bran input weight.

Alternative III

For the X-M processing facilities, the costs considered have been given by the Food Engineering International Inc. The saving in the cost of the mechanical polishing equipment (12 cones + elevators and conveyors) is partially absorbed by the cost of the belt conveyors transporting the shelled rice from the mill to the X-M plant and the polished rice back to the mill.

The specifications of this plant are as follows:

- raw material input : 30,000 Kg
- crude oil output: 1.4% of the raw bran weight
- defatted bran output: 6.8% of the weight of paddy milled
- steam consumption: 2,300 Kg/hr.
- power consumption : 600 kWh/day, based on 24 hr.
- water consumption: 265 lit/min.
- solvent losses: 0.38 lit/ton of paddy processed.

Note: In accordance with the wishes of the UNIDO, Indus Inconsult availed itself of the services of Food Engineering International, Inc., a subsidiary of the RIVIANA FOOD Inc., Houston, Texas, which holds the world-wide exclusive patent for the X-M process (Third alternative in the feasibility study). F.E.I. alone should, therefore, be held responsible for the data (product yield estimates, capital costs, operating costs etc.) utilised in the feasibility calculations of the X-M processing plant.

40. PROJECTIONS OF TOTAL DOMESTIC DEMAND FOR MILLED RICE (in tons)

Year	Low	High
1970	4,712,151	5,096,161
1975	5,361,103	5,773,494
1980	6,217,745	6,696,003

(A) Source: "Rice Economy of Thailand" - Division of Agricultural Economics Office of the Under Secretary of State, Ministry of Agriculture, Bangkok, December 1964.

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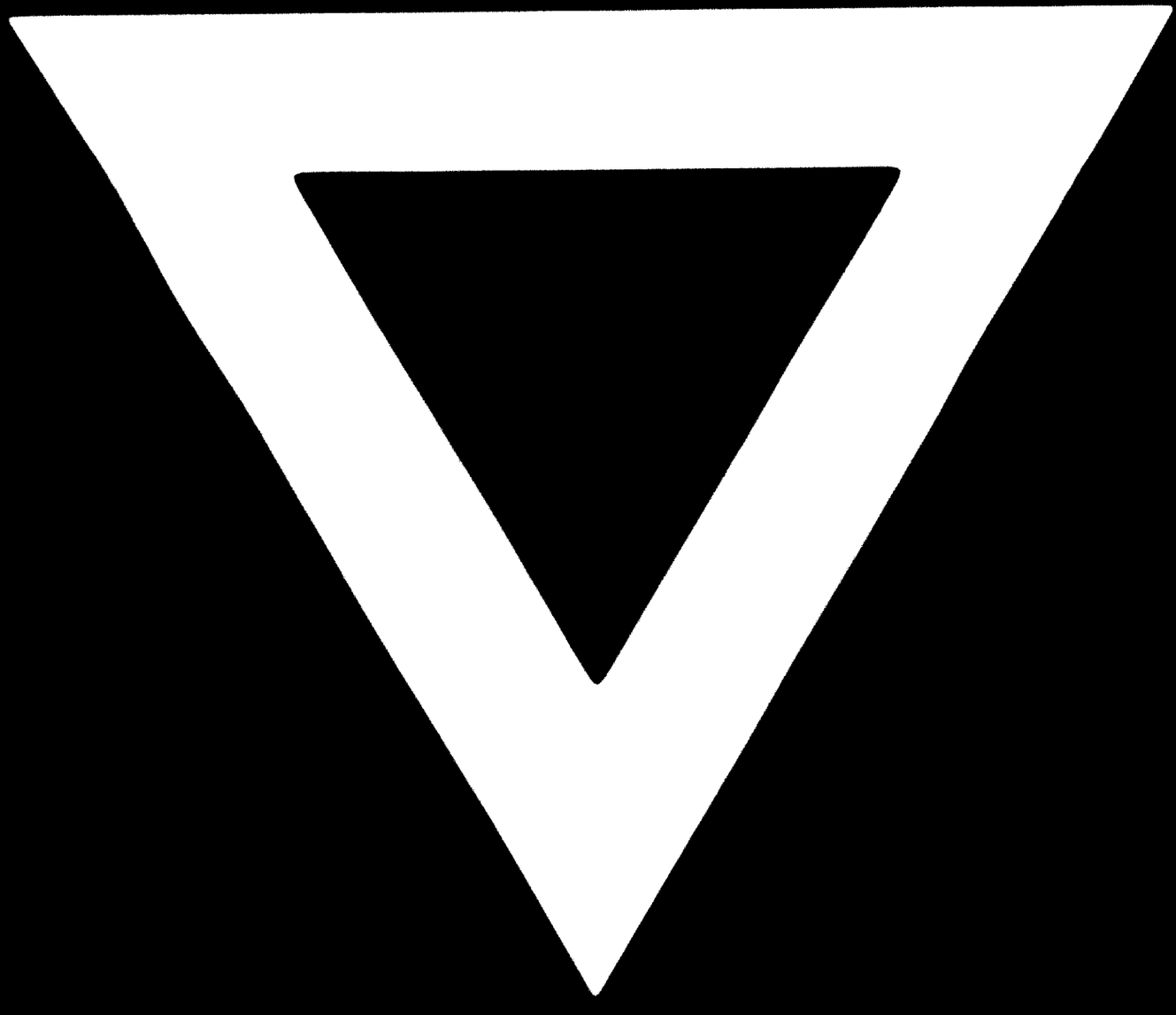

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APPENDIX III

MARKETING, TRANSPORT AND STORAGE OF PADDY