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CORN and RICE in THAILAND

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Contents

COUNTRY CROP PAPER

THAILAND

CORN

I. RECORD TO DATE

1. Crop Production

A. Historical Note.

Corn was probably introduced into Thailand by the Portuguese in the mid sixteenth century. It was grown primarily by the hill tribes from that date until the mid fifties and as a garden crop for household use, primarily as chicken feed. In the mid fifties, a marked upsurge in production began with Guatemala flint corn which has continued to expand since that time until at the present yields are in the one million to one million two hundred thousand metric ton range. (see below).

The principal corn producing areas of Thailand today occur in a broad belt just to the North of the Central Plains (see map 1). Although there are nine Changwats which produce together approximately 88% of the total national production. Of these, Lopburi, Nakhon Sawan, and Saraburi produce 70%.

First recorded attempts at improvement were in 1924 when two varieties of dent corn were introduced by Prince Siddhiporn for cultivation at his farm as feed for livestock. Crosses between these dents and earlier introductions resulted in superior varieties known as Pakchong

dent. Government interest in corn dates from 1950 when variety testing and selection was started.

In this year six varieties of field corn were introduced from Indonesia by the Department of Agriculture. Fifteen new varieties were also introduced from the U.S., Guatemala, and El Salvador in 1952. During the next two years, seeds of these varieties were increased and tested by the Department for adaptability to local conditions in the Northeast. From these "Pakchong dent" varieties, research workers selected a variety known as collection No. 113 which because of its innate adaptability, became the major variety for commercial growers from 1954 to 1959. It has now been replaced with a flint corn in order to meet demands of the foreign market.

Among the introductions of 1952, there was a variety of Guatemala yellow flint corn, which showed promise. It was designated as collection No. 110. At present it is Thailand's most popular corn and is preferred by the Japanese market. Thai corn farmers call this variety Guatemala corn.

By 1967, it is estimated that as much as 85% of total corn production was of this variety. For the purposes of this paper, Guatemalan flint is considered as a new variety.

B. Thai Corn Production by Years in Metric Tons.

1950--27
1955--68
1958--186
1959--317
1960--544
1961--598
1962--665
1963--858
1964--935
1965--1021
1966--1250
1967--1200 (estimate)
1968--1375

The national average for corn today is approximately 0.760 MT per acre. However, yields for the earlier variety of Pakchong dent are estimated to be 0.5 to 0.630 MT per acre as compared to yields of 0.759 to 0.885 MT per acre for Guatemalan flint.

C. Thai Corn Area Planted in Acres by Year.

1950--87,200
1955--138,800
1958--316,800
1959--499,600
1960--714,000
1961--766,400
1962--809,800
1963--1,031,700
1964--1,369,300
1965--1,442,000
1966--1,390,000 *
1967--820,000
1968--1,480,000 (estimate)

As seen, there was a sharp upward swing in acreage planted in the late fifties which doubled by 1965 but has held relatively steady since then.

* National Statistics Office.

2. Input Utilization.

A. New Seed Varieties.

As stated above, Guatemalan flint was first introduced into Thailand in 1952. In this year an import through USOM of 100 pounds was made. This was multiplied at Bangkhen and Tha Phra Agricultural stations. During the following years the seeds were multiplied and distributed to selected farmers. By 1959, this variety made up from 85 to 95% of the corn grown in Thailand dependent upon which report is accepted. This increase in use of flint corn was due to the demand of Thailand's foreign market for this corn. During previous years, while the dent corns were popular, the Department of Agriculture continued multiplication of the improved seeds of this variety at its multiplication stations and seed farms. By 1960, the variety was available to all farmers desiring to grow it. During this period investigations were also undertaken on pest and disease control, cultural practices, and fertilizer requirements. In 1961, a seed certification program was started, which in 1962 included the first contracted growers of certified seed.

Annual acreage to this variety again must be estimated. However, as stated, by 1959, the largest percentage of the corn acreage was in Guatemala corn. Total acreage can be computed from the above tables by taking 90% of the total acreage reported as being in Guatemalan flint.

B. Land.

Following is acreage of corn by five year gaps.

	Total acreage in corn	Acreage in Guatemalan Flint
1950	87,200	0
1955	138,800	5,000 (estimate)
1960	714,000	606,900
1965	1,480,000	1,326,000
1968	1,480,000	1,326,000

The total acreage planted to corn and the increase of both the total acreage and the acreage to Guatemalan flint corn show a close coorelation. Since the big increase in both corn production and acreage planted came in the period after 1955, these are the figures used. Although scientists have developed higher yielding plants, the major increase in production of corn has come largely from the development of new land. During this period, production of all major crops in Thailand show an upward swing. The increase in area planted to corn has not been at the expense of rice. The two major lowland or wet bed crops of rice and sugar cane show a steady increase in production both in terms of yield per plant and in acreage, while the production of sugar cane has been about the same. Further, other competing upland crops such as cassava, tobacco, cotton, peanuts, etc. also show a relatively steady increase in production tonnage. Thus, the increase in corn could not have been at the expense of these other crops.

Corn farmers in general plant larger area of corn than do rice farmers. A University of Kasetsart study* involving 62 farms in three Amphoes - Pakchong, Chai Badan, and Takhli found that the sizes ranged from 1 - 80 hectares. The average and range in hectares for Pakchong, Chai Badan, and Takhli Amphoes were 17 (2-52), 18 (3-48), and 10 (1-80), respectively.

The average yield and range in yield in Kilograms per Hectare for Pakchong, Chai Badan, and Takhli are 2206 (1069-3438), 2150 (1325-3269), and 2725 (1388-4350), respectively.

C. Fertilizer.

Following is a table showing fertilizer imports into Thailand through 1967. Production from Thailand's plant at Mae Moh came on the line in 1962. Other than limited production from this plant, all fertilizer is imported. However, new laws being proposed to protect the production from Mae Moh may reduce future imports of Urea and Ammonium Sulfate.

Imported Fertilizer in Metric Tons:

1950--9,354	1960--52,163
1951--6,495	1961--54,757
1952--17,465	1962--66,465
1954--12,164	1963--97,375
1955--24,280	1964--108,977
1956--23,429	1965--86,617
1957--40,020	1966--131,407
1958--29,170	1967--217,944
1959--47,639	

* See Table - Cost of Production of corn in three Arphoes in Thailand, first crop, 1967. University of Kasetsart.

There are no reliable figures for fertilizer consumption on corn. The TVA report of May 10, 1966 estimates that only 5% of fertilizer imported for use in Thailand is applied to corn. Indications are that this figure is now too low. Since a large part of the corn acreage is on newly cleared lands, yields have held relatively steady for the first couple of years with little fertilizer application, then, yields decrease sharply thereafter. Within five years the yield of corn grown on the same unfertilized land may be reduced by 50%.

No figures are available for public-private distribution of fertilizer. However, except for demonstration purposes, the bulk of fertilizer is sold through the private sector.

D. Water.

There has been a marked increase in the total of irrigable acreage of land available in Thailand since 1949. This has increased from 1,559,000 acres to 4,392,000 acres between 1949 and 1962. However, in the Northeast only about 3% of the land in cultivation is under irrigation.

It is estimated that probably less than 5% of field corn acreage is irrigated. Corn under irrigation is mostly sweet corn.

E. Pesticides.

Import figures available for 1967 show a total import of 7,578 MT of other agricultural chemicals, the bulk of which is assumed to be pesticides. This has risen steadily from a figure of 4,578 MT in 1963.

Over 40 species of insects have been identified of which 16 are considered to cause serious destruction. Of record, a 1963 infestation of grasshopper was controlled through spraying in Lopburi Province. Currently a pest control program is being carried on by pest control units of the Ministry of Agriculture.

F. Equipment.

Thailand has shown an annual growth rate of tractor imports of 32.15% since 1957. In round numbers, there is shown a total import of 3,700 tractors in 1966 and 9,434 in 1968 or 10,000 in round numbers.

The introduction of mechanization into corn production has made it possible to put corn growing on a commercial basis. Land preparation is now done largely with tractors. Shelling is also mechanized. In time other practices such as harvesting which is now being done by hand will also be mechanized.

The largest percentage of Thai corn is sun and air dried. If current plans are carried through, drying and storage capacity will be increased to accommodate approximately 220,000 MT of bulk corn.

3. Policies and Prices.

A. Output Prices.

It is estimated that at least 90% of corn produced in Thailand is exported. Records of prices paid to farmers are very fragmentary in the field.

Studies made in 1962 by the University of Kasetsart* show that corn farmers received 62.2% of the export price, local dealers received 15.8%, exporters 16.5%, and the cost of transportation of corn to Bangkok is 5.5% of export price. With reference to the cost of production, it was calculated to be about 50% of the price received, excluding salary to farmer and his family labor. Unpublished data for 1967 indicate about the same percentages.

As to producer prices, Thai farmers usually have had good prices for corn. Also RTG has had a support policy since 1964, but it has not had to implement this program. The average Thai corn farmers operate units 2-3 times those of rice. He usually relies on the village merchants or middlemen for his total market outlet, and in most cases is dependent on such merchants or relatives for his farm credit and living credit needs. Usually there is one intermediate between farmer and Bangkok exporter. With the exception of the installations established by the Calabrian/Thai Company, there are no large individual interior collection and storage points. Calabrian is no longer operating in Thailand. (See attachments).

Historically, producers themselves have little or no financial capability and in many cases cannot begin the new crop season without borrowing for purchase of seed and fertilizer. The lack of funds and credit reduces producers desire to improve seed and fertilizer qualities

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* Chaiyong Chuchart, Gordon Sitton, and Arkom Soothyian. Production and Marketing Problems Affecting the Expansion of Corn Growing in Thailand. Kas

because of the additional monetary costs involved. The support price program discussed below and corn trade agreement with Japan has tended to keep prices to farmers in line. The result is that the farmer has not had to liquidate his corn at unfavorable prices.

The principal outlet for the individual village merchant is the Bangkok market through the exporters. Amounts offered by village merchants vary considerably.

In later years there has been a price support program by the Government through the Public Warehouse Organization. This support price was set at $35.00 per MT for 1966 and at $40.00 per MT for both 1967 and 1968.

Available export prices, FOB Bangkok are as shown below:

1960--$50.40 per MT
1961-- 50.00 " "
1962-- 51.15 " "
1963-- 53.60 " "
1964-- 56.60 " "
1965-- 58.30 " "
1966-- 60.20 " "
1967-- 65.30 " "

At no time has the RTG found it necessary to implement the program. The mere fact that it exists is adequate reason for prices to remain satisfactory to all concerned.

The export price of corn to Japan has been based on a Thai-Japanese trade agreement. This agreement provided for the export price to be based on the Chicago futures closing quotations for U.S. corn No. 2

yellow during a period of 30 days prior each shipment period. Through these negotiations the quantity of corn to be exported is also determined and then the RTG issues the export permits. When the Chicago price dropped below the world price, during the dockworkers strike in the U.S., the RTG wanted to adjust the price of corn upwards. The Japanese refused to pay a higher price, so Thailand cancelled the agreement in December 1968. At present the price of export corn is negotiated on the basis of the world price.

The Japanese-Thai Maize Trade Agreement had the effect of fixing and to a degree stabilizing the price of corn for export only to Japan. The export price of corn to other countries has been at higher prices based on world prices due to foreign markets demand.

It should be pointed out that the Japanese agreement, by providing a steady export market at a favorable price even though below the world price, did provide the incentive required by farmers to expand production phenomenally. It will be seen in this table that Japan is now reducing its corn imports from Thailand, while Taiwan is increasing its, and has now becoming a significant importer. At least 96% of corn exports are within Asia. (See following table).

The prices fluctuate over the season. At the time the Japanese agreement was cancelled, the price based on the Chicago futures was $53.17 MT, while the price to Singapore and Taiwan was $60-62 MT.

ตารางที่ ๖.—ข้าวโพดที่ส่งออกจากประเทศไทยโดยเมืองกรมส่ง ปี ๒๕๐๐ ถึง ๗ ธ.ค. ๒๕๑๑

Table ๖.๑ Export of corn from Thailand, by country of destination, 1957 through 7 December, 1968*

เมืองกรมส่ง Destination	1957 พ.ศ. 2500	1958 2501	1959 2502	1960 2503	1961 2504	1962 2505	1963 2506	1964 2507	1965 2508	1966 2509	1967 2510	to 7 Dec. 1968 ถึง 7 ธ.ค. 2511
	เมตริกตัน 1,000 metric tons											
Japan ญี่ปุ่น	36	130	189	441	405	239	453	845	560	826	696	549
Taiwan ไต้หวัน	-	-	-	2	1	-	10	10	9	57	146	350
Singapore สิงคโปร์	10	15	18	35	82	92	79	74	82	142	100	132
Hong Kong ฮ่องกง	3	4	10	11	44	103	112	108	82	77	84	119
Malaysia มาเลเซีย	5	14	20	25	31	46	50	51	54	67	63	104
Others อื่น ๆ	-	-	-	-	4	2	40	13	17	49	23	46
Total รวม	64	163	237	514	567	473	744	1,115	804	1,218	1,112	1,299
	เปอร์เซ็นต์ของข้าวโพดที่ส่งออกทั้งหมด Percent of total corn exports											
Japan ญี่ปุ่น	56	80	80	86	71	49	61	76	70	68	62	42
Taiwan ไต้หวัน	-	-	-	-	-	-	1	1	1	5	13	27
Singapore สิงคโปร์	16	9	8	7	15	19	11	7	10	12	9	10
Hong Kong ฮ่องกง	5	2	4	2	8	22	15	10	10	6	8	9
Malaysia มาเลเซีย	23	9	8	5	5	10	7	5	7	5	6	8
Others อื่น ๆ	-	-	-	-	1	-	5	1	2	4	2	4
Total รวม	100	100	100	100	100	100	100	100	100	100	100	100

* TABLE PREPARED BY THE DEPARTMENT OF AGRICULTURAL ECONOMICS, KASETSART UNIVERSITY.

Source: 1957-1967. Royal Thai Government, Department of Customs: Annual Statement of Foreign Trade of Thailand.
1968 Board of Trade of Thailand, Board of Trade Bulletin (weekly)

Table 2. Cost of Production of corn in three Aumphoes in Thailand, first crop, 1967.

Item	Unit	Aumphors: Rak Chong Ave.	Rak Chong Range	Chai Badan Ave.	Chai Badan Range	Takli Ave.	Takli Range
Hectares in Corn	hectare	17	(2-52)	18	(3-48)	10	(1-80)
Yield	Kg/Hect.	2206	(1069-3438)	2150	(1325-3269)	2725	(1388-4350)
Variable Costs of Production							
Pre-Harvest	baht						
Seed	"	32	(19-44)	31	(19-50)	31	(13-50)
Planting	"	81	(56-125)	100	(75-131)	100	(75-158)
Subtotal	"	113	(81-157)	131	(106-163)	131	
Land Preparation	"	319	(206-500)	288	(206-419)	350	(188-513)
Weeding	"	275	(150-375)	225	(138-375)	256	(125-425)
Subtotal	"	600	(344-781)	506 513	(344-757)	600	(394-869)
Pre-Harvest Subtotal	"	713	(425-894)	644	(450-919)	731	(519-1013)
Harvesting							
Ear picking	"	156	(75-200)	100	(31-163)	131	(69-182)
Drying	"	19	(13-44)	25	(13-50)	25	(13-38)
Shelling	"	75	(38-113)	69	(44-107)	88	(44-25)
Transporting	"	75	(19-1014)	38	(6-82)	144	(56-213)
Harvest Subtotal	"	325	(144-519)	231	(144-363)	388	(206-557)
Total Variable Costs of Production	"	1038	(613-1363)	875	(613-1282)	1119	(750-1613)

6.25 rai = 1 hectare
20 baht = US $1

Prepared by Dr. Arkom Sootipan and Dr. Delane E. Welch, Dept. Agr. Economics, Kasetsart University.

B. Input Prices.

Prior to this crop year, importations of fertilizer and insecticide have been on the open market with moderate import taxes. Credit, by and large, has been on a historical basis as explained above.

Beginning with the 1968 crop year, there is an import restriction or ban on the importation of bulk fertilizer of Urea and Ammonium Sulfate in order to protect the local Urea plant. Since only a small percentage of the corn crop is fertilized, this will probably have little effect on production. However, the ban will raise local prices of Urea and Ammonium Sulfate fertilizers. Locally produced Nitrogen fertilizers cost from $25-$30 per ton more than imported Nitrogen fertilizer.

C. Net Return.

The University of Kasetsart made a cost of production study on corn in three Amphoes. The details are given in Table X-2. There it will be seen that the average total variable cost of production per Kg. of corn per Hectare ranged from ฿0.41 to ฿0.47 in the three Amphoes. Generally, as practiced, there would be a limited input of cash into the production cycle other than the costs for chemicals and for custom preparation of the land.

The Kasetsart study by Drs. Soothipan and Welsch found that only 7 farmers out of 62 used insecticides and only 2 out of 62 farmers used fertilizer. Costs were found to range between 3-75 Baht per Hectare for insecticides and from 25-75 Baht per Hectare for fertilizer. Few farmers

except large-scale operators own heavy equipment. Those who do may contract land preparation on a custom basis. Labor is probably the major input item. Family labor was estimated at 10 Baht per day in the three Amphoes investigated in the Kasetsart study.

When planted in March-April (hereafter this crop will be referred to as the dry season or second crop), labor is available and would generally be underutilized unless corn or another dry season or second crop were grown.

Although the net return to the farmer* as well as the middleman and the exporters may be small, it is enough incentive for farmers to increase production and the area planted.

D. Input Availability.

Government policies in the past have not discouraged the production of corn. Government initiated the seed increase program for the improved variety and assisted in seed dissemination. Until 1968, imports of fertilizer were not restricted and price policies in effect were tied to world prices through the tie of the Japanese Trade Agreement to the Chicago market. There is no export tax beyond the cost of export permits.

There is general agreement that an increased use of fertilizer will be required to keep new land in production over extended periods of time and to generally increase total production. The action of restrictions on import of bulk fertilizer in order to protect Thai plant production will, if carried to its ultimate of restrictions on all fertilizer imports, reduce

* per acre or hectare

the demand for fertilizer because of its high costs. Action and reaction on this factor remains to be seen.

To date, Thailand has not had a foreign exchange problem to effect imputs.

E. Market Limitations.

To date, there have been no limitations by Government on sale of grain output other than that imposed by the export limitations covered under the Thai-Japanese agreement. However, studies indicate that Thai corn, as now produced has no real limitations. Theoretically, Japan will take all the corn that Thailand can produce. However, this has not materialized as will be seen in Table V-1. This has caused Thailand to look elsewhere for other export markets and other domestic uses for corn, such as in a livestock industry. In relation to the U.S., Thai corn is at an advantageous price relationship for the Japanese market because of lower shipping rates and a product suitable in so far as the Japanese market is concerned.

4. Institutions.

A. Research and Extension.

Thailand Government activities in relation to corn production in effect started with the introduction and distribution of Guatemalan flint starting in 1952. This started from an importation of 100 pounds of seed and its further multiplication. Also from that time a program of trials and observations on the required agronomic practices for best results

was carried forward and demonstrations made in the corn growing areas. Studies on time of seeding, method of seeding, seedbed and cultivation practices, pests and disease control, fertilization and use of green manures were carried forward and results carried to farmers through demonstrations by the Extension service.

In 1959, a mass demonstration program was carried out in the province of Udon. Every village in the province had at least one demonstration (916 villages). These included all phases of production and all known improved practices.

Since 1957, Thailand, under various cooperating programs and with programs within their own research capabilities, has carried on adaptive research in corn. In 1957 a large number of U.S. hybrids were tried. Also starting in 1958, Oregon University under U.S. contract conducted hybrid investigations. These in general produced increased yields but developed weakness.

A second introduction of Guatemala flint was airshipped from Guatemala in 1960. This was again reproduced and distributed.

Again in 1962, the Ministry of Agriculture purchased an additional 500 pounds of Guatemalan corn which was also reproduced and distributed.

Starting in 1961, a program for the continued testing and improving of corn varieties was introduced in cooperation with the Rockefeller Foundation, as part of the Inter-Asian Corn Improvement Program, which in turn is part of the Center for Maize and Wheat Improvement in

Mexico. From this was developed a joint research project into which all contributors would donate. In 1966, the Thai National Corn and Sorghum Research and Training Program was established, which is a three-way venture involving the Department of Agriculture (Ministry of Agriculture), Kasetsart University, and the Rockefeller Foundation. The Center is located at Farm Suwan, near Pakchong. This Center is also now the Headquarters for the Inter-Asian Corn Program. Thus, the programs of the Ministry of Agriculture and Kasetsart University are coordinated. Resulting from this, all USOM funds from both the University of Oregon Contract and the Crop Development Project along with Rockefeller and contributions from the Thai National Research Foundation funds were grouped under the single program for maize research. Accurate numbers as to research workers in the Thai Government and of those, the number devoted to work on maize are not available. However, in the early stages of the research program it was generally conceded that the number of RTG workers was not so much a problem as their lack of professional training. Under various programs, a total of 56 Thai scientists were trained in the United States for work in the various research programs. A Training Center for corn workers has also been established at Farm Suwan for Thai research and extension personnel, Kasetsart University students, and research and extension workers from other Asian corn producing countries. This project is a cooperative arrangement among the Rockefeller Foundation, A. I. D. (Training), and home country.

Through these various training programs, an excellent staff of trained workers are now engaged in planning and expanding the corn program.

The same is true from a viewpoint of extension workers. Over 2,000 extension workers are on the rolls working in Thai agriculture. Generally, the same basic problems arise in these programs as in others - namely, a bias toward centralization of planning and program direction from Bangkok with a minimum of coordination in the field.

B. Credit.

In spite of various plans to organize agricultural credit, both through Government sources and to encourage private lending through loan guarantees, the bulk of the credit to the corn farmer comes through traditional sources. Kasetsart University studies indicate that corn merchants and relatives are principal sources of credit. A detailed breakdown follows:

Corn Merchants	43 per cent
Relatives	23 " "
Grocers	14 " "
Cooperatives	7 " "
Neighbors	6 " "
Banks	4 " "
Others	3 " "

The usual procedure is for the village merchant to advance to the farmer necessary capital for his seed and what fertilizer is used plus some living cost credit. In return for this, the merchant receives a fixed amount of corn from the crop, regardless of the price of the commodity at time of harvest.

The Calabrian enterprise entered into the corn production and credit picture in 1966. However, for many reasons, which are out of the scope of this report, the company went into receivership.

Commercial credit has made a tremendous impact on tractor availability to the corn producing area. Most of the tractors in the area were sold on credit terms. The contracts vary in length, but are usually for three years. Usually 1/3 of cost is required for down payment. Interest rates are from 10 per cent up.

C. Input Distribution.

Again, except for fertilizer and early seed distribution programs, the private sector has been responsible for the bulk of cash imputs into the program. Fertilizer and insecticides are available through local Distributors. The larger distributors are in addition carrying on training programs for their dealers and have developed through these dealers a type of extension service for the distribution of their products. Seed is generally available in village merchant stores, from the Ministry of Agriculture, or is saved back from previous crops.

D. Marketing and Storage.

The Thai farmers almost wholly rely on village merchants or middlemen for their total market outlet. Except for the Calabrian/Thai installations, there are no large individual interior collection and storage points. In some areas of the corn country, jobbers and brokers operate. Their functions are to deal directly with the farmers, to buy corn from the

producers and move same to the interior market for resale to the country merchant, or occasionally to act as an agent for the country merchant to the Bangkok exporter. The single outlet for the individual village merchant is the Bangkok market. Exporters are very active in this area. Amounts offered by the village merchant can vary from a few 100 kilo bags to truckloads or to barge loads which may amount to as much as 300 tons at one time. Country merchants have developed over a period of time a very close relationship with individual Bangkok exporters.

The exporters in Bangkok are large in number with the most recent estimate totaling 137, but they tend to form associations and then export as a group. With overall corn exports reaching over one million tons (1.4 million tons in 1968), it is obvious that many exporters do not deal in corn alone. Most corn exporters are also dealers in rice. Regardless of the quantity of rice exported, they all contribute to an orderly marketing and to an expansion of the trade.

The general practice by exporters in the past has been to secure an export permit and a sale and then begin to purchase supplies of corn to fill this sale. If he is unsuccessful in filling the order either in amount or at a profitable price, he will default and then start over under another name or organization. There has been a significant penetration of the corn export trade by the Japanese. This in part is due to the Japanese-Thai corn agreement which guarantees not only the Japanese purchase

of corn but a minimum involvement in the exportation of such corn.

Change in the Bangkok exporters scene came with the advent of Calabrian into the Bangkok market and with activities in the interior. The organization of Calabrian drew some of the largest Thai corn merchants together and resulted in the formation of the Titan group, an association of six large local exporters.

Until the current crop year of 1968-1969, the bilateral Japanese - Thai corn agreement was negotiated by the Government. Those of the current year were handled by the Bangkok Board of Trade in cooperation with the Government. The Thai Maize Exporters Association, a subsidiary of the Bangkok Board of Trade, exerted some influence.

Storage in the countryside is varied. Some farmer groups have limited storage consisting of up to 50 ton capacity at village locations. Calabrian has built storage facilities in the country and at collection centers capable of handling 200,000 tons. Other facilities are private go-downs in the Bangkok and port areas.

E. Land Tenure and Ownership.

A Kasetsart University sampling survey in 1959 showed an average of $6\frac{1}{2}$ acres of corn grown for each of the 192 sample farms studied in the corn growing areas. A considerable number of the farms sampled ran to size of some 40 acres and some as high as 100 acres. More detail studies made in 1967 show that farm sizes range from $2\frac{1}{2}$ acres

to 200 acres in the Amphoes of Pakchong, Chai Badan, and Takhli. The averages for the farms studied in these three Amphoes are 42, $44\frac{1}{2}$, and $2\frac{1}{2}$ acres, respectively. From what is known, much of the corn land has been newly developed farms in areas that prior to development were considered as public domain. In the earlier stages much of the corn was grown as a part of the shifting cultivation program carried on in the hill country where ownership of land is still in question. Recent programs of the Government have shown concern about the resultant erosion and loss of forest land due to corn cultivation. This concern will probably evolve into ownership laws and regulations. As indicated from the rapid pace of development of the corn industry, it can be assumed that tenure and ownership have not been a determent in the past but may be to future expansion.

F. Agricultural Education.

There are 25 schools or institutions in Thailand which teach some agricultural courses. These are well spread over the country.

Kasetsart University in Bangkok, University of Khon Kaen, and Chiang Mai University have full agricultural course leading to a B.S. degree.

It is estimated that 40% of school age children are in school. This figure is considerably lower in the rural areas.

Table II-1:/ Physiographic Characteristics of Changwads in the Northeast and Central Regions: Area, Rainfall, Temperature and Relative Humidity

Region and Changwad[a]	Area[b] (Square Kilometers)	Rainfall, 1937-1963[c] (Millimeters) Mean	Rainfall, 1937-1963[c] (Millimeters) Standard Deviation	Mean Annual Temperature[d] (°F)	Mean Relati Humidity[e] (percent)
	(1)	(2)	(3)	(4)	(5)
NORTHEAST					
19 Chayaphum	10788	1108	235		
20 Nakhornratsima	19590	1188	185	81.0	70
21 Buriram	10771	1251	268		
22 Surin	8784	1265	294	81.7	70
23 Srisaket	8813	1410	263		
24 Ubonratthani	22758	1555	278		68
25 Nong-kai	7223	1550	293		
26 Loei	10936	1291	526		
27 Udornthani	16605	1503	212	80.3	73
28 Sakonnakhorn	9539	1398	286		72
29 Nakhornphanom	9749	2258	315		
30 Khon-kaen	13404	1198	254		73
31 Mahasarakham	5760	1271	270		
32 Kalasin	7650	1376	247		
33 Roi-et	7856	1407	237		70
CENTRAL					
Bangkok Plain					
1 Chai-Nat	2636	1210	231		
2 Singh-buri	842	1120	278		
3 Lopburi	6588	1276	289	82.6	68
4 Sara-buri	2963	1482	255		
5 Ang-thong	981	1265	232		
6 Ayuthya	2480	1266	336		
7 Nonthaburi	623	1231	226		
8 Pathum-thani	1497	1402	205		
9 Thonburi	450	1408	262		
10 Phra-nakhorn (Bangkok)	1099	1451	199	81.9	76
11 Nakhornayok	2414	2262	431		
13 Samutprakan	934	1387	269		
48 Nakhornsawan	9677	1220	265	83.3	71
51 Suphanburi	5339	1275	234		
53 Nakhornpathom	2178	1257	264		
54 Samutsongkhram	399	1124	254		
55 Samutsakhorn	840	1416	303		
Southeast Coast					
15 Cholburi	4485	1360	270		72
16 Rayong	3307	1388	283		
17 Chant-buri	6052	3177	439	81.2	78
18 Trat	2919	3493	554		
Marginal Plains					
12 Prachinburi	11795	1976	405		
14 Cha-choengsao	5422	1360	224		

Table II-1 (continued)

Region and Changwad[a]	Area[b] (Square Kilometers)	Rainfall, 1937-1963[c] (Millimeters) Mean	Rainfall, 1937-1963[c] (Millimeters) Standard Deviation	Mean Annual Temperature[d] (°F)	Mean Relative Humidity[e] (percent)
	(1)	(2)	(3)	(4)	(5)
Upper Plain					
41 Uttaradit	7614	1543	321	82.1	72
43 Sukhothai	6841	1313	273		
44 Phitsnulok	9659	1343	297	82.2	73
45 Kamphaengphet	8954	877	311		
46 Phichit	4530	1370	239		
47 Phetchbun	11166	1326	409		
49 Uthai-thani	6472	1079	186		
Western Highlands					
42 Tak	15609	997	207		
50 Kanchenaburi	19486	1000	318		64
52 Ratburi	5120	1206	250		
Peninsula					
56 Phetburi	6357	1156	293		
57 Prachuap-khirikhan	6373	1130	252	80.7	77

[a]The Central changwads are subdivided to approximate Pendleton's physiographic subdivisions (which did not always follow changwad boundaries). See Pendleton, et al. [II-30, Figure 1, p. 36].

[b]Until 1946 Kalasin was part of Mahasarakham. Other, relatively insignificant changes in changwad boundaries and areas have also occurred in the period of the study, but no systematic records of such changes are available. The area figures which are presented here are those found in Thailand [III-18, Table I, pp. 1-3].

[c]Calculated from data in Thailand [IV-2]. For Kalasin, the series began in 1947 (See footnote b above). For various other changwads, some observations were missing, as is indicated in the data which is presented in Appendix A.

[d]Nuttonson [II-28, Table 25, p. 40].

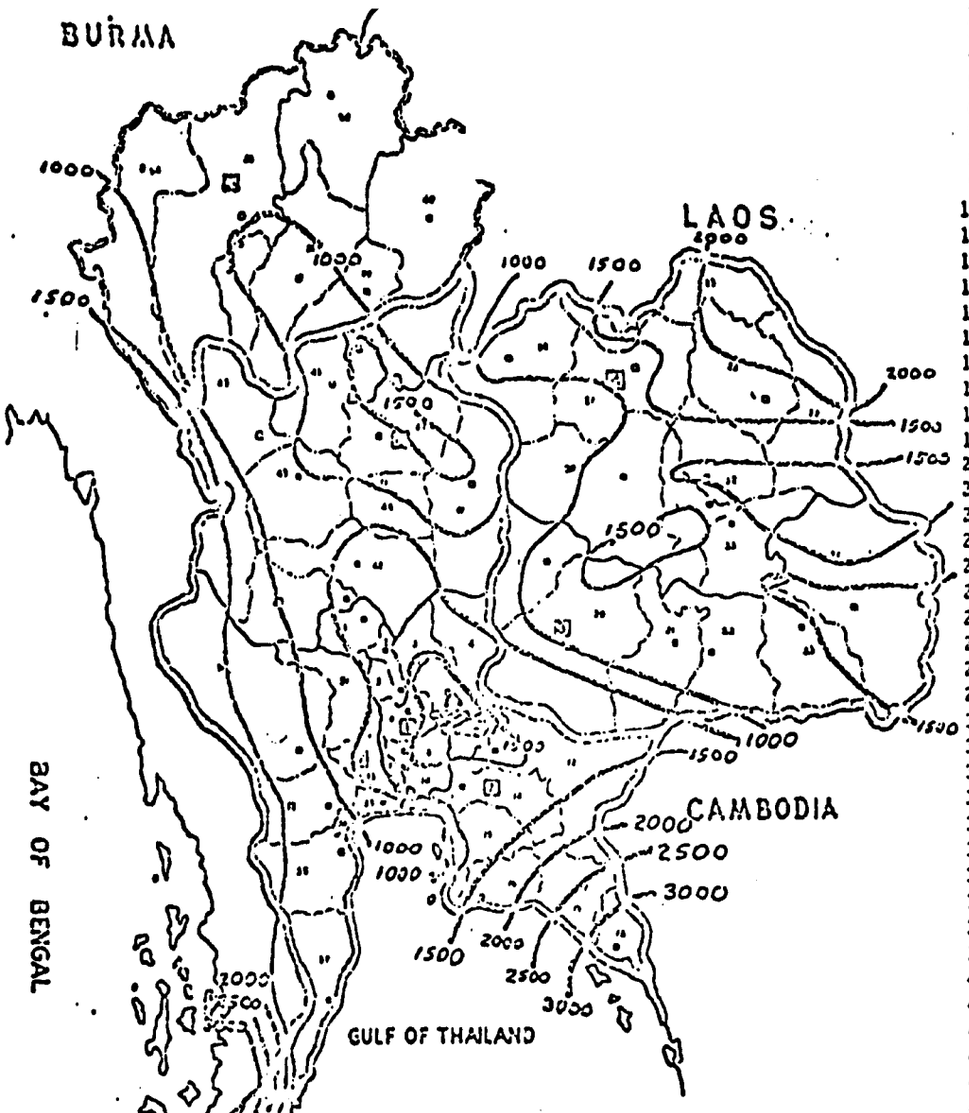
[e]Nuttonson [II-28, Table 27, p. 42].

Table II-2: Mean Monthly and Annual Temperatures in Selected Changwads in the Northeastern and Central Regions[a]

Region and Changwad	Mean Monthly Temperature (°F)												Mean Annual Temperature (°F)	Years of Record
	J	F	M	A	M	J	J	A	S	O	N	D		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
NORTHEAST														
20 Nakhornratsima	75.0	80.4	84.4	85.8	84.4	83.7	82.9	82.6	81.7	80.1	77.4	73.6	81.0	14
22 Surin	75.8	80.5	85.0	86.6	85.4	84.6	83.8	83.3	82.6	81.2	77.9	73.5	81.7	8
27 Udornthani	72.7	77.5	82.6	84.9	84.6	84.0	83.1	82.2	82.0	80.6	77.2	72.1	80.3	13
CENTRAL														
Bangkok Plains														
3 Lopburi	79.2	83.5	86.2	86.7	85.3	83.8	83.1	82.6	82.2	81.9	79.5	77.2	82.6	13
10 Phra Nakhorn (Bangkok)	78.1	81.0	84.0	85.6	84.9	83.8	82.8	82.8	82.0	81.3	79.5	77.4	81.9	27
48 Nakhornsawan	77.4	82.0	86.5	88.5	86.7	85.5	84.6	84.2	83.5	82.8	80.6	76.8	83.3	13
Southern Coast														
17 Chanburi	79.0	81.0	82.8	83.5	82.9	81.9	81.3	81.3	81.0	81.3	79.9	77.9	81.2	14
Upper Plain														
41 Uttaradit	75.6	79.3	84.4	87.8	86.4	84.2	82.4	82.9	83.5	82.8	80.2	75.6	82.1	12
44 Phitsanulok	75.9	80.2	84.6	87.1	85.8	84.2	83.5	83.1	83.1	82.8	80.2	76.3	82.2	14
Peninsula														
57 Prachuap-Khiri Khan	76.5	78.8	80.8	84.0	84.0	82.6	82.4	82.2	81.9	80.4	79.2	76.1	80.7	11

[a] National [II-28, Table 25, p. 40].

...g. II-2: Isohyets for the Northeastern and Central Regions



[a]Isohyets represent contours of equal annual rainfall in millemeters. Isohyets are drawn on the basis of the changwad annual rainfall means in Table II-1 and the map provided by the Hydrology Section of the Royal Irrigation Department in Thailand [III-2 (1961), p. 124+].

Changwads:

1 Chai-Nat
2 Singh-buri
3 Lopburi
4 Sara-buri
5 Ang-thong
6 Ayuthya
7 Nonthaburi
8 Pathum-thani
9 Thonburi
10 Para-nakhorn
11 Nakhornayok
12 Prachinburi
13 Samutprakan
14 Cha-choengsao
15 Cholburi
16 Rayong
17 Chant-buri
18 Trat
19 Chayaphum
20 Nakhornratsima
21 Buriram
22 Surin
23 Srisaket
24 Ubonratthani
25 Nong-kai
26 Loei
27 Udornthani
28 Sakonnakhorn
29 Nakhornphanom
30 Khon-kaen
31 Mahasarakham
32 Kalasin
33 Roi-et
34 Mae-hongsorn
35 Chiengmai
36 Chiengrai
37 Lamphun
38 Lampang
39 Phrae
40 Nan
41 Uttaradit
42 Tak
43 Sukhothai
44 Phitsnulok
45 Kamphaengphet
46 Phichit
47 Phetchbun
48 Nakhornsawan
49 Uthai-thani
50 Kanchanaburi
51 Suphanburi
52 Ratburi
53 Nakhornpathom
54 Samutsongkhram
55 Samutsakhorn
56 Phetburi
57 Prachuap-khirikhan
58 Chumphorn
59 Ranong
60 Phang-nga
61 Surat-thani
62 Nakhornsrithamrat
63 Phuket
64 [illegible]
65 Trang
66 Phatthlung
67 Satun
68 Song-khla
69 Pattani
70 Yala
71 Nara-thiwat

5. Weather.

The climate in Thailand qualifies in the Koppen classification as a "Tropical Rainy Climate" (Warm temperatures throughout the year with no month having a mean temperature less than 64 degrees F. and an annual rainfall of greater than 30 inches.) (See isohyetal map attached). (Also see tables attached for mean annual monthly temperatures for the primary corn growing areas).

Most of the rainfall originates in the Southwest and Northeast monsoons, cyclonic storms from the South China Sea and convectional thunderstorms which arise in the Gulf of Thailand.

The seasonal rainfall pattern is fairly regular, although the fluctuations which do occur may significantly affect agricultural production. The Southwest monsoon breaks over the west coast soon after mid May and is well established over the whole country by June, bringing a season of heavy rains. The Southwest monsoon blows steadily from May to September then gives way to the cooler, drier Northeast monsoon which continues into February. The monsoon pattern is modified by local thunderstorms which in the Gulf of Thailand and by cyclonic storms which originate in the South China Sea and pass over northern and northeastern Thailand in June and September.

The variation of rainfall over space is determined primarily by the topography. The major sources of rain are the Southwestern monsoon, local storms which arise in the Gulf of Thailand and which do not no...

venture far inland, and the cyclonic storms which pass over north and northeast Thailand. Heavier rainfalls, thus, are concentrated in the areas which are southwest of mountain ranges, close to the Gulf of Thailand and/or sufficiently north or northeast so that the cyclonic storms from the South China Sea pass over regularly. Examination of the isohyetal map disproves the assertion that the Bangkok plain receives more rainfall than does the Northeast. Thus, the relative shortage of water in the Northeast results more from the incapacity of the soils to retain water and the topography which encourages rapid runoff.

In summary, Thailand overall has a dry season occuring in November, December, January, February, March, April and part of May. The balance of the year is considered wet.

II. ASSESSMENT OF CAUSES

1. Aggregate Statistical Relationships.

Although not covered above, there are several time series events that appear to be significant in the rather steady growth of corn production.

First: The rather abrupt and sharp upturn in production correlates rather closely in Thailand with the opening of the Friendship Highway, the sharper decline in the area of the incidence of Malaria and the introduction and propagation of the Guatemalan flint variety of corn.

Second: Although not charted here, it is believed you would find a rather sharp correlation between the upward movement of animal protein intake in the Japanese and the production of corn-export in Thailand. Not that the Thai corn production was effective in the broadening of the Japanese diet but the demand there for livestock feeds resulted in a ready market for Thai corn at a price which gave the Thai farmer incentive to produce.

One could also overlay the production of corn with the increase in the import of fertilizer and find fair correlation. This, however, is believed to be due to broadening of the market for fertilizer through commercial operations and to the vegetable-rice crops rather than the corn crop.

2. Input Co-efficient Studies.

Drs. Soothipan and Welsch, as mentioned earlier in this report (see Table / on page 11b) found for Amphoe Chai Badan (Lopburi) that every baht spent on land preparation and weeding returned 4.19 kg. of corn. Further if corn sold for Baht 0.90 per kilogram, they calculated that for each baht spent the returns would be Baht 3.52. The authors caution that their conclusions

based only one year's data are valid under special cases in Amphoe Chai Baban and the same would hold for the other two amphoes. For Amphoes Pakchong and Takli the returns are 3.68 and 4.54 kg. of corn. In terms of bahts spent, each baht would bring baht 2.94 and baht 3.63, respectively.

3. Judgemental Assessments.

Various authors and report writers have given four causes or events which have attributed to the increase of corn production in Thailand:

1. The introduction and rapid spread of Guatemalan flint corn.

2. The construction of the "Friendship Highway" and its consequent opening up of the upper reaches of the central plain and the North East.

3. The relatively successful control of malaria.

4. The availability of the Japanese market for export of corn at prices which allowed production incentives.

All four of these factors took place within approximately the same time span and at the same time period and unquestionably were interacting in their end results. They took place in the time span of from roughtly 1955 to 1962.

It is difficult to assign any one of the above factors the position of prime importance. They happened as a part of an overall development program and were a part of articulated Government and US policy of development of the North East and the economy of Thailand.

The introduction and dissemination of the Guatemalan flint corn was a part of the Government and USOM plan and policy for the

diversification of agriculture in the country.

The malaria control program was supported by USOM and later by WHO. The reduction of death rate was steady after 1947 but the real downturn started in 1952 after USOM participation in the program. Deaths per 100,000 population are attached.

There is some question as to the full impact of the Friendship Highway on the corn program. It is believed, however to have given an initial thrust to the larger breakthrough in production and facilitated the Malaria Control Program. However, soil factors have of late years had more influence in the location of the principal corn producing areas than apparently has transportation. The crop has gradually shifted into the northern part of the central plain where the lighter limestone and sandstone soils occur.

Table II-7: Annual Malaria Death Rates Per 100,000 Population in Thailand: 1937-1962[a]

Year	Death Rate	Year	Death Rate
1937	262	1950	183
1938	234	1951	169
1939	251	1952	139
1940	282	1953	99
1941	268	1954	74
1942	295	1955	63
1943	351	1956	53
1944	329	1957	43
1945	305	1958	38
1946	283	1959	33
1947	297	1960	30
1948	243	1961	25
1949	202	1962	24

III. U. S. ROLE

1. Policy Influence.

Thailand has a long history of rice production as a single basic crop. The low gradient and abundant water in the Central and Southern plain areas were inducive to this crop to the point that Thailand had an export history of rice prior to the introduction of USAID assistance. One of the first agricultural programs supported by AID programs was that of crop diversification. Of this program, corn received the most attention.

Records show that early agronomy advisors such as Dr. H.H. Love and Howard Ream were early instigators of a crop diversification program. It was Dr. Loves' recommendation which led to the development of a separate Rice Department which would concentrate on rice and leave the rest of the Department of Agriculture to work on other crops.

As a result of this early work, a whole series of new crops were tested and their use encouraged, especially on the newly opened lands and in the areas other than the central and southern plains. As a result, today Thailand has relatively important commercial crops in cassava, kenaf, castor bean, edible legumes as well as fruit and vegetables. Of all the crops used in the diversification program, corn has become the largest earner of foreign exchange and is the second major crop. In addition to the work of the Crop Development Program sponsored by USOM, there were programs of road development financed by AID funds in addition to the Friendship Highway. A large portion of the new lands were cleared

and made ready for cultivation by USAID procured and financed equipment. Rural areas where corn is grown were assisted by USOM sponsored and assisted Community Development and Agricultural Extension programs and with technical assistance in the formation of credit and marketing cooperatives.

It is difficult to assign statistical values to the inputs into the corn program. The total expenditure on the Crop Development Project (US and Thai contributions) was $7,129,000 through 1962. Since that date, Agricultural programs have expended $2,335,000 (U.S. contributions only). Of the seven million plus expended prior to 1963, $2,491,000 was U.S. dollar contribution.

By 1963, 17 US Agricultural advisors had served with the program of crop development for a total of 41 man years. In addition, also to this period, USOM funds had provided US training of six months or more for 43 Thai participants and an additional 60 participants had received short term third country training.

Approximately one-third of the US dollar input was spent for commodities such as transportation, equipment and scientific materials.

As stated earlier, US funds and procurement were responsible for the first and second introduction of source seed of Guatemalan flint corn.

The period prior to 1963 is considered the more important time period of the success of the program since this covered the introductory and dissemination periods of the industry.

Since 1962, work has continued on improvement of the corn crop. However, research and variety development of the crop has been delegated to the Rockefeller Foundation since continued assistance to the extension and cooperative activity have continued with an upgrading of technician programs and work to make the system more effective. Best estimates available are that no more than 10% of US input in the agricultural sector can be attributed to corn.

2. Physical Inputs.

US actions were present and generally accountable for the initial impetus to the corn development program. While small in amount, the introduction of the source seed and the assistance in increasing it at the research stations and through contracts with selected farmers are basic to success in establishing Thailand's corn industry.

Although the push in 1959 to establish corn production in Udorn province through mass demonstration was not successful in establishing this province as a major producing area, much valuable information was obtained, this has provided guidance in carrying successful throughout the country by the Thai extension service under the auspices of the USOM. The principal corn producing area occur in nine changwats of which Lopburi, Makhon Sawan, and Saraburi are the most import (see Map on page 25).

Other than the seed, fertilizer demonstrations and extension work coupled with other US programs of road building, malaria control, land clearing, and steady attention and encouragement to the program could be considere the primary US inputs. The overall success of the program must again be considered in the light of the several economic factors such as a ready market, expanding economy and land expansion. The US physical input into expanded transportation facilities were large, market development minimal. It can best be said, that the US inputs into the corn program at that time were the right catalystic agents.

3. Technical Assistance Inputs.

As previously stated, a total of 41 years of technical assistance by US experts can be accredited to this program. These people were primarily responsible for the introduction of the variety and its initial multiplication. Work they initiated or assisted in agronomic practices such as spacing, cultivation, fertilization, time of planting, all led to improvement in net yields per unit of land. Basically, they can be credited with the idea of the need for diversification from rice into other cash crops of which corn is the leader. They further assisted in the implementation of the policy which developed from this idea.

4. Overall Effectiveness.

This one program of crop development has paid for itself many times over. Corn exports have brought a FX income of $326,950,000 to Thailand for the period 1960 through 1967. (6,539,000 MT exported at $50.00 per ton).

Of itself, US inputs to the corn production story can be considered small. Corn production received special attention but was only a part of the overall technical assistance program.

IV. ECONOMIC, SOCIAL AND POLITICAL RAMIFICATIONS.

1. Differential Adoption of New Technology.

Overall acceptance of the new variety has been almost total. It is estimated that at least 90% of all the corn grown in Thailand is of the Guatemalan flint variety.

Acceptance has been two phased. Guatemala corn, in view of the demand for it, quickly replaced traditional varieties among farmers who had been growing diet corn and was generally the only variety used among new producers growing corn for the first time.

There is little evidence that size of farm has had anything to do with acceptance of the variety. The bulk of corn produced in Thailand is still produced on small plots although several times larger than rice plots as a dry season crop. Size of planting on most farms is probably more related to availability of machinery for land preparation and labor at the time of planting, and the success of the wet season rice crop than to other factors. However, there are larger units (25 - 200 acres) producing corn on newly cleared and unlevelled lands where corn is the only major crop for that unit.

2. Differential Availability of Inputs.

None known.

3. Income Distribution Effects.

The larger farmer who has either speculated in development of new [illegible] because of corn crops or through desire of officials and business men to broaden the base ofcapital distribution probably has the

edge on the traditional farmer in direct income from his enterprises. The traditional farmer sells his corn generally through the village merchant. His crop is pledged against his living expense and other expense debts to the merchant. One study made by Kasetsart University indicates that the Thai farmer receives about 62.2% of the export price. His cost of production is estimated at half this figure.

Generally, for the smaller farmer, corn is a cash crop grown in conjunction with his subsistance rice. It is one of the crops he grows for cash income in order to purchase goods and services outside of subsistance farming patterns.

In some cases, rice farmers from the Delta also have a corn farm in the highlands and migrates there in January-February to get a March-July crop of corn. He then returns to the Delta for July-December crop of rice.

4. Employment Effects.

Corn, being primarily a second or dry season crop has little effect on the overall employment pattern of the rural areas. If it were not grown, the labor would be under employed or unemployed.

From this viewpoint, the growing of corn can be considered to be a net contributor to the productive use of the existing labor force and not a drain on or in competition with other demands on labor.

Again, a direct tie to or measurement on the use of machinery in the crop is difficult to assess. However, the fact that Thailand is reaching the figure of some 10,000 tractors per year imports is indicative of the impact of corn on the mechanization of farming. As yet, the tractor industry

has not developed a large impact on the rice culture.

Any trip through the North East and the corn growing areas of Thailand will amaze the viewer with the large number of tractors in those areas.

5. National Aggregate Economic Effects.

Using 1967 figures, Agricultural production had a value (converted to dollars at constant prices based on 57-59 index) of 828,8000,000. Of this total, corn was valued at approximately 5,500,000 dollars. Since this is the export figure value, then corn produced some five and a half million dollars in 1967.

6. Inter-Sectoral Effects.

Indicies of Agricultural crops has risen to 159 over the 57-59 base. It is assumed that corn rose with this. The steady increase of farm machinery has already been noted following the same curve as increased production in corn and related dry land crops. In all probability, tractors and pumps have accounted for the larger share of the import increase in farm machinery. Fertilizer imports have arisen as shown at a steady rate. However, little of the fertilizer import and consumption use can be attributed to corn.

7. Political Effects.

There has been little or no marked change in political organization or expression over the period under study. There has been a buildup of the communist inspired action in the North East part of the country. The impact of the corn production program on conflicting this buidup has not been estimated or measured.

V. PRODUCTION AND DEMAND PROJECTIONS.

1. Domestic Demand Projections.

Export demand for this crop should continue to grow over the next five years. Faught and Raskin in their reports indicate that there is no reason to believe that Japan iteself would not take all the corn of the quality grown in Thailand. However, because of difficulties in negotiating a price suitable to Thailand and Japan, the tonnage of rice exports to Japan have decreased. In addition, the Hong Kong, Singapore, Taiwan and Korean markets continue to grown. Thailand is in at least a five dollar a ton competitive edge over the U.S. for this product due to shipping rates. For this reason, the controlling factor on corn production will hinge on use of fertilizers and opening up of new lands more than on market demands.

There remains the possibility that the work of the Thai National corn and sorghum program being operated by Ministry of Agriculture, Kasetsart University and the Rockefeller Foundation will come up with a break through variety which will replace Guatemalan flint within the next five years. This, coupled with increased use of fertilizer and improved cultural practices could vastly increase production. Production of corn per unit of land is not high compared to U.S. standards. The knowledge and other elements are available for increased production of corn.

Increased domestic use of corn is a possibility. There is considerable attention being paid to the possibility of setting up livestock industry as well as

a broiler industry in the Northeast and exporting the corn through this industry rather than in the form of grain. If this works out, it could greatly influence the domestic use of the crop.

Production of corn has leveled off during the past three years. It is expected to hold at least the average level of the last three years and to increase on a somewhat lessening curve over the coming five years.

2. Production Prospects.

The RTG has set its targets on a doubling production during the next five years. This increase will come through increasing the yield per unit of land rather than through an exportion of the area in corn.

VI. REQUIREMENTS FOR PRODUCTION PROJECTION

1. Physical Input Requirements.

It is estimated that there is considerable leeway for increased production of this crop through increased production per unit of land cultivated to the crop. As stated, only about 5% of the corn crop is fertilized. The TVA study states that conservative estimates give an expected increase of 50% over present yields for approximately 30% of the acreage if proper fertilization practices are followed. Thus, an overall 15% increase in yield on existing acreage is obtainable. This would mean a crop of approximately 1.4 to 1.5 million MT.

Again, TVA estimates of need for fertilizer for the corn crop to reach the proposed increase is the application of 29,180 MT of 12-12-6 complete fertilizer. This is estimated to give the farm a 2:1 income return. It is difficult to estimate the crop pattern in the Northeast when the PaMong and other irrigation schemes come on the line. What percentage of the millions of acres under these projects will be devoted to corn and other crops and what to rice is difficult to predict. However, if the present trend of possible lessening of the rice export market potential materializes, corn would be one of the benefiting crops and acreage should increase by as much as 40-50%.

2. Institutional Requirements.

Again using the TVA report, it is stated--"the single most detrimental factor to the expansion of fertilizer use (and thus crop production) in Thailand is the lack of credit to farmers and the hesitancy of distributors

to assume a larger credit burden."

From the above statement, it can be seen that the Thai Government and USOM policy of assisting in encouraging and organizing credit to the farmer are required in the overall development program. These programs are underway through the Amphur farm groups, cooperative encouragement and through assistance from banks, including the Bank of Agriculture and Agricultural Cooperatives.

It is questioned that additional infrastructure in extension and research is required. More effective use of that available will be required. Results from the corn and sorghum research at Farm Suwan, and the work at The Agricultural Center Northeast, and Kasetsart University on varietal improvement and the combination of all Ministry of Agriculture Extension people into one Department should provide the necessary base for production increases.

3. Policy Requirements.

There are several desirable changes in policy which would enchance the production potential. Such moves as recommended by Raskin in the control of exporters, a better grading standard with price differentials, some increased storage and drying facilities, better price and market reporting are all desirable. One of the critical requisite at present is the resolution of the import policy on fertilizer. Government action limiting the export of bulk fertilizer to protect the investment in the Mae Moh complex and the possible regulations against the import of mixed and bagged fertilizers could hold back development.

4. Input Availability.

When and if the import restrictions on fertilizer are overcome, there appear to be adequate inputs available. Corn will probably continue to require a complete fertilizer as recommended in a 2-2-1 mix.

It is possible that up to a 30% increase in production is possible with the use of fertilizer on the present variety. However, it would seem logical to let the crop take its own expansion course without too much regulation at least until Farm Suwan at Pakchong has developed and tested new varieties with the same export demand qualities as the present variety before any great push is made for increased acreage or fertilizer consumption use.

VII. SELF SUFFICIENCY, EXPORTS AND DIVERSIFICATION.

1. Estimate of Likelihood/Date of Self Sufficiency.

Country presently 15% in an export position on this grain.

2. Possibility of Comparative Advantage for Export.

As stated previously, Thailand has an export advantage to the prime users of Japan, Korea, Taiwan and Hong Kong over other major corn production countries. There is at least a $5 per ton advantage in shipping costs. A second advantage is the variety grown. The Guatemalan yellow flint has characteristics the Japanese want in color, protein and carotene content. In addition, its flint characteristics make it easier to dry, store and ship without excessive loss. The bulk of U.S. corns for export are dents.

Fertilizer of the kinds needed are available on the world market and will be imported by private companies such as Esso unless Government restrictions on imports become a block.

3. Possibilities for Diversification.

As previously stated, corn is part of a diversification program from rice at the national level. From all indications now, there is an available export market which will take all the corn that Thailand will grow over the next five years.

4. Policy Commitment to Above Options.

Not applicable.

5. Choices of Full Input Import Requirements not Met.

Lessening of fertilizer imports (the only limiting factor now) will result in no expansion of the corn export program coupled with a lowering of per unit production. Lack of fertilizer imports to keep present lands in full

production could result in the unwise opening of new lands on steeper slopes. This will run against Government efforts toward lessening of erosion and better control of forest lands.

VIII. FUTURE U.S. ROLE AND CHOICES.

1. Policy Influence.

Policy influence by the U.S. on this program should continue to be light. There is always the risk of stirring up controversy of assistance to corn production in countries which are exporting in competition to U.S. production (which Thailand is).

Most needed and probably most effective U.S. involvement in the program should be with encouragement of credit availability to the producer. This in effect is needed for all agriculture in the country and will be only a part of a program for development of a strong agriculture base.

2. AID Requirement.

Other than continuing interest in and contribution to the credit program (One advisor) and continuing assistance in improving the performance of the extension program. The necessary research is in good hands.

IX. FUTURE RESEARCH NEEDS

1. Technical.

Continued varietal testing and development is required. With each new variety, there is required a field testing program for location adaptation. Along with it is required continued testing of fertilizer and cultural practice requirements and responses.

2. Economic and Social.

Empirical research is already underway in the effect of irrigation on the people of the Northeast, on the effect of the dams on cultural habits and industries, etc.

The only further research in these areas recommended is a review of that already done and some attempt made to put it to use.

X. ECONOMIC, SOCIAL AND POLITICAL IMPLICATIONS FOR FUTURE.

Corn is a diversification crop away from a primary rice agriculture. As import nations continue to expand their higher protein diet, the place of corn as a feed grain in the area becomes more important. This shift in diet in Japan accounts for the growing demand for feed grains to that country and has marked the expansion of the Thai production picture.

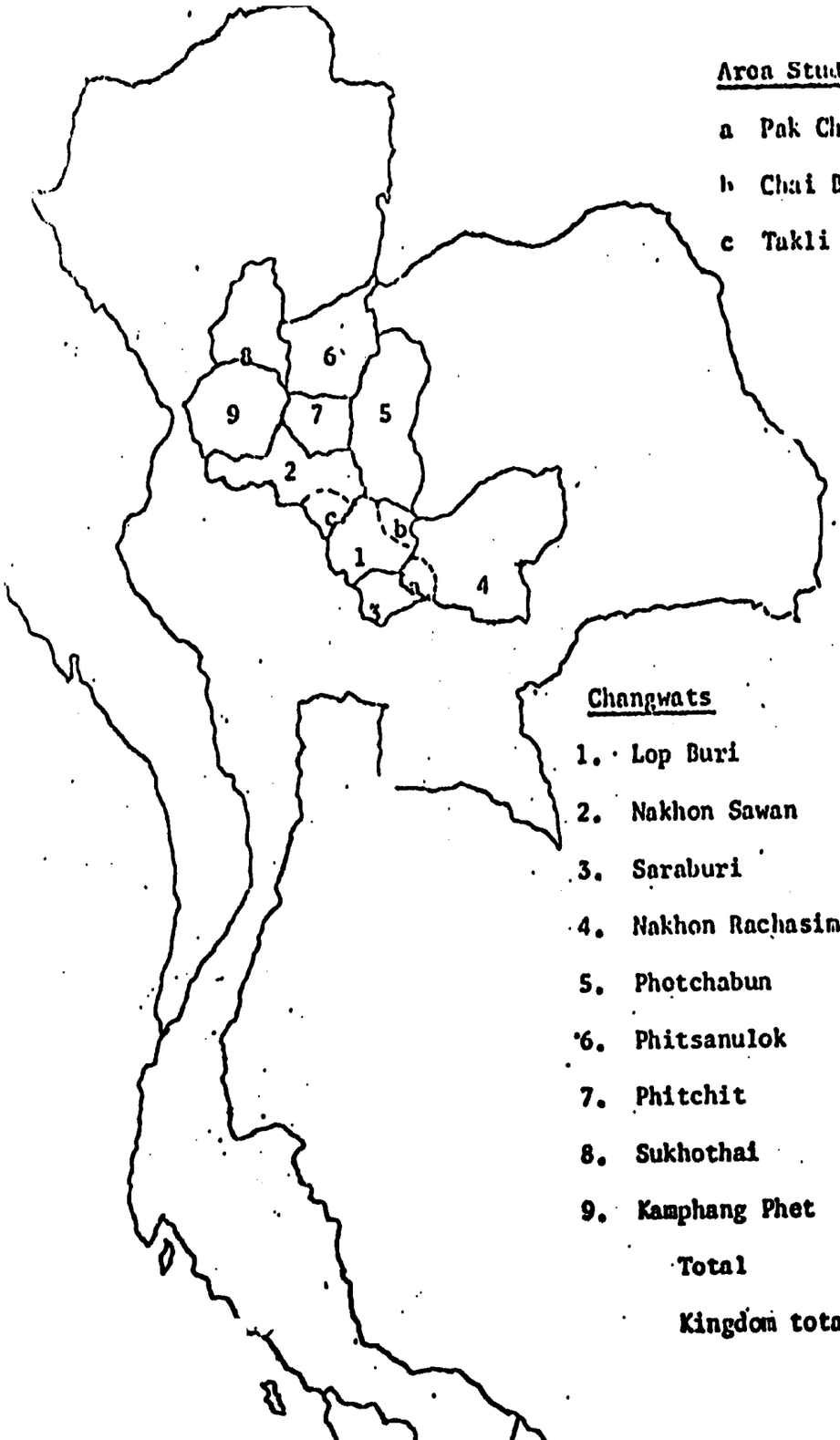
It is possible that the expanding Thai economy and concentration of people into urban areas will expand the demand for higher protein food in that country. This increased demand should result in increased prices and hence a greater profit for livestock growers. The production of feed grains and corn could result in them being fed to domestic livestock with a resultant expansion of the livestock growing and feeding enterprises as well as the connected slaughtering and marketing industries.

The growing of corn as a second or dry season crop utilizes the labor that is largely idle during that season in a rainy season rice culture. Corn is a cash crop. As such, it expands the cash market in the country resulting in expansion of merchandising into the rural areas.

Corn as an export crop is a valuable earner of foreign exchange. Under present conditions of expansion of rice production through increased yields per unit of land and the possibility of decreased use of rice per capita, corn as an export and earner of FX could become more important to the Thai economy.

As long, as the present policy of relatively free trade and enterprise in the corn industry is followed, there should be no adverse political results from Government and AID assistance to the crop.

Map 1 Corn Location (9 changwats) in Thailand (Five - year average 19[illegible]/66)



Area Studies	% of Total Area Planted (Kingdom)
a Pak Chong	3.2
b Chai Badan	16.2
c Takli	12.9

Changwats	% of total Production	% of total area planted
1. Lop Buri	27	25
2. Nakhon Sawan	26	26
3. Saraburi	17	15
4. Nakhon Rachasima	4	5
5. Photchabun	4	4
6. Phitsanulok	4	4
7. Phitchit	3	3
8. Sukhothai	2	2
9. Kamphang Phet	1	1
Total	88	85
Kingdom total	100	100

Source: Calculated from Faculty of Economics and Business Administration, Kasetsart University, Production Data for Major Thai Crops and Livestock, by Regions, Changwats, and Years: 1949/50-1965-66, November 1967.

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UNITED STATES GOVERNMENT

Memorandum

TO : EA/TECH/ARD, Mr. Don Davis DATE: April 7, 1969

FROM : PPC/POL/ES, Edward B. Rice

SUBJECT: Thailand Corn Paper

(1) The Thai corn story is a control case, since it involves rapid adoption by farmers of a new technology (the Guatemala flint) without the introduction of the "miracle" high yield hybrids. To be useful, the story should analyze the adoption process, and, from the charts in your Paper, I assume this really means the period 1955-1963, especially the first five years. We should be asking the same questions for that period that we are asking of Turkey, India, Pakistan, Vietnam, and the Philippines for the last four years, i.e., what were the respective roles and relative importance of (1) the seed itself (which means we need some rough comparison of the yield and profitability of flint with either the dent or whatever else farmers were growing before they adopted flint), (2) extension (were most flint farmers in contact with the extension service, etc.), (3) credit (what percentage of the pioneer flint farmers needed credit), price policy (when was the Jap-Thai agreement signed, and what were corn export prices during the whole period), an organized GOT promotional campaign (if any), and the other explanatory variables.

The information in the Paper doesn't really cover the 1950s, except for general statements about the Friendship Highway, malaria, and the fact that the GOT "assisted in seed dissemination". Notice that the draft Paper doesn't even give a date for the Friendship Highway, and, to accept it had something to do with opening the North East, the reader ought at least to be informed when the road was completed through the major corn districts. Without more of this data we won't be able to use the Thai corn story as a control. I realize there are major information gaps, but there ought to be some material available to give us a better feeling for the sequence of events, the prevailing market prices, and the importance of different institutions during the 1955-1963 period.

(2) I've itemized below the principal omissions in the Paper, arranged as in the Paper's outline. Some deal with gaps in the 1955-63 story; some with other sorts of missing material.* I'll need your judgment as to how much of the missing material can be secured and how soon.

* The most important omissions are preceded by an (*)

5010-106

I. 1A (page 3) Is there an error in the 1967 figure for area planted?

2A (page 4) Paper says that by 1959 flint covered 85-95% of area, but this is inconsistent with earlier comment (page 2) that the 113 dent was the major variety from 1954 to 1959.

2 B (page 5) The 1965 figure in the Table (1,480,000) is different from the figure on page 3 (1,442,000).

2 C (page 6) How much was the "limited production" from the Mae Moh plant? Can you provide a figure for 1967 to compare with imports. The problem may simply be an error in the "1962" figure. The Thailand rice paper says the plant didn't come on-stream until 1967.

(page 7) There are apparent inconsistencies in estimates of how much fertilizer is used for corn. On page 7 the paper says 5% of imports is used for corn. On page 12 Paper says a survey found only 2 farmers out of 62 using it. Yet figures and comments on page 116 (relatively high cost of "land preparation") and elsewhere suggest fertilizer is a pretty important input to corn. What is real situation? What percentage of all corn farmers use fertilizer?

2 E (page 8) Paper should relate pesticide discussion to corn. Are any being used on corn?

2 F (page 8) Can you give any estimate of the percentage of corn land which is mechanized during preparation and harvest periods? 10%? 80%?

* 3 A (page 8ff) This section should provide price information for 1950-1963, including comparison of dent and flint prices, and giving both market and support prices. Discuss the Thai-Japanese agreement - dates, etc.

* 3 C (page 12) We need to compare profitability of flint with dent (or whatever other crop present corn growers were growing before they adopted flint), especially in late 1950s. Ideally we should show profitability of other crops which could be grown on present corn acreage.

(page 12) Is there an error in either the 2 out of 62 farmers report or the 25-75 Baht "range". If not, then I assume one of the 2 farmers spent 25 Bahts on fertilizer, and the other spent 75 Bahts.

* 3 C (page 13) Paper suggests net return to farmer is small, but data briefly introduced on pages 28 and 29 suggest it is not (that in fact the return is of the order of 3 to 1). This is a crucial issue, and must be explained.

* 4 A (page 14 ff) Paper needs to say much more about role of extension in spreading flint (1955-63).

* (page 15) With regard to research, has adoptive research program mentioned in middle of page produced improved flints which have significantly replaced the pioneer Guatemala flint? Or is the flint now grown the same as the one Love brought in in 1952?

4 B (page 17) How many pioneer flint farmers needed credit?

(page 18) Paper should describe the Calabrian enterprise since it refers to the latter several times.

(page 18) Paper says credit is important for tractor buyers, but doesn't say how many corn farmers own or borrow tractors.

4 C (page 18) What was the mechanism for getting seeds and fertilizer distributed in the late 1950s = the private sector? extension?

* 4 E (page 20) 1959 survey says average corn holding was $6\frac{1}{2}$ acres. 1967 survey says 42, $44\frac{1}{2}$ ($2\frac{1}{2}$, though this must be a mistake). Are we to believe the corn business has switched from small farmers to large farmers, or that the sample areas were very different?

4 F (page 21) No relation to flint story. Did the schools and institutions have anything to do with introducing flint in the late 1950s?

5 (page 26) We need to know whether weather conditions were particularly favorable to corn growers 1955-63.

II. * 1 (page 28) What are the dates for the Friendship Highway, particularly in the corn areas? Also, relate the malaria issue to the present corn area - was malaria particularly bad in the area and had to be cleaned out first.

* 3 (page 29) This is where Paper should discuss the 1955-63 era, identifying the factors that made the difference. In fact, the Paper does just that, but provides almost no hard data either here or elsewhere to support the conclusions.

III.	1	(page 32ff)	I would like to see a fuller discussion of the U. S. influence on introducing Guatemala flint, but this has lower priority than the issues raised above.
	2	(page 35)	Ditto, though I think Paper should say something more about the percentage of trunk and feeder roads (and land clearing operations) in the corn areas which were paid for by AID.
	3	(page 35)	This discussion is inadequate, but again it has lower priority and anyway we have the USOM 1963 Report to refer to.
IV.	1	(page 37)	This is inconsistent with apparent shift to large farms in last eight years (see 4E above). Latter may be my misinterpretation of the data, however.
	4	(page 38)	Paper suggests corn gets most of the tractors. Is this true?

To: Edward B. Rice, PPC/POL/ES

From: Don Davis, EA/TECH

Subj. Thailand Corn Paper.

Following is a point by point fill out to the best of the knowledge we have.

1A, Page 3. This is a typo. This should be 1,320,000.

2A, Page 4. These are quotes from two different sources. The statment that 113 became the commercial major variety from 1954 to 59 is from a Thai Div. of Agric. Report. The statment that by 1959 that Guatemalan flint made up from 85 to 95% of the corn grown in Thailand is from a USOM report. It should be understood that it was not until 1960 that Guatemalan flint became available on a wide scale to all growers. Also, these years were the years of what push was made by the Government to put over the new variety.

2B Page 5. The figure of 1,480,000 is from the FAO report on world production. Again a different source. There are two sets of figures in Thailand, one from the department of statistics and the other from the Ministry of Agric. There is considerable rounding off of figures.

2C, Page 6. I do not have a figure for the 1967 Mae Moh production. It is correct that the Mae Moh plant did not come into production until 1966 when construction was completed and real production did not start until 1967. The ferterlizer complex there has a capacity of 200 tons per day from the ammonium sulphate complex and 90 tons per day of urea. There is a project for a 665,000 ton per year capacity proposed which does not show to be in production by 1968, latest figures we have from FAO.

Page 7. There are no figures published that I can find on how many farmers use fertilizer on corn. The concensus of officials is that only a limited amount of the fertilizer used is on corn. The survey which reports 2 farmers out of 62 using fertilizer was from the North East plateau which is outside the primary corn growing belt as far as production is concerned. The 5% is

an estimate.

The story on fertilizer use on corn is a developing one. As the corn lands expansion ceases to grow at the earlier pace, then fertilizer becomes more important on the older corn lands with loss of fertility through use and leaching. There are at present no studies that I have found on the cost benifit ratio of fertilizer use on corn. The N. E. center is initiating this study but results will not be available for another two to three years.

2E, page 8. The only pesticide being used on corn is through the research work of the Ministry of Agric. and the N. E. center. This is negligble.

2F, Page 8. I asked the question of three different officials as to how much mechanization was used in corn production and got three different answers from very little to approximately 50%. My personal estimate from observations in the area would rϕun to around 35%.

3A. I did not find any price information on corn prices prior to 1960. These are shown from '60 on. (Export). Export prices of corn have been governed by the world market price of corn which is almost univeraally determined historically by the Chicago Market. For Thailand, this means the Chicago price less the difference in freight costs between Bangkok and port of delivery to that of US shipping points and points of delivery.

As to support prices, this, as stated,first became effective in 1966 but has never been used. Prior to support prices, prices to the farmer and buyer were determined between buyer and grower with the ~~grower~~ buyer-exporter having his price determend by the export price he could get as generally established by the world market and export price. As stated by Raskin, corn exporters seldom purchase any corn until they have an export permit at a fixed price. They then enter the market to purchase. If they can purchase so that a profit results, they do so. If they cannot, they renig on their contract and start over with a new export permit (generally under another firm name but still the same buyers.)

Re prices of corn prior to 1960. I find no reports on price of corn prior to that time. A report by Breightdnbaugh submitted in 1963 states that in 1950, that only 218,000 ria (54,000 acres) of corn were planted. This was values at ฿29,100,000 ($1,452,000). He reports that 10 year s later, 14,862,000 acres were planted valued at $33,142,500. He further states that during that period, area planted to corn increased more than 800% and that production increased more than twenty times over that of 1950.

Re the Japaneese trade agreement. This agreement was negoitated to become effective in 1962. Until 1968, the agreement was made between Governments. In 1968, the negoiatinns were turned over to the Bangkok Board of Trade. As stated, the agreement was dropped in 1969. The formulas for the agreement are stated in the report.

There are no published figures that I can find comparing the prices between dent and flint corns. I would assume that there was a discount for dent after the flint became dominant primarily through the larger demand for export of the dent. flint. I give the reasons for swithh to flint corn in/ to the reports that the flint variety, Guatemalan, consistently outyielded the native dents by an average of 30% per unit planted without additional imputs and to the fact that there was a larger demand for flint due to its higher protein and carotene content and its better keeping qualities in transit in a tropical climate.

3C, page 12. As stated above, there are no figures that I found comparing profitability of flint with dent. One could assume that the increased average yield of 30% of flint over dent was a major enough factor to the corn producer to cause the shift. In later years, the 1960's, there has been an increase in other export crops from thialand as cash crops, these are Cassava and kenaf. However, during the 50's and first years of the 60's, the markets for these crops had not been developdd to the point of prifit for the grower, hence

corn, with an established market and easily grown on newly cleared lands was a natural choice for the grower. As stated previously, most of the corn acreage increase was on new lands.

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3C Page 13.

Data questioned re this point is for the return to be derived from two cultural practices; "land preperation and weeding'. As stated, careful attention to these two cultural practi ces will bring in a good margin of profit. This through increased production due to better seed bed and the lessening of competition of weeds. Their study, unfortunately did not include other imputs such as labor, countour planting, etc. which are a part of the total package imput along with fertilizer and insecticides. Hence, the supposition that net return to the farmers is relatively small but suffecient to give them incentive to grow corn can hold.

Re fertilizer imputs on corn. Again from Brietenbaugh paper it is stated; 'Preliminary studies have indicated the probability the open pollinated Guatemala corn responds ppp poorly to fertilizer usage---the germ plasm components capable of responding to fertilizer applications have probably become so masked by other components incapable of such response that Guatemala corn is no longer highly responsive.'

From the above, it can be assumed that through this series of trials, it was found that without response, it would be unwise to push fertilizer use on the Guatemalan variety. They go on to state in the paper however 'However, whe unfertilized, the new releases (Guatemalan) will still produce substantially more than does the old variety.

4A, Page 14 The role of extension in the distribution of Guatemalan flint and its acceptance.

As stated, the original introduction of 100 pounds of Guatemalan seed was was in 1952 and multiplication was carried on at the Tha Pra and Bangkhen stations. The next year, this was distributed to selected farmers for further multiplication. From these multiplications, seed was secured for demonstrations in each of the corn growing areas ////// . The Extension program, through its demonstration programs carried on corn demonstrations with this variety in each of the subsequent years in conjunction with the plant development departments crop improvment program. This is not a partiticularly intensive campaign until the mass demonstration projects in 1959. In all truth, we can say that the extension effort was effective in that it showed farmers the new variety and let them know where to get the seed. This is part of any extension pr9gram and as with nearly all good things, does not take a lot of pushing beyond simple demonstration and seed availablility.

Page 15. Re research by Rockefeller et al.

The Thai National corn and sorgum research center has not released for distribution any new varieties to replace the Guatelaman flint. They have developed some very promising new flint varieties which are more responsive to fertilizer. These are under adaptation trials on various farms and stations in the country. The anticipate release of one or more new varities within the next three years. At present, the /// Guatemelan flint variety is the pre dominant corn used.

4B page 17. No data on how many peoneer flint farmers needed credit.

As stated, nearly all farmers, in any enterprise need credit in one form or another. The credit picture is changing as to a possible source of credit. during the expansion period of Guatemalan flint production, the only source of credit available was the traditional family-merchant source. This was used.

Page 18. The Calabrian story. This is attached in as clear a form as I have seen.

4C, page 18. Seed availability.

In the late 50's the source of getting seed was largely from the private sector of the merchant. Source seed was multiplies by the Ministry of Agric. on its stations and through contract farmers, then distributed to selected farmers from where it reached the market and the merchants. Much of seed sown was held back from the previous crop by the individual farmer.

As to fertilizer, except for research and trials, the only fertilizer available was through the private sector.

4E, page 20. Between 1959 and 1965, corn acreage more than doubled. This acreage increase came largely through the development of new lands through clearing and cultivating the lesser slopes surrounding the major rice production areas. I would believe that this would account for the increase in the size of holdings since the newly cleared lands were generally not suitable for paddy rice production but were for corn. The 21 acre figure for Takhli is what the report says. Takhli is one of the furthest provinces from the port of Bangkok and hence one of the most expensive places to produce corn for export, hence, it is possible that corn is being produced on smaller plots. Further, this is one of the least opened up of the provinces from the viewpoint of transportation since water transport is the main source down the river to Bangkok.

4F, page 21 Relation of schools to distribution of corn program.

I find no evidence that the schools as such were an instrument for the distribution of corn or were involved in the extension process.

5. page 26. Favorable relationship of weather to 55-63 seasons.

There is no reason to believe that this period was a severe swing in the weather cycle, therefore being especially favorable to corn production.

Since most of the corn crop is grown during the dry season and more dependent on hold over moisture and early rains for ripening, the normal variations in the wet season pattern would not have too great an effect. From other studies I have seen, the normal ten year pattern is to have 4 years below average, four above and the other two close to average.

II. 1, page 28. Friendship highway.

Work on the Friendship highway started in 51 and was completed in 57.

The highway was progressively worked from the Bangkok end and should have reached the foothills north and East of the central plain in 57. Thus, the highway was effective in the major portions of the corn producing areas at the same time it reached the foothill area.

Incidence of malaria was relatively widespread and even in distribution. It control is primarily important in the corn story in the relationship of human energy to production. The debilitating effect of malaria, where prevelant, reduces the energy required to enter into another crop within the year such as was required for corn production. Its control leaves the farmer with energy and strength to do more than the minimum required for him to grow subsistance food.

3, page 29.

Unfortunately I have no further hard data available.

III. 1, page 32. US influence on introducing Guatemala flint.

~~It/was/thrown/~~

See following page and make special note of footnote and also handwritten side note.

D. The Introduction of "Guatemala" Corn

One of the early activities of the Thai-USOM Crop Development Project was the introduction and observation of large numbers of crop varieties. Among these corn was one of the most important. In 1950 and 1951, under Dr. Love's direction, the program introduced a collection of corn varieties from the U.S. and a second collection from Indonesia, where the Dutch had been active in corn research.

In 1951 Mr. Howard Ream assisted in the plant introduction work together with Mr. Somchai Dhamnoonragsa. From their observations, one variety among the Indonesian collection especially impressed them. The variety responded better to local conditions than did the American material. It yielded well and the grain was a flint type with a beautiful golden yellow color. The variety was called 'Tiquisate Golden Flint". It had in fact been introduced to Indonesia from Guatemala only a short time previously.[1] Mr. Ream selected this variety which he called "Guatemala" corn for propagation.

On Mr. Ream's advice USOM obtained 100 lbs. of "Guatemala" corn seed directly from its country of origin. This was multiplied at the Banglhen and Tha Pra Agriculture Experiment Stations during the 1952 growing season and distributed to selected farmers for further multiplication in 1953. The variety proved so successful that it rapidly became Thailand's only corn for commercial production. It is estimated that "Guatemala" corn now accounts for more than 95% of the corn exports.

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[1] "Tiquisate Golden Flint" was produced by the Iowa State Tropical Research Center in Antigua, Guatemala. It was developed as a varietal cross between a Cuban flint corn and a Guatemalan dent variety. It was taken to Indonesia in 1949 by the director of the center, Dr. Molhuse who served at the time as a consultant on a six month assignment in Indonesia.

The construction of feeder roads has been one of the major pushes of the AID ARD program for the purpose of opening up the N. E. as a part of the counter insurgency program. It has also been a part of the THAI effor to open up the country as a whole. I have no detailed information on how many roads have been built. However, from flights over the country, you can see all weather roads running out from the main trunk highways to most large villages, even into the rougher country. AID has, through the ARD program provided a complement of equipment to most provinces. This equipment has been used to build feeder and connecting roads. Also, the military needs or desires has brought about many all weather roads to the point where most settled areas are reachable by truck.

Jan clearing operations by the above and other AID equipment have been mostly bootlegged.

See attachments: 1. The Calabrian Mafia.

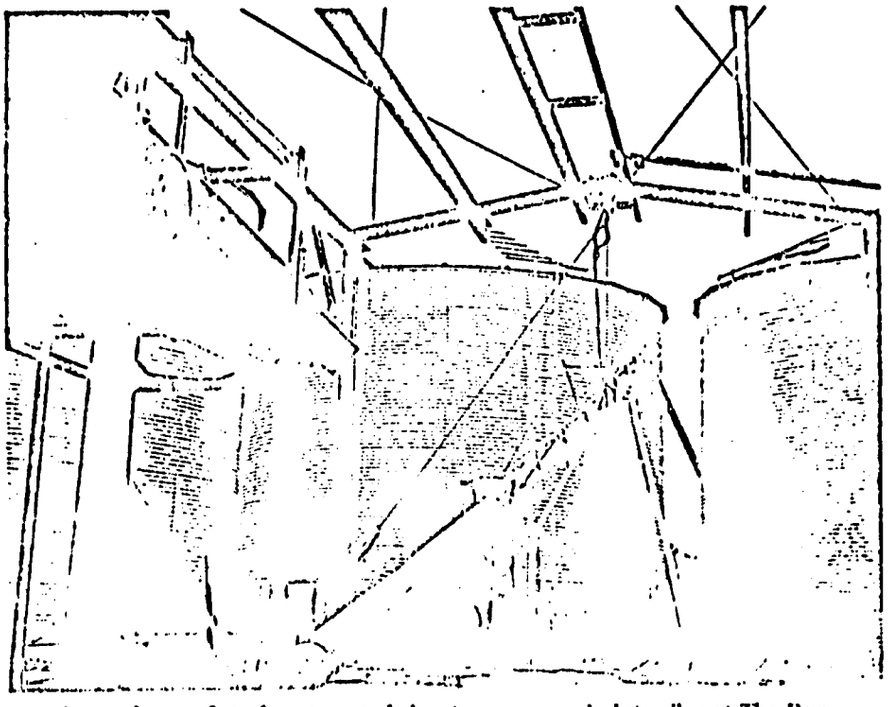
THE CALABRIAN MAZE

Calabrian (Thailand) Company Limited is under new management. The unique aspect of the change of ownership is that Calabrian, a private American firm, was taken over by the United States government in hostile circumstances. The action was taken in Bangkok on 31 January against the wishes of the former directors who are now taking steps to obtain redress. A legal battle is shaping up in Bangkok and Washington in which the former owners are attempting to recover damages and prevent disposal of the assets by the new management. The issue is complicated by the involvement of the Bangkok Bank which is accused by the former owners of failing to honour an underwriting agreement at a crucial moment.

Calabrian dealt in maize, its collection, storage, processing and marketing. Since it began large-scale operations in 1967, the company coupled its commercial activities with a farmer assistance scheme providing credit, technical help and equipment: Funds for the operation were backed by United States government guarantees worth US$ 7.5 million. This money was quickly exhausted, and when further funds failed to materialise in mid-1968 the company was forced to forfeit the fall harvest and the chance of good grain sales. The mounting financial crisis was relieved by the intervention of the US government which set in motion a proceeding for the liquidation of the company that is still in progress today.

An inevitable bitterness pervades the whole affair, contrasting sharply with other, more optimistic developments that have dominated the maize trade in recent months. Among these developments are the successful prosecution of a price war against Japan, and the opening up of a richer market in Taiwan. The future for Thai maize now looks more assured than ever. But for Calabrian that fact can bring little consolation.

Thailand's Maize has grown in Thailand since Portuguese traders introduced the crop some 400 years ago. The seeds were believed to have been obtained from stocks brought to Europe by Christopher Columbus on his return from "discovering" the Americas, where corn fossils have been found in the relics of ancient Aztec cities. The popularity of the crop was recorded by a French visitor to the court of King Narai at Ayutthaya. The crop found apparent acceptance in royal circles and soon spread among the people who named it "Turkey-wheat."



A symphony of steel: automated elevators move grain into silos at Tha Rua

Systematic cultivation began in the last century but maize remained an insignificant crop until a few years ago when its production and export underwent a phenomenal transformation. Thanks to the successful adaptation to Thai soil of Guatamalan varieties, production, which in 1948 was a mere 17,200 tons, leaped from 317,000 tons in 1959 to over 1 million tons in 1967. Maize now ranks fourth among the exports of Thailand, after rice, tin and rubber, and in 1967 it raised US$ 68 million in sales to Japan, Taiwan, Hong Kong, Singapore and Malaysia, for use almost entirely as animal feed. The 1968-69 crop is estimated at 1.35 million tons, of which all but some 60,000 tons will go abroad.

Only the open-pollinated yellow flint and the yellow dent Guatamalan types are suitable for export, but a local variety known as green crops provides some sweet corn for home consumption. The export varieties respond particularly well to the sandy soils of North and Central Thailand, and the long wet season permits two crops per year--March/June and July/August. But crop yield is still relatively low, and it was the possibility of increasing productivity and marketing in large amounts that first attracted Calabrian to Thai maize.

Enter Calabrian. The Calabrian Company Incorporated is a commodity trading company in New York with more than 20 years experience in grain trading. Most of the shares are owned by Charles Cogliandro. Though modest by international standards, the company has built up a steady business marketing grains, sugar, coconut and other commodities. A pharmaceuticals plant is operated in the Virgin Islands and branches or affiliates are located in such disparate centres as Johannesburg, Tokyo and Saigon.

Mr Cogliandro came to Thailand in

1963 to investigate prospects for b ing a sugar refinery. Half the cost of trip was paid by an investment su program of the U.S. government Ag for International Development, of wh the United States Operation Missi known as USOM, forms a part. T sugar project failed to materialise, b by 1965 Calabrian was exporting sm quantities of Thai maize to Japan.

Encouraged by the findings of a mo detailed study, Mr Cogliandro in 19 developed a proposal for an ambitio investment scheme in Thailand th would combine a trading business i maize with a farmer assistance schem The central idea was to deal direct with the farmer, who would be give advice on planting, weeding and fe tilisers, and at the same time receive a assurance that a market would exist fo his increased production. The reaso ing was that by raising productivit and eliminating the middleman, the fa mer could hope for a better profit Calabrian could make its profits, too by simplifying handling operations, in troducing economies of scale, and rely ing upon its international network for a superior knowledge of market condi tions.

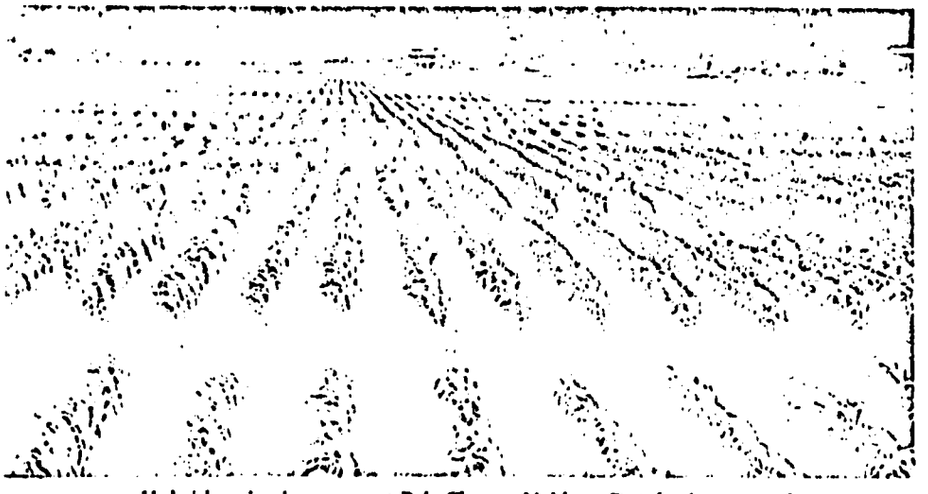
In July 1966 Mr Cogliandro despat ched Calabrian vice-president Kennet van de Laar to open an office in Bangko and lay out a provisional plant. In Washington, the scheme was welcomed by AID becuase, if it were to be suc cessful, an important agricultural de velopment consistent with U.S. govern ment objectives in Thailand would be accomplished at no cost to the U.S government. Furthermore, the scheme coincided with Thai government policy which encouraged the establishment of industries processing raw materials. Given an adequate flow of capital, AID believed, Calabrian would be successful in establishing a viable business.

Reservations about the substantial risks involved in a venture of this sort made the project no less im pressive once the prospective benefits to the Thai farmer were fully appreciat ed. By mutual agreement, the projected cost of Mr Cogliandro's proposal was scaled down from US$12 million to US$4.5 million. In response to AID enquiries as to the company's finan-

cial reputation, the Chemical Bank New York Trust Company recommended Calabrian as a good customer.

Enter Calthai. Meanwhile in Bangkok the Calabrian (Thailand) Company Limited - Calthai, as it came to be known - had been registered on 16 November 1966. The original directors were Charles Cogliandro, Irving Sverdlik, an attorney who became managing director, David Safer and Albert Lyman, a leading Bangkok lawyer who held no stock in the firm.

Calthai was almost wholly owned by Calabrian, which was to invest US$ 500,000 in Calthai stock. In addition, Calthai was obligated to borrow the baht equivalent of US$ 1 million (about 20 million baht) and arrangements were made to secure this from the Krung Thai Bank.



Hybrid maize is grown at Pak Chong, Nakhon Ratchasima, test farm.

In April 1967 AID authorised an Extended Risk Guaranty of a US$ 3 million loan to Calthai from the Chemical Bank New York Trust Company. The Guaranty scheme seeks to help business ventures in developing countries which, because of their high risks, cannot be financed from the regular money market. But conditions attached to the Guaranty restricted the use of the Chemical Bank loan to the payment of the US portion of operating expenses, the dollar costs of erecting facilities in Thailand and the dollar portion of salaries of American citizens employed by Calthai. As was later to be realised, the additional cost of American supplies as against the comparable Thai-made items was to contribute to an unwelcome increase in overheads.

Some 20 American agronomists were recruited to join an overall Thai staff numbering 400 at its peak. By November 1967 Calthai had built half a dozen small collection and storage facilities equipped with silos capable of handling 1,600 tons of maize at a time. These were also bases from which Calthai advisors gave credit to farmers, hired out tractors for custom ploughing and dispensed seed, fertiliser, pesticides, herbicides and other agricultural materials. When purchased, maize was transported from the growing areas to Calthai's major facility at Tha Rua, near Ayutthaya, an inland terminal whose elevators–the largest in Thailand–can clean, dry and store 65,000 tons of maize at a time. The grain was held at Tha Rua until the market was receptive. It would then be weighed, blended and shipped by barge to seaport silos for export.

In the red. In December 1967 it became apparent that Calthai was facing a substantial loss for the year. The project had started late in the trading season. A bumper American crop had depressed the world price, and a threatened drought in Thailand caused the government to embargo maize exports to everywhere except Japan, the country's best market. Calthai had been unable to line up substantial sales. Calthai had also hoped to sell maize to Europe, a region traditionally supplied by the United States. Freight costs made this an ambitious objective from the start, and the closure of the Suez Canal in June 1967 ruled it out completely.

Other problems faced the company too, but Calabrian saw what it thought was a solution in the construction of even more upcountry stations which would increase the volume of maize that could be handled and permit sales at the most advantageous time in the corn buying season. The company's thinking was confirmed by an independent specialist assigned by AID to which Calthai had turned for the provision of additional financial support. Calthai began negotiating for long-range sales with seven Japanese firms.

A new financial plan was drawn up for additional equity to be invested in Calthai by Calabrian of New York and by the Bangkok Bank. New guarantees were authorised for a US$ 4 million loan from the Chemical Bank and for US$ 1.5 million of new equity, on the understanding that the Bangkok Bank would invest US$ 1 million in preferred stock of Calthai and that Calabrian would invest an additional US$ 2 million in Calthai stock. Calthai agreed to financial supervision by an employee of the Bangkok Bank who was placed in the Calthai offices.

In the event, Calabrian was unable to raise the extra US$2 million from American sources. Time pressures mounted as the new facilities had to be completed by the August harvest. In March Calthai appointed a new managing director, retired colonel Henry A. Mucci. The following month, the second financial plan was modified.

The new financing totalled US$6 million. Of this Calabrian was to raise US$3 million to be made up by a US$1 million equity investment by the Bangkok Bank, and by a loan of US$1.5 million from the Chemical Bank backed by an AID Guaranty. In addition, US $500,000 was to be borrowed from A. & S. Steel Buildings Incorporated, the American firm which had built the Tha Rua facilities and which was now negotiating for a new construction contract. A new backer, the Bank of America, agreed to another loan of US$3 million, which was also to receive an AID Guaranty.

AID officials in Bangkok assert that the agency agreed to the second round of financing because of assurances from Calabrian that new capital would be

forthcoming, and because of an understanding on the part of AID that a specific commitment had been taken up by the Bangkok Bank for the investment of US$1 million in preferred stock. The agency believed the need for funds was so great that it insisted upon obtaining agreement from Calabrian that AID could sell all of Calabrian's holding in Calthai if no new equity was found after 1 October 1968.

Counting the cost. Its financial problems seemingly settled, Calthai embarked on a vigorous building program to raise to 11 the number of upcountry grain stores. Construction also began on an additional 20-rai terminal complex at Khao Yai-ka-ta, Lamnarai, which would complement the Tha Rua facility. In the year ending July 1968 Calthai had bought 95,000 tons of maize from the farmers, but its aim was to sell as much as 300,000 tons per annum to Japan. An attempt was therefore made to persuade the maize traders to accept revisions in the Thailand-Japan agreement which would help to strengthen Thailand's position. These proposals were contained in a letter circulated to the trade. The proposals had not received clearance from the Ministry of Economic Affairs and action was not then forthcoming.

According to AID officials, Calthai had given assurances that it could line up sales with Japan. But people in the trade say that the firm lacked adequate relations with foreign buyers with whom other traders of long standing had built up a fund of goodwill. Furthermore, it appeared that buyers from Japan were reluctant to encourage Calthai because they feared the strength that derived from the American firm's resources.

The backbone of the trade, the Thai dealers and exporters, were not altogether happy with the company either. For one thing, it was felt that Calthai lacked a sufficient appreciation of the trading conditions and marketing practices current in Thailand. Upon commencing business, the company announced that it would purchase maize direct from the farmers, instead of going through middlemen. It would purchase the commodity at prices which were 2 baht per picul (60 kilograms) higher than those prevailing in the Bangkok market. As a consequence of buying at inflated prices, the company's motives generated suspicion in the trade. Moreover, Bangkok dealers proceeded to buy up maize in large quantities country-wide, hoarding up stocks so that prices rose. Several dealers suffered an immediate loss through Calthai buying operations. As for Calthai itself, it had to buy up corn at increasingly high prices, and when it had accumulated a stockpile of its own it was unable to find sufficient outlets.

Another problem was the dampness of the maize, a result of inadequate examination at the time of purchase. Normally this may cause a variation of 10 baht per picul in the price paid. Damp maize purchased as dry meant a substantial loss to the company.

Having built up large stocks the company made a determined effort to dispose of them. Unable to do so, its liquid resources fast depleted. There came a time, for example, when a large unsold stockpile had to be disposed of on the Chicago futures market. This plan was thwarted by a lack of funds resulting in a loss of some US$500,000.

Calthai's start-up costs had been much higher than anticipated and the operation was carrying too high an overhead. Transportation costs were multiplied by the need to service many distribution points. Drawbacks in communications between company staff in outlying rural areas caused delays in conveying trading instructions. There were too many Americans on the payroll.

For the Thai staff, the company paid out monthly salaries which were in excess of customary levels. This was done in the hope that it would avoid corruption, but the outcome was by no means what had been hoped, because corruption there certainly was. Thus when purchasers went out to acquire 10 truck loads of maize, 10 would be loaded, but only eight or nine might reach the warehouse, the others being deposited en route. But the checkers would sign for 10.

About this and similar practices the top management could have no knowledge, because the documents would show the full amount. Supervision over such wide distances was obviously a difficult task, but the management's difficulties were not confined to the Thai alone. In June 1968 an American agronomist dismissed by the firm filed suit for damages. In counter-charges the management cited misappropriation of funds and a conflict of interest between the former employee's position in the company and his partnership in a Lamnarai nightclub. The man's salary was reported as US$ 18,000 per annum plus US$1,500 in allowances.

Blocking operations. Despite these difficulties, Calthai was confident of turning its losses into profits as the buying season approached. The same could not be said for AID. Unable to obtain audited financial statements from the company, the agency commissioned a full audit of Calthai by an independent British firm in Bangkok, Turquand Youngs. Calabrian of New York had already drawn down the US$ 1.5 million loan from the Chemical Bank, and Calthai had drawn down US$ 1.6 million of the US$ 3 million loan from the Bank of America.

By June 1968 the Bangkok Bank had signed an underwriting agreement with Calabrian for the US$1 million in preferred stock that AID had been assured the bank was committed to investing. AID had objected to one provision in the agreement which called for deposit of the new U.S. dollar equity in the Bangkok Bank, and this provision was deleted by the parties to the agreement before AID went forward with its Guaranty.

In early August it was learned that the Bangkok Bank had blocked the Calthai account into which the bank's equity contribution had been paid. Calthai then sought a drawdown of the US$ 1.4 million balance in the Bank of America loan commitment for transfer to Thailand as working capital. AID opposed this move because Guaranty funds were to be used only for procurement in the United States.

On 27 September Calthai's attorneys acknowledging that the Bangkok Bank had not put in its equity, requested AID's waiver of several defaults under the loan agreement, and again sought approval for the drawdown of the remaining US$1.4 million in the Bank of America. The agency, by now armed with the independent audit report, refused to permit the drawdown. In the

16 months prior to 31 July 1968, the report had revealed, Calthai had recorded losses of US$2.6 million.

The situation had reached crisis proportions. In an effort to restore the confidence of the financial community and avert a headlong crash, the company had been inviting prominent people to accept the chairmanship of Cal-Thai. Among these figured Foreign Minister Thanat Khoman, concurrently Chairman of the Export Promotion Board. In declining the offer, Thanat spoke warmly of the worthy objectives of the company in helping Thai farmers obtain better prices for their produce and of increasing the export of Thai food grains. In reply, Calthai chief Henry Mr [illegible] assured that the minister's concern for the Thai farmer's welfare and well-being was now well known throughout the rural community.

Whichever way Calthai tried to turn, there was no escaping the fact that nothing but an immediate transfusion of local funds-essentially from the Bangkok Bank or the Bank of America-would save it from having to cease operations. It appeared to AID that Calthai would go into bankruptcy.

The takeover. As principal creditor, AID initiated moves to effect a composition of creditors by which AID would advance enough funds to complete construction of unfinished facilities-some US$ 400,000-pay salaries and separation allowance for most of the employees, and offer the assets of Calthai for sale. Discussions to this end in Washington were broken off when Charles Cogliandro flew from there to Bangkok.

Confronted by demands for interest payments from the Bank of America and the Chemical Bank, the agency withdrew US$59,678.25 from the Guaranty Reserve Fund. AID was also trying to persuade prospective purchasers to invest in Calthai, but according to the agency none of them would entertain the idea unless Mr Cogliandro and Calabrian were out of the picture.

Within a few weeks, the agency made sure they were. On 5 December, after a negative response to a demand on Calabrian for repayment, the Chemical Bank obtained relief from AID on the US$ 1.5 million loan it had extended to the company. Invoking the agreement with Calabrian which had governed the second round of financing, AID then assumed ownership of the 512,070 shares of Calthai owned by Calabrian.

The action was taken more than two months after the date, 1 October, specified for the purpose under the agreement. The company registrar, the Bangkok Bank, duly recorded the transfer of holdings, and the agency, now the major shareholder in Calthai, sought to reestablish contact with the prospective purchasers with whom earlier it had been holding discussions.

Throughout this period, Charles Cogliandro refused to hand over control of Calthai, contesting the legality of the AID action. As a result, Rey M. Hill, acting director of USOM, convened an extraordinary general meeting of shareholders in Bangkok on 31 January at which Charles Cogliandro and [illegible] directors were voted out of office placing them as the new board a[illegible] Mr Hill, Osborne L. Hauge, USOM's assistant director for capital development, and Mr Jidjeua Kanabhu. The third nominee is managing director of Thai Machinery Industry Company which, together with Jalaprathan Cement and Chemical Fertilizer, share with Calthai an impressive building on New Petchburi Road.

The mobile suit. On the morning of the meeting, several hours prior to their removal from office, the former directors performed a final official deed. In the name of Calthai, they entered a suit in the Civil Court claiming damages of 30 million baht from the Bangkok Bank. In addition the company, represented by attorney Albert Lyman, demanded payment by the bank of a 20 million baht equity investment in Calthai representing the local currency equivalent of the unpaid US$ 1 million.

Interviewed later, Charles Cogliandro gave this explanation of the eleventh-hour drama: "It was a last resort measure. From July when payment was due, we felt it the better part of valour to try conciliation rather than take court action." In the event, neither course of action materialised since some few days afterwards the new owners of Calthai withdrew the suit without prejudice to further claims. As luck would have it, they were ill-prepared for such an ordeal. Failure to withdraw in time, AID officials confided, would have meant proceeding with an action about which they lacked sufficient knowledge.

AID has announced no plans to re-enter the claim, though the three parties involved in the matter quite independently assert that the possibility of its revival precludes their disclosure of the disputed issues. In question apparently is the interpretation of certain clauses purportedly in the agreement which the Bangkok Bank invoked in justification of its blocking action. Mr Cogliandro insists there can be no justification and forecasts that since in his view the matter is at the heart of Calthai's financial problems, a future settlement of the claim is inevitable.

Charles Cogliandro's argument is that the bank's failure to release promised funds triggered off the suspension of financial aid at the outset of the corn-buying season. He asserts that the commodities business is notoriously subject to extreme fluctuations in its fortunes, and that if Calthai had been financially operative during the recent harvest season, the very handsome profits it would have earned would have helped towards the recovery of its very handsome losses.

Lost opportunities? It may now be too late for an accurate tally of the rewards that would have accrued to Calthai were it permitted to operate last season. In a sense, the crash has come at a very inconvenient moment. Grain prices are rising above normal levels and foreign buyers are able to consume more than Thailand can supply. This favourable situation has been created by an unexpected spurt in foreign demand and an acceptance by Japan of a free market price for Thai maize.

For several years the trade in maize has been governed by an agreement under which Japan buys Thai corn at a price based on prevailing Chicago rates. This price was artificially depressed by a longshoreman's strike in the United States which began in December and is only now coming to an end. The Chicago price fell to US$53.17 per ton against the prevailing Far East price of US$59-62 per ton. Some shipments have been fetching as much as US$70. Before the strike began, the Board of Trade sought the acceptance of a free market price by the Japan Feed Trade Association. This action was sup-

...ised by the Ministry of Economic Affairs, which had independently received some advice earlier from a Chicago ... especially recruited to study ... pricing problem.

Despite diminishing stocks in Bangkok, Japan held out until 18 February when a communique announced free negotiations on price and quantity for the remainder of the season. Only some ...000 tons remain to be shipped before July, when it is expected that the next agreement will incorporate a new, more advantageous pricing formula or a continuation of the present arrangement. It seems clear that in future Thailand will come to depend less on Japan, whose share of the export market has declined noticeably this year. The expansion of the cattle feed industry on Taiwan has raised that country's annual demand for maize to ...000 tons. Since Taiwan can hardly afford the very substantial orders that would make it a worthwhile market for American suppliers, it can be expected to look to Thailand for a substantial portion of future shipments.

In the current season Thailand's production has fallen below target, and urgings to intensify production, have come from none other than Dr Puey Ungphakorn, Governor of the Bank of Thailand. It was just this step-up in production-and profits-that Calabrian originally set out to achieve.

Armed to the hilt with substantial safeguards against losses, Calabrian's appearance on the Thai scene miraculously escaped the public uproar that greeted the earlier formation for similar objectives of a Japanese scheme. The Japanese scheme had to be shelved. Calabrian, having had a chance to establish its name with the growers, has now lost their confidence by failing to make good purchasing promises at the last harvest.

Interested buyers, U.S. government sources in Bangkok affirm their continued belief in the objectives which led AID to assist Calthai. Most desired is the transfer of the firm as soon as possible to a restructured corn trading company backed by adequate funds and sound management. An attempt to establish the book value of Calthai is being made ..., but the full impact of the ...'s debts will not be known for some time. The Krung Thai Bank, the Bank of Agriculture and Agricultural Cooperatives, and Thai Wah stand among the local creditors. Calthai owes some US$30,000 to the Commercial Trading Corporation of Taiwan.

To minimise the final losses discussions have been held with Thai financial institutions to work out a practical solution which will retain the maximum benefit for the farmers and ensure the continued existence of the company as an economic proposition. In addition, AID has before it proposals for the purchase of Calthai stock and/or assets. These were presented in February in reply to an invitation extended last year to Continental Grain, Ralston Purina, Cargill-Tradax and C. Brewer & Co., four of the world's largest grain trading interests.

Keen interest is reported in acquiring key Kalthai installations. A possible purchaser is the Cargill-Tradax group which opened an office of Tradax Ltd. in Bangkok last July. A close study of maize trading conditions is being undertaken by Tradax representative Stanley M Smith, who confirms the group's eagerness to develop its activities in Thailand which for the moment are concentrated on the export of tapioca to Europe. Maize holds good prospects, says Mr Smith in a Silom Road office hooked into Cargill's worldwide telex network. Calthai's successful introduction of mechanised handling has also encouraged plans by a Thai-Japan joint venture for a dryer and wholesale godown at Tha Rua, and a steel barge shuttle service which would move the corn direct to the shipside at Bangkok.

Over to the lawyers. Meanwhile, Calthai continues to function, selling off its remaining stocks, salvaging what it can for the liquidator. Colonel Mucci, a disappointed man, is staying on as manager but his orders come from AID. The foreign staff have been reduced to six, the Thai to about 70.

Most disillusioned of all is Charles Cogliandro, or so it would seem. He is seeking an injunction in Bangkok on 18 March to prevent disposal of the Calthai assets until the dispute is settled by arbitration. The motion seeks the establishment of a new board representing former and new directors. The injunc-

tion is preliminary to an action challenging the legality of the registration of the new directors with the Ministry of Economic Affairs.

In Washington, an action claiming a minimum of US$ 2 million damages and the return to Calabrian of Calthai stock is before the American Arbitration Association, which enjoys a judicial status for the settlement of disputes. AID lawyers are preparing to answer Calabrian's contentions. Yet another source of friction between the two parties is their differing interpretation of the role of arbitration in the agreement. Calabrian contends that any disputes arising must be settled first by arbitration, whereas AID insists that arbitration can take place only if both parties consent to this procedure.

The complexity of the legal and financial issues involved is keeping Mr Cogliandro and his legal advisors busy commuting between New York, Washington and Bangkok. A move from the elegance of the Erawan to more modest accommodation at the Amarin typifies the changed status of his fortunes. Said Mr Cogliandro: "To me, the most tragic aspect of the whole affair is the spectacle of US government and a US firm in conflict in a foreign country. It's something I would want to avoid at all costs. Neither of us is really responsible for bringing this crisis to a head. Even at this late stage, I still hope some way may be found of uniting our forces against the financial circles which have brought hardship not only to us but to the farming people of Thailand."

Risk–free investment: the best of both worlds

Helping the American businessman to help himself and at the same time the people of friendly overseas countries is the aim of a number of programs administered by the Agency for International Development, which forms part of the Department of State, U.S. Government.

Two principal types of investment guarantees are available, the Specific Risk Investment Guaranty Program, and the Extended Risk Guaranties of Loans for Private Projects Program, both administered under the Foreign Assistance Act of 1961, with subsequent amendments

The Specific Risk Program seeks to encourage businessmen to invest in projects of value both for the interests of the United States and the host country by insuring such new investments against losses arising from the specific political risks of inconvertibility of currency, expropriation, and of damage resulting from war, revolution or insurrection. Protection is not, however, offered against such risks as the devaluation of a foreign currency, default of a buyer in paying for purchases, the failure of a borrower to repay due to commercial losses, or against other normal business risks that attend any investment. Thus the intention is to place American businessmen in the same position in respect of investments in developing countries as they would be in a developed country, removing the special risks attendant on such operations but retaining normal business risks.

The Extended Risk Guaranti Loans for Private Projects scheme is somewhat different. Its purpose is to facilitate and increase the participation of private enterprise and private institutions in furthering the development of productive capacities and increasing social progress in less-developed countries regarded as friendly to the United States.

To further this aim, the Agency for International Development guarantees a lender against up to 75 per cent of losses incurred on a long-term loan made to enterprises or institutions which contribute to economic or social development, and the guarantee includes the provisions of the specific risk program also. In addition, the lender may insure the remaining 25 per cent of the investment under the specific risk program.

There are a number of conditions for insurance. The lender must be a U.S. citizen or organisation, and substantially owned by U.S. citizens. The project must be one which seeks to further the development of the economic resources and productive capacities of the country, and excludes luxury industries such as cosmetics or alcoholic beverages. It must also be primarily a private enterprise- a government may participate provided only that private individuals maintain control. The basic financial plan must be sound, and there must be ample coverage for the guaranteed debt. Since the interests of the United States are also a criterion for evaluation, the project should involve U.S. procurement substantially equal to the guaranteed loan, and the object of the enterprise should not be to produce abroad for export to the United States, thus aiming mainly to profit from lower costs in a foreign country. The economic philosophies and policy of the United States are also reflected in the provisions. Thus a project involving a monopoly is disfavoured, as is one which might affect the U.S. economy adversely. Finally a request will be turned down if the investors, the U.S. entrepreneur or the local associates are of such bad reputation that the U.S. would be injured in its relations with the host country if it were to be associated with the activities of such individuals

Under the Extended Risk program, loans for investment in some 70 countries including Thailand are available for guarantee. Hitherto, three such guarantees have been approved and issued The beneficiaries have been Intercontinental Housing, which received a guarantee of US$ 5 million for a housing project, Siam Kraft Paper, which received a guarantee of US$ 4,075,000 for its Kraft paper mill, and finally the Calabrian Company, which received a guarantee of US$ 3 million for grain processing and crop financing, a total of US$12,075,000 in extended risk guarantees.

14.0 Return to Ream

UNITED STATES OF AMERICA
SPECIAL TECHNICAL AND ECONOMIC MISSION
TO THAILAND

Excerpts From:

FIELD AND FORAGE CROPS

SUMMARY REPORT FOR THE PERIOD

July 12, 1951 to Dec. 1, 1952

By

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FIELD AND FORAGE CROPS

The Role of These Crops in Thailand's Agriculture

Crops other than rice, while presently not occupying a large proportion of the total crop area in Thailand, represent a considerable source of income and food to Thai farmers. They likewise are important to the general economic stability of the country. Moreover, the potential area that could be devoted to crops such as groundnuts, soybeans, sorghum, corn, popcorn, forages, and fiber crops is many times greater than that presently utilized. Much land could be planted to another crop following rice provided water could be made available, better cultural methods employed, or crops with lower water requirements, such as sorghum or forages, used. Some land now used for rice produces very low yields. Such areas could more profitably be used to produce other crops. Research is needed to determine the best crops for these areas. Land with sparse vegetation surrounding rice paddies not being productively used may be efficiently utilized for the culture of some of these crops.

Since detailed surveys of soil conditions have not been made in much of Thailand, undoubtedly there are areas not now cropped and not suited to rice production that could be brought into the culture of other crops. All these conditions represent a great potential for many crops other than rice.

Thailand's economy is based to a large degree on the price of rice on the world market. Fluctuations in this price has a resultant effect upon the general welfare of the farmer. In a country that has as great a potential for diversification with other crops as Thailand, there should be a continuous, expanded and coordinated research program in field and forage crops to provide the necessary information whereby farmers can take advantage of these possibilities to improve the overall food production of the country and their economic status. Once improved varieities of crops have been found and better cultural methods determined, these should be demonstrated and distributed to farmers through the facilities of the Extension Service.

CORN INVESTIGATIONS IN THAILAND

Corn investigations with MSA assistance were begun in Thailand in December 1951 with observations of plantings made from seed of six varieties received from the Agricultural Institute, Bogor, Indonesia. These were planted on raised beds at Bangkhen and notes taken, which are summarized in Table 1. In these observations two varieties appeared quite promising, namely, C 104 - Durum 28 and C 102 - Maja 7. C101 Gele Menado 1 and C 103 - Colombo 27 were rated Fair and Fair-, respectively, and the other two varieties, Poor and Very Poor.

With the acquisition of additional lots of seed from Dr. I. E. Melhus, of the Iowa State College Tropical Research Center, Antigua, Guatemala, Central America, and from Cuba and El Salvador supplied by Mr. Howard Hyland, Field Crops Introductions, B.P.I., U.S.D.A., together with collections of varieties from various places in Thailand, other plantings were made on April 2 and 3 and May 12 and 28, 1952. Notes on these observations are given in Tables 2, 3 and 4. The following varieties appeared to be quite promising: C 104, Durum 28, C 102, Maja 7, and C 119, No. 732 from Indonesia; C 110 Tiquisate Golden Yellow, C 111, Selection 142-48, and a hybrid C 118 Guatemala Top Cross 112 A 45 x 7 A 35 from Guatemala; another hybrid, C 117 Cuban 4 way cross 67-51, C 121, Salvadorean Yellow No. 1, C 123 Empalezada; and C 124 Venezuela No. 3 - from El Salvador; and C 113, a local Thai yellow dent corn from Tap Kwang.

Variety Trial at Tap Kwang May-August 1952

Dr. I. E. Melhus, of Iowa State College and the Tropical Research Center, Antigua, Guatemala, Central America, who in early 1952 served on the staff of MSA in Indonesia as Advisor on Corn Investigations, supplied enough seed for a variety trial of eight varieties which he was testing in Indonesia. To these were added a local variety C 113, yellow dent from Tap Kwang. The experiment was planted in a randomized block at Tap Kwang on a dark colored silt loam soil, on May 3, 1952. Tap Kwang is at an elevation of about 50 ft. above sea level. Three replications, X, Y, and Z (Table 5) of each variety, were planted in single rows each 10 meters long, in hills 1 meter apart, and rows spaced 1 meter apart. Four kernels were planted per hill and when the plants were 25 cm high were thinned to 2 plants per hill. Eighteen grams (30 Kg. per rai) of ammoniated phosphate (11-48-0) fertilizer was applied at the side of and below the seed in each hill. One variety, C 116-US single cross 187 - 2 x L 317, failed to germinate and these plots were planted with the check variety C 113 - Tap Kwang yellow dent, to insure uniformity in the plots.

The results of this trial are given in Tables 5, 6 and 7. Yield differences between varieties are highly significant. The top ranking varieties on the basis of yields were C 118, C 117, and C 113. The first two are hybrids and the latter an open pollinated variety which has been grown at the Tap Kwang Station, in East Central Thailand, for the past 30 years. It was introduced from southeastern U.S. at that time by Prince Sithiporn, and presumably was called Nicholson's yellow dent. The data indicate that yields could be increased materially through the

development and use of hybrids. The best hybrid (C 118) out-yielded the best open pollinated variety (C 113) by 14%, and showed an increase in yield of 23.4% over the average for the three top ranking open pollinated varieties (C 113, C 111, and C 10). Undoubtedly, hybrid varieties that would show even greater increases could be developed to meet specific local conditions in Thailand.

Disregarding the two hybrid varieties, three open pollinated varieties appear promising. These are the local variety, C 113 and the two from Guatemala, C 111 and C 110. Additional tests are needed to determine the best of these.

Variety Trials at Tha Phra and Surin, Northeast Thailand, May-August 1952

With the limited amount of seed available, two variety trials were conducted at Tha Phra and Surin in Northeast Thailand during the period from May 3 to August 28, 1952. The experiment was planted on a deep loamy sand soil at Tha Phra where the elevation above sea level is approximately 530 feet. The soil is classed as moderately low in productivity. At Surin the trial was planted on a loamy sand soil, somewhat less productive than that at Tha Phra. Here the elevation is approximately 490 feet above sea level. Although no rainfall records were available, the available moisture was more than adequate to mature a good corn crop.

The same varieties were planted at both locations, using randomized blocks, with three replications. Each plot consisted of four rows of 12 two-plant hills, with a spacing between hills of 1 meter x 1 meter. Ammoniated Phosphate (11-48-0 fertilizer was applied at the rate of 18 grams per hill (30 Kg. per rai) at the side of and below the seed. Ten hills from the middle two rows (with one hill on each end discarded in each of these rows) were harvested for yield. The results of the Tha Phra trial are shown in Tables 8 and 9 and that of Surin in Tables 10, 11 and 12.

Differences in yields between varieties were highly significant in both trials. The rankings, omitting variety C 103, were identical except that C 113 was first and C 104 second at Tha Phra, while their positions were reversed at Surin. In both cases varieties C 105 and C 104 yielded very poorly. Variety C 103 which ranked second at Surin was sixth at Tha Phra. Varieties C 113 and C 104 were within the 5% level of L.S.D. and these, and varieties C 111, C 102 and C 110 fell within the 1% level of L.S.D. at both locations.

As a result of these tests varieties C 113 and C 104 appear to have considerable promise and C 111, C 102 and C 110 likewise are worthy of further testing. C 103 should also be investigated further to determine if some factor may have gone unnoticed in the test at Tha Phra, which lowered its ranking over that at Surin.

Additional Observations and Variety Trials

Since the observations and trials shown in the attached tables were made twelve additional varieties have been collected, making a total in all of 36. These have been planted for observation and seed increase, but observations and notes are not available at this time.

A corn variety trial was planted at the Kuan Kud Agricultural Experiment Station, near Patalung, on November 12, 1952. This includes twelve of the varieties which have looked promising from observation and previous variety trials.

Recommendations

1. Corn Improvement

Hybrid corn, on the basis of the results in the Tap Kwang trial (Tables 5, 6 and 7), and experiences elsewhere around the world, has a definite place in Thailand's agriculture. The tests so far conducted also indicate that there are some very promising stocks of open pollinated varieties from which selections could be made for starting hybrid corn breeding work. However, at present it is questionable whether an improvement program based upon the development of hybrids should be started. There are at present no Thai scientists assigned to do corn work, and no one with sufficient experience in crop improvement appears to be available at the present time. Before such a program can be successful men in sufficient numbers must be trained. Likewise, Thailand today has no seed multiplication program for any crops, nor do they have the facilities developed or personnel trained to start such a program. No channels for the distribution of improved seed have been sufficiently developed as yet, so that it would be possible to get hybrid corn seed to farmers each year. There must be interest in developing these facilities and channels, and some definite planning to do something along these lines before a successful hybrid corn program can be launched.

For the present, then, and until steps are taken to correct the above conditions, emphasis should be on training Thai agronomists to select the better varieties of open pollinated corn for distribution to farmers. In this process they will gain experience and secure training in working with the corn crop that will be valuable when a hybrid corn program is launched.

2. Variety Trials

While the variety trials have indicated that certain varieties have distinct possibilities in those locations where the tests were conducted, before any conclusive recommendations can be made these need to be repeated a number of times, and new varieties, as they are acquired, tested along with the old. Tests should be repeated at Tap Kwang, Tha Phra, Surin and Patalung, and new locations for trials selected at San Patong and Kok Samrong. As the need arises, trials may be expanded to other areas.

3. Time of Planting

Studies should be conducted in various sections of Thailand to determine the best planting dates for corn. Corn is grown in some sections during two and sometimes three seasons. Information is needed on when during each of these seasons it is best to plant.

4. Cultural Methods

Corn fields in Thailand have been observed to be very weedy. General practice is to cultivate once, sometimes not at all, after planting. Studies of frequency of cultivation, as well as other cultural practices, such as row spacing, planting rates, etc. should be conducted.

The possibilities of inter-cropping with other crops, such as peanuts, should be investigated.

5. Corn Fertilization and Crop Rotations

Observations indicate that it is questionable whether corn can be grown successfully and profitably over a period of years, even in good cropping systems, without the use of fertilizers. Even on the relatively poor soils of Northeast Thailand, yields the equivalent of over 45 U.S. bushels per acre were obtained from the best variety in the trial at Tha Phra, by using the equivalent of 165 lbs. per U.S. acre of a 11-48-0 fertilizer. This is a good yield for southeastern United States even on better soils than those of Northeast Thailand. With fertilizer corn can undoubtedly be grown on many soils now considered too poor. However, studies should be made to determine such things as what kind, how much, when to apply, and how to apply fertilizers to the corn crop. Information and data are needed to determine the best cropping systems in which corn should be grown to obtain maximum yields, maintain soil productivity, and reduce soil erosion.

H. W. Ream
Field Crop Specialist
MSA Bangkok, Thailand

25 November 1952.

Summary of Notes of Corn Varieties Planted for Observation

Bangkhen, Dec. 27, 1951

TABLE 1

	Variety - No.(Thai) Name and Source	Height of plants av. cm.	Stalks	Ear size	Approx. days to maturity	Rating
C101	Gele Menado 1 - Indonesia	230	Sturdy	Rather small	90	F
C102	Maja 7 - Indonesia	250	"	Fair size	88	G
C103	Colombo 27 - Indonesia	215	--	Rather small	100	F-
C104	Durum 28 - Indonesia	270	Sturdy	Large	97	VG
C105	Bowman 124 - Indonesia	220	Rather weak	Medium	90	P+
C106	Gendjah Warangen 411 - "	150	Very weak	Small	90	VP

Summary of Notes of Corn Varieties Planted at Bangkhen, April 3, 1952

TABLE 2

	Variety - No.(Thai) Name and Source	Days to Maturity	Av.Ht. in cm.	Rating on Appearance	Remarks
C 108	Tuxpan U.S	None Germinated			
C 104	Durum 28 - Indonesia	93	230	G	
C 109	Gele Oost Java 4 - "	94	199	F	
C 116	187-2XL317 US Single Cross	106	237	G	Large ears;no lodging.
C 114	White Variety - San Patong Thailand	95	153	VP	Very small ears - stunted plants.
C 115	Yellow Variety - San Patong Thailand	86	120	VP	Severe lodging.
C 110	Tuxpeate Golden Yellow - Guatemala	95	237	VG	Ears medium size - no lodging.
C 111	Selection 142-48 "	105	240	VG	Ears large - no lodging.

Summary of Notes of Corn Varieties Planted at Bangkhen, April 2, 1952

TABLE 3

Variety - No.(Thai) Name and Source	Days to Maturity	Av.Ht. in Cm.	Rating on Appearance	Remarks
C 101 Gelo Menado 1 - Indonesia	99	211	F	Stalks sturdy - ears quite small.
C 102 Maja 7 - "	100	228	G-	Stalks sturdy - ears fair size.
C 103 Colombo 27 - "	100	242	P+	Stalks fairly sturdy - ears quite small.
C 105 Bowman 124 - "	91	224	F	Stalks somewhat weak.
C 106 Gendjah Warangen 411- "	89	167	VP	Stalks weak and spindly.
C 113 Tap Kwang - Yellow Dent - Thailand	102	224	G	A number of stalks badly lodged; large ears.
C 110 Tiquisate Golden Yellow - Guatemala	100	234	VG	Stalks sturdy - ears medium.
C 111 Selection 142-48 - "	107	235	VG	Stalks very sturdy - ears large.
C 107 Mexican Juno - US	99	220	--	Only one plant.

Bangkhen Animal Husbandry Farm

Summary of Notes of Corn Varieties Planted May 12 & May 28

Notes Taken August 5, 1952.

TABLE 4

Variety - No.(Thai)	Name and Source	Days to Maturity	Height Plants in cm.	Insect Damage Rating		Remarks
	Gele Menado 1 - Indonesia	93	284	3	F	Ears not uniform height, many not well filled - ears small.
110	Tiquisate Golden Yellow - Guatemala	100	244	3	G+	Ears not uniform height, well filled large ears, tight tips.
C111	Selection 142-48 - "	106	262	2	EX	Ears quite uniform height, very large, tips tight.
C116	187-2XL317 US Single Cross	93	206	2	P	Only 2 plants - short, ears poorly filled, small.
C117	67-51 - Cuban 4 Way Cross	100	262	3	G+	Ears very variable in height, well filled large ears tips tight.
C118	112A45X7A35 - Guatemala Top Cross	86	267	3	G	Ears variable height & maturity, large, well filled ears, tips quite open.
C119	732 - Indonesian	100	270	3	G-	Ears fairly uniform in height, medium size ears, tips open, bird damage bad.
C120	734 - "	85	263	3	F+	Ears fairly uniform in height, ears small.
C121	Salvadorean Yellow No. 1 El Salvador	98	270	2	G	Ears fairly uniform in height, medium size, tips somewhat open.
C122	Taveron (White Kernel) El Salvador	84	227	3	F+	Ears very variable in height, medium to small size, tips medium tight.
C123	Empalezada (White Kernel) El Salvador	84	235	3	G-	Ears fairly uniform height large, tips medium tight.
C124	Venezuela No.) (White Kernel) El Salvador	110	229	2	G+	Ears fairly uniform in height, very large tips somewhat open.

Corn Variety Trial Tap Kwang May - Aug. 1952

TABLE 5

	Variety-No.-Name	Yield in Kilograms per Rai X	Y	Z	Mean
C101	Gele Menado 1 - Indonesia	270.2	185.8	209.6	221.8
C110	Tiquisate Golden Yellow - Guatemala	444.8	494.0	540.8	493.2
C111	Selection 142-48 - Guatemala	477.3	489.3	635.2	533.9
C113	(Check) Yellow Dent - Tap Kwang, Thailand	527.7	591.6	625.3	581.5
C117	67-51 Cuban 4 Way Cross - Hybrid	603.6	572.6	653.3	609.9
C118	112A45X7A35 Guatemalan Top Cross	585.1	695.5	705.3	662.0
C119	Indonesian No. 732	349.4	363.9	336.2	349.8
C120	Indonesian No. 734	481.6	434.4	339.5	418.5

TABLE 6 Analysis of Data

Variation Due to	D.F.	Sum Squares	Mean Square	S	F. Value
Blocks	2	6,202.12	3,101.06		0.951
Varieties	7	451,880.12	64,554.30		19.79**
Error	14	45,674.25	3,262.45	57.118	

** Highly Significant

Ranking of Varieties

TABLE 7

Rank		Variety-No.-Name	Mean Yield in Kg. per Rai	
1	C118	112A45X7A35 Guatemalan Top Cross	661.96	
2	C117	67-51 Cuban 4 Way Cross - Hybrid	609.93	
3	C113	(Check) Yellow Dent - Tap Kwang, Thailand	581.53	5% level
4	C111	Selection 142-48 - Guatemala	533.93	1% level
5	C110	Tiquisate Golden Yellow - Guatemala	493.20	
6	C120	Indonesian No.734	418.50	
7	C119	Indonesian No.732	349.83	
8	C101	Gele Menado 1 - Indonesia	221.86	

Standard Error of Mean = 32.978
L.S.D. (1%) = 138.82
(5%) = 100.023

1963 ANNUAL REPORT

Joint Thailand-USOM Crop Production Committee
Ministry of Agriculture, Bangkok

INTRODUCTION

In the present report the writer has attempted to illustrate the cooperative role USOM has played in helping to promote Thailand's corn industry. In many cases that attempt may give the mistaken impression that USOM achieved this progress alone. Actually, such is not the case. The effort that has promoted this industry is the direct result of a very close cooperation between USOM and the Government of Thailand.

It has, in fact, been difficult to separate the efforts and contributions of USOM and those of the Thai Government. During many years of its operation, USOM did not attempt to distinguish its development programs from those of the host country. The cooperating parties, to a large measure, acted as one. As a result, the part each government played in corn development cannot be defined precisely.

PART I, THE DEVELOPMENT OF THAILAND'S CORN INDUSTRY

A. The Importance of Corn to Thailand's Economy

Among the developing nations, Thailand is cited as one which has made outstanding economic progress. The Kingdom's development is noteworthy on two accounts. First, it has moved at a rapidly accelerating pace since 1950. Second, this progress has been achieved quite largely through increased agricultural production. In contrast, the European community of nations, Japan, and other countries emerging from instability after World War II, depended on industry for their recovery.

The story of Thailand's economic progress is directly related to that of its crop diversification, a program in which the AID program has played a major role. It is more than a coincidence that U. S. technical assistance to Thailand began in 1950 and that one of its strongest programs has been that of crop development.

Before 1950, the Kingdom depended heavily on rice for her foreign exchange earnings. That year 34,625,000 rai [1] were planted to the crop. The rice harvest equalled 6,782,000 tons and its value was estimated at ₱5,190,600,000. [2] Total rice and rice product exports equalled 1,419,090 tons and earned ₱1,674,285,000 in foreign exchange.

In the same year, 1950, only 218,000 rai of corn were planted. Production equalled 26,900 tons and the value of the crop was estimated at ₱29,100,000. Of this, 12,630 tons were exported and earned ₱10,479,000 in foreign exchange.

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[1] 1 rai = .395 acre

[2] 1 ₱ (baht) = $.05

Ten years later, in 1960, 37,107,000 rai of rice were planted and 7,789,000 tons of rice were harvested having an estimated value of ฿6,628,100,000. Total rice and rice product exports equalled 1,213,040 tons and earned ฿2,596,241,000 in foreign exchange.

In contrast to rice, by 1960 developments in corn were remarkable. 1,785,000 rai of corn were planted, 543,900 tons of grain were harvested and the value of the crop was ฿549,300,000. A total of 514,745 tons of corn were exported, earning the nation ฿550,734,000 [1] in foreign exchange. In a ten-year period the area planted to corn increased more than 800 per cent. Production increased more than twenty times over that of 1950, and the foreign exchange earned by corn was over 21 per cent of that earned by rice in the same year.

Over the same ten years the area in rice production increased only 2,482,000 rai, a relatively small expansion. Most areas suited for paddy production had been under cultivation for many years already and new areas of inundated land for expansion were, practically speaking, no longer available. Although production in 1960 exceeded that in 1950 by 1,007,000 tons, total exports were actually down by 206,050 tons. This reflects a general increase in national prosperity which enabled people to consume more rice, and a population increase estimated at 3% per year. The increased value of exported rice in 1960 as compared to 1950 was ฿921,956,000 a gain which resulted largely from the higher price of Thai rice on the international market.

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[1] In 1960 the value of the corn crop was ฿549,300,000 while the nation earned ฿550,734,000 in foreign exchange. The difference resulted from a hold-over of part of the 1959 crop, the sale of which was reported under

Recently released figures show that the 1962 corn crop reached 684,827 metric tons. The value of the crop was ฿787,050,000. A total of 612,837 tons were exported, earning ฿651,568,300. /1 /2 By 1962 Thailand was the world's fourth exporter of corn, ranking after the U. S., Argentina, and South Africa. This demonstrates the importance corn has assumed in the national economy.

/1 Due to difficulty in agreement on fixing an equitable sale price with Japan, exports to that nation began late in 1962 and then continued well into 1963. The figure ฿651,568,300 is the earnings from the 1962 commitment though sales extended beyond the calendar year.

/2 In 1962 an additional ฿13,613,555 was also earned by the export of 11,723 tons of corn meal.

Note:

Statistics in this section were taken from "AGRICULTURAL Statistics of Thailand, 1960 - A bulletin printed by the Agricultural Statistics Section, Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture, Bangkok, Thailand.

1962 figures are based on yet unpublished information recorded by the port authority of Bangkok.

B. USOM's Cooperative Role in Crop Diversification

By tradition the Thai people have been rice farmers. Their culture for centuries has depended on rice. Until recently there was good reason to maintain that pattern. The uplands were largely jungles and without heavy equipment they were difficult to clear. Malaria was a serious problem and communication was almost non-existent because of the lack of roads.

USOM-Thai Cooperative efforts have been influential in changing the situation. By 1950, when the program began, it was already clear that rice culture had been extended almost as far as was advisable. Such early agronomy advisors as Dr. H. H. Love recognized that an improved rice culture would not support the national economy by itself. While he worked to develop the superior rice varieties Thailand is using today, he recommended that the Agriculture Department be strengthened and made independent of rice. A separate Rice Department was formed and Agriculture was encouraged to intensify its research on upland crop production.

Among its first efforts the Crop Development Project introduced and tested large numbers of rice as well as upland crops. Dr. Love and Mr. Howard Ream were early U. S. instigators in this program. Among the Thai Counterparts were Dr. Sala Dasanamla and Dr. Krui Bunyasingha. Besides corn, many varieties of kenaf, cassava, castorbean, edible legumes, fruit crops and vegetable seeds have continued to be introduced and tested under the program started then. The development of means by which such crops can best be produced and multiplied under local conditions has been the second phase of this program. Today evidence of the success of the work is shown by the rapid opening of upland areas for the production of new crops. A wide series of such crops are now grown on permanent farms which employ the improved farming practices worked out under the Crop Development

Project. In some cases the program has entered a third stage, i.e. specific breeding programs. An example of this is work on corn to develop varieties which fit specific needs. That work is reported under Part II of this paper.

The success of the crop development program is illustrated in the following table which shows the area cultivated, the production, and the export value of four principal upland crops: corn, kenaf, cassava and castorbean from 1950 to 1960.

Table 1

AREA CULTIVATED, PRODUCTION, AND EXPORT VALUE OF CORN, KENAF, CASSAVA AND CASTORBEAN (1950-1960)

	Area Cultivated 1,000 rai				Production 1,000 tons				Value of Exports 1,000 Baht			
	Corn	Kenaf	Cassava	Castorbean	Corn	Kenaf	Cassava	Castorbean	Corn	Kenaf	Cassava	Castorbean
1950	228	31	25	27	26.9	4.7	256	3.2	10,479	1,296	29,940	11,1
1951	259	68	25	82	41.7	20.0	256	12.5	21,307	4,337	17,485	39,8
1952	291	67	86	79	44.8	13.1	257	10.0	27,923	2,931	24,089	51,4
1953	298	60	94	65	51.1	11.0	282	9.2	46,958	7,602	45,810	52,3
1954	332	37	94	94	62.3	8.2	283	16.2	56,141	11,904	70,579	42,8
1955	347	53	86	91	67.5	9.8	258	15.5	79,998	8,537	69,165	35,8
1956	514	109	55	118	114.2	17.0	225	23.9	96,133	18,645	112,153	62,9
1957	606	78	240	166	136.8	21.0	418	32.5	74,391	46,128	136,678	86,9
1958	792	127	276	144	186.3	29.6	487	28.6	182,667	69,449	191,265	42,8
1959	1,249	278	391	176	317.2	50.0	1,083	34.0	249,512	88,323	223,191	77,3
1960	1,785	877	447	197	543.9	181.3	1,222	43.0	550,734	230,024	287,038	71,3

1/ Agricultural Statistics of Thailand, Bulletin by Agricultural Statistics Section Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture, Bangkok, Thailand.

The samples cited are important because they represent export crops which earn foreign exchange upon which the growth of the national economy depends. Equally important, though not cited, is increased production of the edible legumes such as peanuts, soybeans and mungbeans of the vegetable crops and of the local fruits. In the latter cases, increased production has largely gone into domestic consumption.

What has been achieved is the result of several joint Thai programs. The Crop Development Project could not have done the job alone.

Beginning in 1950, the Malaria Control Program freed thousands of rai of upland areas of malaria and made them habitable for cultivation. USOM-financed roads such as the Friendship Highway made communication possible in areas that had been inaccessable. Along such roads, it became possible to transport the new crops back to the consuming markets. USOM assisted land settlement cooperatives and with USAID-procured bulldozers, the jungles were cleared for these settlements. USOM assistance helped the developing rural areas with Community Development projects, with Agricultural Extension Education, and with Credit and Marketing Coops. USOM expenditures helped bolster the nation and stimulate its economy.

C. The Early History of Corn in Thailand

The first introductions of corn into Southeast Asia date back to a period shortly after the European colonization of the Americas. Corn was brought to Europe on Columbus' second voyage from the New World. Soon thereafter Portuguese merchant ships introduced the crop to Africa. By the middle of the 16th century, the Portuguese are known to have taken corn to China. Probably it also arrived in Thailand about this time as the Portuguese ships that traded with China also frequented ports in Thailand in the 16th century. In any case, corn was being grown at Ayuthya by the middle of the Ayuthya period 1350-1767. The crop, however, appears to have been grown mostly as an oddity until relatively recent times./1

After World War I, sporadic interest developed in the production of corn among certain individuals who had the opportunity to observe it in the United States. Such a person was Prince Sidhiporn Kridakorn who introduced two varieties of dent corn in 1932, while Director General of the Department of Agriculture. These were multiplied and grown at the government farms

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/1 This is not true of the Hill Tribes of Northern Thailand who appear to have been growing and utilizing a rustic type of corn as part of their diet over a long period. The first Christian missionaries to work among them in Burma noted that these people were growing corn in the middle of the 19th century. At the higher altitudes at which the Hill Tribes live the conditions are poor for the production of rice, though it is the staple diet. Corn may have caught on because it yielded a larger crop and could be grown with very little care.

for livestock feed. From then on, production gradually expanded. As far as is known, subsequent introductions were of U. S. origin and were apparently not well adapted to local conditions. They were poor in yield and quality.

D. The Introduction of "Guatemala" Corn

One of the early activities of the Thai-USOM Crop Development Project was the introduction and observation of large numbers of crop varieties. Among these corn was one of the most important. In 1950 and 1951, under Dr. Love's direction, the program introduced a collection of corn varieties from the U.S. and a second collection from Indonesia, where the Dutch had been active in corn research.

In 1951 Mr. Howard Ream assisted in the plant introduction work together with Mr. Somchai Dhamnoonragsa. From their observations, one variety among the Indonesian collection especially impressed them. The variety responded better to local conditions than did the American material. It yielded well and the grain was a flint type with a beautiful golden yellow color. The variety was called "Tiquisate Golden Flint". It had in fact been introduced to Indonesia from Guatemala only a short time previously.[1] Mr. Ream selected this variety which he called "Guatemala" corn for propagation.

On Mr. Ream's advice USOM obtained 100 lbs. of "Guatemala" corn seed directly from its country of origin. This was multiplied at the Bangkhen and Tha Pra Agriculture Experiment Stations during the 1952 growing season and distributed to selected farmers for further multiplication in 1953. The variety proved so successful that it rapidly became Thailand's only corn for commercial production. It is estimated that "Guatemala" corn now accounts for more than 95% of the corn exports.

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[1] "Tiquisate Golden Flint" was produced by the Iowa State Tropical Research Center in Antigua, Guatemala. It was developed as a varietal cross between a Cuban flint corn and a Guatemalan dent variety. It was taken to Indonesia in 1949 by the director of the center, Dr. Melhuse who served at the time as a consultant on a six month assignment in Indonesia.

The program for introducing and multiplying "Guatemala" corn achieved outstanding success. In 1962, ten years after the original propagation, corn production had expanded from 281,000 rai to well over two million rai and the value of the crop had increased from about 46 million baht to over ฿ 787,000,000. US$ 39,350,000

E. The Broader Aspects of Corn Production

One occasionally hears the opinion that the construction of the Friendship Highway, also USOM supported, was responsible for the success of corn production in Thailand. Although it is true that large areas adjacent to the highway have become profitable corn producing areas, due in part to the convenient market access provided by the new road and to newly developing foreign markets, it is also true that without the work of the agronomists who sought out, tested, and established a well adapted variety, and who had the seed multiplied, distributed and grown, the crop could not have prospered in the area. Moreover, only about one-third of Thailand's corn is produced in the vicinity of the highway. It is, however, of interest to note that the 1960 and 1961 export earnings of the Guatemalan corn grown in the vicinity of the heralded Friendship Highway could of themselves pay for the total cost of its construction. Such observation helps to bring into proper perspective the relative importance of activities such as those of Crop Development, which are comparatively insignificant in cost and seldom make dazzling headlines, yet which contribute importantly to the development of Thailand's economy. This is amply supported by another simple comparison: the total cost of the Agronomic Development Project in baht and dollars for the ten-year period 1952-1962 has been about $7 million,/1 whereas the total export earnings of "Guatemala" corn alone have been approximately $130 million during the same period.

/1 It is estimated that not more than 10% of this sum was used for corn research. For a detailed break-down of how project funds were spent see PART II, Section J. "The U.S. Contribution to the Crop Development Project".

F. The Effect of Management Practices in Increasing Corn Production

Since 1951 the Crop Development Project has supported activities in the fields of Agronomy, Soil Fertility and Crop Defense. Soon after the introduction of "Guatemala" corn it became apparent that its yield depends heavily on the management practices employed in growing it. Specific requirements need to be provided if the variety is to approach the yield of which it is capable.

The requirements of the crop were systematically studied and the results of this research have gradually been passed on to the growers through farm demonstrations and extension education. The success of this research is borne out by continued national average increases in corn yield. In 1950 the average yield of the corn crop was 127 kg. per rai. By 1955 it had reached 196 kg. per rai. From then to the present the national average has continued to increase ever more rapidly as shown by the following table. By 1961 the national average reached 321 kg. per rai, but by then it was apparent that, because of soil depletion, some areas were already in danger of rapid decreases in production. The need of chemical fertilizers and of land conservation practices had become evident. This problem is discussed in a later section.

Table 2.

AVERAGE CORN PRODUCTION INCREASES (1950-1961)

Year	Av. Yield
1950	127 kg/rai
1951	163 "
1952	165 "
1953	173 "
1954	191 "
1955	196 "
1956	225 "
1957	229 "
1958	238 "
1959	256 "
1960	306 "
1961	321 "

1) Time of Seeding

Among the early research on "Guatemala" corn was a study on its response to sunlight. Time of seeding was found to be closely related to production. American technical advisors and Thai counterparts worked together to study the problem. They found that in each area, highest yields were obtained when "Guatemala" corn was planted as early as possible after the rains set in. Subsequent trials under irrigated conditions showed that the variety's ability to yield was proportionate to the number of sunlight hours it received. Thus rain was the limiting factor in determining how early to plant the crop in any particular area. The rain records over many years were studied and from them recommended seeding dates were worked out

for the entire Kingdom. They correspond in each area to the earliest date that the monsoon normally falls in a continuous pattern. In the area adjacent to the Friendship Highway, the rainy season is somewhat longer than in Saraburi and Lopburi, Thailand's two other major corn production areas. This allows the production of two crops of corn in some seasons. The practice is not recommended because the first crop must be planted in April or May, at least a month before the rains normally fall on a continuous basis. The first crop frequently fails or, because of insufficient rain, it develops poorly. The second crop likewise yields less than a planting at the recommended seeding date because it cannot be planted until August or September, two months after the recommended seeding dates. USOM and the Ministry of Agriculture jointly recommend one crop of corn followed by a grain legume in the area.

2) Method of Seeding

It was found that drilling the seed in rows, a method of planting generally practised in the U.S., was not best when using the "Guatemala" variety. Unlike many American hybrids, it never tillers and generally produces only one ear per stalk. This may account for the fact that best yields are achieved when the variety is grown in hills. Successive trials have revealed that a planting distance of 1 meter between rows and fifty cms. between the hills in a row produce the highest yields.

Two plants per hill have been found to be the best number on old soils. This is equivalent to 6,400 plants per rai. On new land or on soils where adequate rates of chemical fertilizer are applied 3 plants per hill, a population rate of 9,600 plants per rai, have given the highest yields.

3) Seedbed and Cultivation Practices

The USOM agronomy advisors have continuously recommended that the seedbed be carefully prepared before planting corn. They have recognized the need of good cultivation to control competitive weeds. The importance of good farm management practices was difficult to explain to the new generation of corn farmers. Many of them had been accustomed to growing rice, a crop in which the fields are left unattended after the seed has been planted until the rice is harvested.

Controlled trials were run in 1955 and 1956 by the USOM Agronomy Advisors Messrs. Reece Dampf and Gordon Middleton to compare the yields obtained when "Guatemala" corn was planted on poorly prepared land without cultivation and when the crop was grown with adequate land management practices. They found that the yield was proportionate to the care given it. Middleton was responsible for influencing some of the farmers in the Pakchong area who first imported tractors. Since then the success of those farmers and the boom in the corn market has encouraged the importation of an ever increasing amount of farm machinery. As a consequence, seedbed preparation and cultivation for the control of weeds has improved each year.

4) Corn Fertilization

The Crop Development Project has placed considerable emphasis on corn fertilization and the use of chemical fertilizers in the production of corn. Numerous comparative yield trials have been run in various parts of Thailand and generally they have demonstrated a good response to fertilizer use. However, the use of chemical fertilizers on corn has not expanded as fast as had been hoped. The reasons for this are various. The cost of fertilizer is relatively expensive. Adding to the expense is the fact that

transportation costs are high. Usually the farmer lives on credit until he can sell his produce. Interest rates are high. The use of chemical fertilizers has thus not always been compensatory, a fact which has led to the wide-spread belief that fertilization is not necessary. Besides, there is confusion on the part of individual farmers as to what fertilizer ratios, grades and rates should be employed on their particular farms.

Considerable progress has been made in lessening the confusion. As a result, the use of fertilizers in corn production is now helping to increase the national production average.

The first step in the fertilizer research program was to find a suitable ratio of Nitrogen, Phosphorus and Potash. A $2N:2P_2O_5:1K_2O$ ratio gave the best results for most corn producing areas of Thailand. As the soils analyses of the areas show that the natural supply of Nitrogen and Phosphorus is moderate while that of Potash is high, the 2:2:1 ratio found best in yield trials is as expected.

Next, different grades of fertilizers compiled in a 2:2:1 ratio were compared to determine which formula gave highest response at least cost. A 12:12:6 formula was calculated to be the most economical. This is equivalent to 12 kgs. of available N, 12 kgs. available P_2O_5 and 6 kgs. available K_2O for each 100 kgs. of the formula used. The sources of fertilizer generally employed are ammonium sulphate, double superphosphate and potassium chloride.

Finally, so as to make further headway in dispelling the confusion, a general application rate of 12-12-6 fertilizer grade was sought. In most cases this has turned out to be 50 kgs. per rai or the equivalent of 6 kgs. N, 6 kgs. P_2O_5 and 3 kgs. K_2O per rai for soils of average fertility. Of course,

this is too low an application rate for depleted or poor soils and in each case it would be best to have a soils analysis before making an individual recommendation.

5) The Use of Green Manures

A program was undertaken to test the effect of a late crop of green manure at the end of the previous season on increasing the corn crop the following year. Twelve green manures were grown and turned under, both alone and with different fertilizer treatments. It was found that of the twelve green manure species, Crotalaria juncea gave the best results in increasing corn production.

When chemical fertilizers were used in conjunction with the Crotalaria crop, the most effective one was a single application of double superphosphate at a rate equivalent to 6 kilos of available P_2O_5 per rai. This should be applied at the time the Crotalaria is seeded.

G. The Crop Demonstration Program

By 1959 "Guatemala" corn was well disseminated throughout the Kingdom. It was available to anyone who wished to use it for seed; in fact it was already difficult to buy the previously established varieties. The basic agronomic requirements for good production already had been established for the variety, though the use of these practices was still limited.

Many upland farmers continued to plant corn on the basis of a primitive shifting agriculture. The brush or forest was slashed down and the larger trunks burned. The crop was seeded in patches, worked between the remaining roots. Such a system allows for the production of two or at most three corn crops. Then yields decline and the farmer has to move to a new area allowing the old patch to revert back to brush.

The available research findings were slow in being extended. The Agronomy Advisor in 1959, Dr. Jameson Bell, believed that a crash demonstration program was the best way to get Thailand's rice-oriented upland farmers to employ the new practices tested under upland farming conditions. The province of Udorn was chosen for this program and with the assistance of the Soil Chemistry Division of the Department of Agriculture, the resources of the Crop Development Project were placed behind it. Mr. Jin Rakkarndee, who was then governor of Udorn, also supported the program enthusiastically and backed the demonstrations with the assistance of the strong community development organization which he had developed. In 1959 every village in Udorn was provided with demonstrations on improved methods of growing upland crops. There were demonstrations in 916 villages. There were 475 sugar cane demonstrations, 444 peanut demonstrations, 1,832 plots demonstrating the use of green manure crops and 721 demonstrations on the newest methods of corn production.

The program has been criticized for its over-saturation of efforts. Many officials within the Department of Agriculture felt that the same results could have been achieved with fewer demonstrations and a stronger program of farmer extension education. They considered that the program provided an excessive use of project funds for a single province and believed that this should not have been justified since it meant other crop development activities of more general application had to be restricted. Nevertheless, in retrospect the 1959 program helped to produce very positive results. Through the undertaking the value of farm demonstrations was made clearly evident as a method for getting new upland practices accepted. The demonstration techniques developed then have continued to prove effective in the cooperative USOM-Department of Agriculture efforts to expand the establishment of upland farming on a permanent basis. In fact, Dr. Bell's initiative and the techniques he employed are often given credit for first having gained large scale acceptance of what were then newly tested farm practices. Since 1959 similar farm demonstrations have been employed on a more moderate scale throughout most of the Kingdom's upland farming areas. They continue to be an important tool of the Extension Service.

PART II, RESOLVING TECHNICAL PROBLEMS OF CORN PRODUCTION IN THAILAND

A. The Problems Related to National Corn Production

As corn production continued to rise in the late 1950s the nation became dependent on the foreign exchange the crop earned. Nevertheless, there were already warnings that the crop's long term expansion was threatened. These are discussed below.

1) Thailand's Restricted Market

One of the problems Thailand's corn trade faces has been its unbalanced dependence on a single market. About 80% of Thailand's corn goes to Japan. Her other markets are Hong Kong, Singapore and Malaya (14%) and the United Kingdom (6%). For this reason the Japanese have held a strong bargaining position and they have used it. They have justly complained about the high moisture content in Thai corn. They have caused concern in influential government circles by a persistent claim that the desired golden yellow color of "Guatemala" corn is degenerating and losing its intensity. /1

/1 Guatemala corn was in fact developed as a cross between a golden flint and a canary colored dent. This intervarietal origin is responsible for its good production. At the same time it results in a certain percentage of segregation each generation to the lighter colored parent type. There is no evidence that the rate of the segregation is increasing. A poor selection of ears for seed, i.e. a selection for size with a disregard for color, can increase the amount of light colored grain in the following generation. This problem is being met by a seed certification program discussed later.

2) Intensive Cultivation without Fertilizer Usage

By 1960 it had become apparent that the entire belt along the Friendship Highway where corn production had made its initial advances was threatened by soil depletion. After two or three cultivations without chemical fertilizers the production on many farms tapered off seriously. However, this is the area where double corn cropping has been extensively practiced. The use of proper seeding dates, advised seeding rates and good soil tillage practices did assist in increasing production, but they could not prevent production decreases when soil fertility became depleted. Also serious erosion is developing due to the clearing of forests on land too steep for row cropping. In short, over-intensive cultivation is already a problem.

3) New Land for Further Expansion Is Limited

In Thailand where upland farming has had a short history the problem of shifting agriculture was not recognized at first. With the increase in upland farming, new lands available for cultivation have been reduced. Consequently, in recent years an effort has been made to preserve existing forests for the nation. This means future increases in national corn production will have to be achieved largely through improved farm yields per unit area. Soil and water conservation practices will have to be taught and applied. Chemical fertilization will be required on an expanded scale and superior varieties must be developed.

4) A Need to Obtain Improved Corn Varieties

The realization that "Guatemala" corn was not a fixed type and the knowledge that its yield potential is below that of American Hybrids, has caused concern.

In 1957 Mr. Somchai Dhamnoonragsa, after a year's training under the U.S. participant program, returned to Thailand with a large number of U.S. inbred lines. He began to make hybrids in Thailand. His hybrids yielded better than Guatemala corn, but they were dent, a type of corn unacceptable to the Japanese market. Also, under the tropical conditions of Thailand most of the U.S. inbred lines were too weak to be maintained.

In 1958 Oregon University, under USOM contract to assist Kasetsart University, initiated a second series of hybrid investigations. Dr. F.E. Fore, the Oregon corn-breeder, introduced a collection of hybrid corn varieties from the U. S. and the Philippines. A number of Dixie hybrids and one Philippine hybrid showed good yield potential, but this hybrid program was also faced with serious hurdles for the same reasons mentioned above. Hybrid seed has to be made each year, for if planted a second time, the yield is seriously decreased.

5) Insect Pests and Disease

During the early years of Thailand's corn industry, the need to use defense practices against corn insects and corn diseases was not great. As the crop become more intensively cultivated, however, both insects and diseases rapidly increased. Several corn pests are now serious and means for their control must be found.

B. The Need for a Concerted Action Program

By 1960 it was recognized that a serious effort was needed to solve the developing problems confronting the corn industry. It was evident that only a combination of efforts would achieve required results.

The Ministry of Agriculture asked USOM for assistance. The USOM program had played a major role in the development of the corn industry. Now the Ministry hoped the USOM Crops Development project would be equally effective in face of the new problems which confronted corn production.

Variety introduction and testing, the establishment of proper seeding dates, and the investigation of planting and cultivation practices, entailed a simple type of research. Solutions to the new problems, however, required skilled technicians, detailed procedures and advanced research methods. In 1960 Mr. Charles Breitenbach was transferred from Latin America to be Agronomy Advisor in Thailand. He had been associated with the Rockefeller Foundation's Inter-American Corn Projects and served last in Guatemala. There he had worked with Tiquizate Golden Flint, the "Guatemala" corn of Thailand.

The Agronomy Advisor arranged a second introduction of "Guatemala" corn. One hundred lbs. of Tiquizate Flint corn was purchased by USOM and airshipped from Guatemala in June of 1960. The seed was multiplied at Pakchong by the Department of Agriculture. Comparative tests proved that it was identical to the previous 1952 introduction. The new introduction segregated to light colored flint corn in the same proportion as did the original introduction. It was identical in appearance and its productive capacity proved to be the same as the original "Guatemala" corn in comparative yield trials.

This comparative study crystalized two facts. First, it was evident that the decreased yields obtained on an ever greater number of farms in the Pakchong area were not the result of a loss in yield potential. Second, the segregation to light colored dent corn was an inherent character of the variety. This proof that there had been no "degeneration" in either quality or productivity made the need of a breeding program to improve yield and to fix quality self-evident. /1

/1 In spite of the 1960 comparative trial the belief has persisted that Guatemala corn has deteriorated and that this accounts for its segregation. Because of pressure from Japanese importers to maintain the golden flint character, the Ministry of Commerce has been insistent that large amounts of Guatemala Corn once more be introduced from Central America and that the old seed be replaced with new. Under this pressure the Ministry of Agriculture had a third introduction of 500 lbs. introduced for multiplication. Comprehensive trials on seed characters, plant morphology and yield at the Bangkhen Experiment Station have demonstrated again that the three introductions are each identical.

C. The Initiation of the Coordinated Program for Corn Improvement

In 1960 the question was debated whether Thailand should breed a double hybrid as the Oregon Contract team suggested. The USOM Agronomy Advisor did not think so; instead he favored a program for the development of synthetic corn varieties. In Latin America the Rockefeller Foundation had had excellent success with such programs. The conditions in Thailand were not dissimilar.

Mr. Breitenbach made contact with the Rockefeller Foundation and learned that Dr. E. J. Wellhausen, the Director of the Mexican Corn program, was to visit India. The Ministry of Agriculture invited him and the Foundation's corn breeder in India, Dr. Ernest Sprague, to survey the corn situation in Thailand. In October 1960 a meeting was held with Mr. Insee Chandrastitya, the Rector of Kasetsart University, Prince Chakrabandhu Pensiri, the Present Director General of the Department of Agriculture, Dr. Wellhausen, Dr. Sprague and Mr. Breitenbach. A program of coordinated research for corn improvement was developed.

The Rockefeller experts agreed to assist in outlining and guiding such a program on two conditions. They requested that USOM sponsor the program and provide a resident technical advisor, and they insisted that there be only one corn program. The Ministry of Agriculture and Kasetsart University were requested to integrate their efforts under the coordinated program.

USOM agreed to the arrangement since it could not on its own direct and support a program of the scope proposed. As it had been associated

with the corn development program since its initiation, it was anxious to support the joint venture. Since 1960, USOM funds for corn research from both the University Contract and the Crop Development Project have been spent jointly on the coordinated program. Rockefeller funds as well as contributions from the Thai National Research Foundation, the Ministry of Agriculture and Kasetsart University have also been used.

On subsequent trips Dr. Sprague set up a research program and the Ministry of Agriculture provided a one hundred rai tract of land at Prabuddhabat, in the province of Saraburi, for use as the coordinated program's corn center.

The corn breeding activities under the program include: (1) controlled mass selection in "Guatemala" corn, (2) the production of a synthetic corn from "Guatemala" germ plasm and (3) the development of flint and dent synthetic varieties from superior Caribbean germ plasm. In addition to corn breeding, there is a program for the production of certified "Guatemala" corn seed. Work in corn fertilization and pest control are also part of the coordinated research.

D. The Development of a Synthetic Variety from Guatemala Germ Plasm.

This is a program to obtain a pure golden flint corn with an improved yield potential out of "Guatemala" germ plasm. It makes use of the inbreeding procedure so as to break down the germ plasm complex into individual components. These components are tested for their yielding ability. The superior components are saved and recombined into a new "synthetically composed" corn containing only superior germ plasm. In the process the poor yielding components are systematically strained out and eliminated.

This synthetic system utilizes only first generation inbred lines. For that reason the difficulties of maintaining weak advanced generation inbreds do not arise. The first phase of the program is to select a number of individual plants within a multiplication plot; each must be superior in appearance and free of disease or insect attack. About 400 such plants are selected. The male and female flowers are bagged and a self-pollination process is carefully employed. At the time of harvest a cursory examination is made of the selfed ears. Those which demonstrate poor characters, such as malformation or disease, are eliminated. Those that do not have a good golden color or which are dent in type are also eliminated.

The selected ears are degrained and carefully labelled. The grains in each case are separated into two equal parts. One half of the grains of each selfed ear is stored in a cold room where germinability is carefully maintained. These are the "remnant seeds" which will be used to make up the synthetic after a process of testing and elemination.

The second stage of the synthetic breeding program is to produce top cross or "half-hybrid" seed. The latter is used to test the good yielding components in order to strain them off from the poor germ plasm in "Guatemala" corn. In each case, the "non-remnant" half of the seed of every selfed ear is planted in an individual row. It is systematically hybridized with the open-pollinated "Guatemala" variety.

The third stage is to test the "half-hybrids", each composed of a once selfed line fertilized by "Guatemala" pollen. Such "half-hybrids" are tested in comparative yield trials in which the non-improved "Guatemala" variety serves as the control. At the time of harvest, the yield of each half-hybrid is weighed and compared by the analysis of variance method. In every case where the "half-hybrid" yields significantly more than the original Guatemala, the yield trial has proven that the once selfed female parent possesses superior germ plasm than the non-improved "Guatemala" corn. Where the "half-hybrid" yields less than the original "Guatemala" the trial proves that such a once-selfed female parent possesses a significantly inferior germ plasm component. With this the first half of each once selfed line has served its purpose. (Future work in the synthetic process makes use of the "remnant seed" stored in the cold room).

The fourth stage of this procedure is to eliminate those one generation inbred lines which did not produce "half-hybrids" significantly superior in yield to the "Guatemala" variety. These are discarded. Only once-selfed lines which have produced superior "half-hybrid" seed is retained. This superior "remnant seed" is thoroughly mixed, and planted in

isolation blocks for multiplication. The product is a first cycle synthetic variety.

Such seed is now being multiplied at the Prabuddhabat Corn Center. After the first cycle synthetic "Guatemala" corn has been increased the process will be repeated a second time to produce a second cycle synthetic so as to further select a highly productive population from Synthetic I. This seed (Synthetic II) will also be propagated and the process repeated for the third time to produce a third cycle synthetic, and then a fourth cycle synthetic, etc. until no further increase in yield can be achieved by the described method.

The synthetic method has the advantage that seed can be multiplied and released after each cycle. Such seed when maintained in isolation, to prevent contamination from foreign pollen, will breed true as does a pure variety. It has many of the advantages of hybrid seed.

In their Latin American programs, The Rockefeller corn breeders have obtained about a 15%/1 increase in yield during the first and second breeding cycles. In later synthetic cycles increases in yield have been found to taper off because the germ plasm becomes more and more selectively purified after each cycle of breeding.

/1 Preliminary investigations on the first cycle synthetic developed at Prabuddhabat under this activity also indicate that a yield increase of about 15% over the parent variety, open-pollinated "Guatemala", has been achieved.

E. The Development of a Synthetic Variety from Caribbean Germ Plasm

This has been a program for the introduction and testing of new germ-plasm types with known high production abilities. The program was initiated in the following way.

Tester varieties from the different ecological zones of Latin America were grown and compared under Thailand's conditions in a comparative yield trial. The trial demonstrated that the material from the Carribean area of Latin America (Northern-South America, Central America and the Carribean Islands) was well adapted to local conditions. On the basis of this trial, the Rockefeller Foundation supplied the coordinated program for corn improvement with its superior yielding indigenous varieties from the area. The introductions contained both flint and dent varieties.

On arrival in Thailand the introductions were separated into dent and flint populations. These populations have been planted separately in isolated blocks and allowed to intercross for four generations. Each "homogenized" population now is ready for improvement by the "synthetic selection" method described in the previous section.

Within these populations there exists the probability of isolating higher yielding synthetic types than is expected by the same procedure with "Guatemala" corn alone. Among the flint and dent complexes there should be a wider germ plasm base for the selection of good components than when only "Guatemala" germ plasm is used.

F. The Development of a Superior Guatemala Corn Type by Controlled Mass Selection

This is the simplest of the three breeding procedures. It is practised at the Prabuddhabat Station and 10 other agricultural research stations throughout Thailand.

The process is one of controlled selection within the Station's "Guatemala" seed-corn multiplication plots. The plots are systematically divided into minor blocks each 5 meters by 10 meters in area. During the entire growing period intensive care is taken to rogue out of the multiplication plots all off-type plants, all diseased plants, plants attacked by insects and any plants that have poor standing ability.

At the time of harvest the ears in each individual block are harvested separately and the 10 superior appearing ears of flint type are selected by sight. Each of these ears is degrained and the grain weighed independently. In every block the grain of the three ears that produced most yield by weight is saved. This selected seed from all the blocks is then bulked together. It becomes the breeder's seed which is used for the breeding plots the following year.

The procedure is effective only if the breeder's prejudice is eliminated from the selection process. Thus the three superior ears from every block must always be used as part of the bulk seed. This applies equally in those cases where the three ears appear greatly inferior to the ears of other blocks. Such a procedure is the control that eliminates a breeder's temptation to choose all selections from a few superior blocks in the field where high yield may in fact be due to a special condition such as high fertility and not to the innate yield potential of the individual plant.

In the controlled mass-selection breeding program two generations have been grown at each station. The third generation is being selected during the 1963 growing season. At most of the 11 stations, there has been achieved a 3% increase in yield each generation. The process is to be continued until no further increases can be obtained by the selection procedure.

G. The Seed Certification Program

The serious concern which has been expressed by the Japanese importers of "Guatemala" corn in Thailand has already been mentioned. PART II A., "The Problems Related to National Corn Production". They are critical because the variety is not a true-breeding flint. The Thai Government is also concerned because each year a certain percentage of "Guatemala" corn segregates to a light yellow dent-type grain. In 1962 a seed certification program was initiated by USOM and the Department of Agriculture to control that situation. The seed certification program is practised in the following manner:

Each year the mass ears are separated from the selected ears at the eleven agriculture stations where controlled mass selections are under way. The mass ears are inspected to eliminate any off-color dent ears. They are dried, degrained, and the seed is treated with insecticides and fungicides. This is the foundation seed which is supplied to certified seed corn producers the next year.

In 1962, 51 seed certification producers were supplied enough foundation seed to grow 250 rai of certified seed. Their multiplication plots were carefully inspected by agriculture officials to assure that the certified seed farms were in isolated areas and that recommended agronomic practices were employed in the production of their certified corn seed. The officers inspected each field and eliminated off-type plants.

At harvest, an ear elimination was made for the purpose of discarding all off-color, soft-grained ears. Samples of the grain were taken to the Bangkhen Seed Testing Laboratory./2 There they were tested for humidity, germinability, disease contamination, insect damage and other undesirable

properties. Where the seed passed the rigid inspection requirements, the certified seed farmers were given special seed certification tags and allowed to sell their corn as government inspected, officially certified "Guatemala" seed.

Seventy tons of certified seed was purchased by the Ministry of Agriculture in 1961 at 10% above the market price. It was distributed by the Ministry's Extension Service for resale to cooperating farmers at cost. This certified seed proved sufficient to plant an estimated 23,000 rai of improved "Guatemala" corn. /2

In 1963, the program is being repeated and it is hoped that close to 100 tons of certified seed will be purchased by the Ministry of Agriculture this year. Certified seed that is not purchased by the Ministry of Agriculture may also be sold to private dealers together with government inspection tags at the government bonus price.

/1 In 1960 and 1961 the USOM Crop Improvement Project purchased with commodity funds the equipment necessary for the Department of Agriculture to set up a complete seed analysis laboratory. This was in anticipation of the seed certification program. Two Department officials were trained under the USOM participant program in seed technology. They have now returned to Thailand and are now in charge of the seed laboratory.

/2 Two to two and a half kilos of "Guatemala" seed corn is the recommended seeding rate for each rai of land.

H. The Soil Fertility Program

Under the coordinated program for corn improvement, a very heavy application of fertilizer is being used on all breeding plots. This is equivalent to 200 kgs. per rai of a 12-12-6 fertilizer formula. Thus the available nutrients are: 24 kgs. N. 24 kgs. of P_2O_5 and 12 kgs. of K_2O per rai.

This heavy application of fertilizer is utilized to achieve a good resporse to fertilizer usage in the new varieties that the program will develop.

Preliminary studies have indicated the probability that open-pollinated "Guatemala" corn responds poorly to fertilizer usage. During many generations of natural-selection the variety's ability to respond to fertilizer may have become lessened. The germ plasm components capable of responding to fertilizer applications have probably become so masked by other components incapable of such response that "Guatemala" corn is no longer highly responsive.

It is thought that by maintaining high fertility levels in our breeding plots, the new material selected will be capable of greater fertilizer utilization. Chemical fertilizers will then have an improved effect on increasing the yields of our new releases than they do now on open-pollinated "Guatemala" corn. However, when unfertilized, the new releases will still produce substantially more than does the old variety.

Two specific fertilizer trials are being carried out by the coordinated program. The first trial is a comparative yield test of standard fertilizer formulas to obtain further accuracy in the use of fertilizer applications and to learn more about the fertilizer rates which should be recommended to farmers.

The second trial is a calibration of the actual soil nutrients in representative corn soil types with the specific needs of a corn crop in its use of available N, P_2O_5 and K_2O.

I. The Crop Defense Program

During 1962 two surveys were undertaken. The first was a survey of the diseases of corn. The second was a survey of the insect pests of corn. These surveys will have the effect of indicating which diseases and which insect pests may have epidemic potentials in future years. /1 They will provide the opportunity to test the effectiveness of both chemical and biological control measures in preparation for the time when such controls may be critically needed.

The survey and identification work on corn diseases indicates that five diseases were already widespread in 1962. These are: Ear Rot, Leaf Blight, Rust, Collar Rot and Smut. Also Bacterial Top Rot, a very destructive disease, was found in two localized corn producing areas. Investigations are under way by which it is hoped to prevent the disease from spreading.

The insect survey has identified over forty species of insect pests of corn. Of these sixteen species were found to cause serious destruction. One of the most serious is the Corn Borer (Ostrina nubialis). During the survey an effective corn borer insect parasite was discovered. The life cycle of the parasite is being studied with the intention of multiplying it in the laboratory and then releasing it as a biological control.

/1 In the 1962 survey, the Bombay grasshopper was observed and noted to be a serious potential pest. In 1963, it assumed serious epidemic proportions in Lopburi Province. USOM played a major role in the air-borne spraying which contained this epidemic.

J. The U. S. Contribution to The Crop Development Project

The total expenditure on the Crop Development Project in dollars and baht from 1951 through FY 1962 was an equivalent of $7,129,000. Of this, $2,491,000 was the U. S. dollar contribution. The counterpart contribution in baht was equivalent to $2,957,000. The Ministry of Agriculture's contribution from the national budget equalled $1,681,000 in baht equivalent, plus land and facilities.

It is estimated that approximately one third of the U. S. dollar contribution to crop development was spent on American technician's salaries and expenses; one-third was spent on training Thai participants, and one-third on the purchase of commodities for the program.

By 1963, twelve American Agronomy Advisors had served with the Project. Eight of these each served for one two-year tour. There were three Agronomy Advisors who served for two tours, or four years each, and one who served for three tours or a total of six years. In addition, three Entomology Advisors served with the project for one tour each and two Soil Scientists each served for one tour.

Under the project through 1962 the following numbers of participants had been trained abroad in the following fields for six months or more:

1) Planting Breeding - 10 participants
2) Agronomy - 7 "
3) Rotation Crops - 3 "
4) Fertility Usage - 8 "
5) Crop Defense - 15 "

About sixty participants had received third country training for short term periods, either at conferences or on specially arranged programs.

The commodities purchased out of the dollar contributions, in order of importance, were: agricultural equipment, scientific and laboratory equipment, seeds, fertilizers and pesticides, and vehicles.

About one-fourth of the counterpart contribution was used to pay the American technicians' costs and allowances. About three-fourths of the counterpart contributions have been spent on the actual operational expenses of the project.

The Ministry of Agriculture's contribution was employed to pay the salaries of local Ministry personnel and the maintenance of the Agricultural Research Stations.

The Crop Development Project has worked on a variety of field crops, as well as vegetable and fruit crops. It is not possible to determine the percentage of funds utilized in corn research. However, it is estimated that not more than 10% of the total project expenditures have been used for corn research.

COUNTRY CROP PAPER

THAILAND

RICE

I. Record to Date

1. Crop Production

Rice has been an important crop in Thailand's economy for many generations. In addition to being an important domestic food, it also has been one of the country's leading export commodities. The majority of farmers who produce rice are small holders owning their own land. The central region, often called the Menam Plain, is the greatest rice producing region. This plain is generally characterized by a low and flat topography, whose soil is generally a heavy clay. It used to be flooded yearly by the Chao-Phraya, Meklong, and Prachin rivers. However, the upstream impoundments have greatly reduced these inundations.

TABLE I. RICE PADDY (AREA, YIELD, PRODUCTION, 1948-1967)

Thailand

Year	1948-52	1952-56	1961	1962	1963	1964	1965	1966	1967
Area (Thousand Ha)	5211	5345	5654	6191	6387	5995	5970	6878 ~~5901~~	7154
Production (000 MT)	6846	7236	8177	9279	10,168	9624	9588	11,846 ~~13,600~~	11,198
Yield (MT/Hectare)	1.31	1.35	1.45	1.50	1.59	1.61	1.61	1.72 ~~1.64~~	1.63

Although rice production has fluctuated from year to year, the trend has been upward during the past 20 years. In 1967, the crop of about 11 million MT was approximately 46 percent greater than the 1948-52 average. During this same period, the yield per hectare increased from 1.31 MT to 1.63 MT, or 24 percent, while the area grown increased about 37 percent. Thus, the production increase has resulted from both yield increase and more area devoted to rice, with the latter being the more important factor.

Thailand is an example of a country which has been a surplus producer of rice for many years; thus, there has been concern about the foreign market potential and little need for pressure to speed up production for domestic use. The imposition of an export tax on rice exported has tended to depress the price to producers and keep the price to consumers relatively low as well as serving as a source of revenue to the government. The Thailand Government and A. I. D. programs have tended to put greater emphasis on diversification in farming rather than increased specialization in the production of rice.

2. Input Utilization

A. New Seed Varieties.

In 1967, the RTG established a rice production goal of 13.7 million MT for 1971 in its development plan. An agricultural growth rate of 4.3 percent was established for the agricultural sector in the plan.

Most of the increase in agriculture was scheduled to come from increases in crop production, with 0.84 percent per year to come from increases in rice production. In addition to planning for food for an expanding population, the Government aims in the Development Plan to increase rice exports by 30 percent to 2.7 million MT per year by 1971. There is some skepticism, however, among the Thai's of long range prospects for a good market for their rice exports.

The rice program calls for improvements in productivity more than expansion of acreage under cultivation, which is a change from the practice in the past. In its production programming, Thailand has not used the IRRI or Taiwan short stem varieties per se to any extent. However, IRRI varieties were introduced and tested on a trial basis in limited areas with water control during the last two years and excellent results were obtained. However, the Department of Rice has developed crosses which are as good and which possess the characters desired by Thailand in its export rice. These are mainly long-grain, good milling qualities, and high yield. An important reason for not promoting the IRRI varieties is that they are short-stem rices and could not be grown in areas where the water depth is variable (from one to several meters) and not controllable during the growing season. The Rice Department is using the IRRI varieties in its hybridization program. It has also done considerable research work in developing a specialty long-grain rice of good milling quality of glutinous varieties.

These new rices yield over 8.2 MT per hectare in performance trials. Some of the developed varieties are resistant to diseases and are higher yielding. Some are also responsive to the application of fertilizer as the IRRI varieties. The Rice Department is supervising demonstration programs to encourage farmers to increase use of fertilizers and insecticides, and to use its developed higher yielding varieties of rice.

In the October 1968 issue of the Asian Survey magazine, the following research findings were reported: (1) "--that if the sowing season of photosensitive varieties cultivated during the rainy season was delayed, the variety's growth period could be shortened, which would result in more efficient grain production and consequently increase in yield." (2) After 1965 many experiments were conducted in many places in Thailand. The results confirmed, "--that if planting is done in August or September, 30 to 40 days later than usual, the plant height is shorter by 1 meter and maximum output is achieved." (3) "In another experiment in Bangkok in 1966, the recommended variety, Puanahk, which was sowed at the beginning of August and planted at the beginning of September, recorded a yield of over 6 tons/ha. In the test, nitrogen was applied at the ratio of 100 Kg/ha in three installments." (4) "Although this method may not be applicable to every paddy field because of water supply conditions, it is high time for other South and Southeast Asian countries to start experiments along the same lines."

B. Land.

As indicated in Table I above, the trend in acreage devoted to rice has been gradually upward. This has not been at the expense of other crops inasmuch as plantings of other crops have also increased. In 1963, about 66 percent of Thailand's arable land was in rice. Most of the rice is grown under irrigated or rainfed conditions. Upland rice probably represents no more than one percent of the crop acreage. Second crop (dry season) production is also small, but increasing. It probably represents less than five percent of the total rice area harvested. Most of the dry season crop is in the north and Central Plain fringes. The relative importance of irrigated and rainfed areas varies sharply among different provinces. Rice cultivation is composed of paddy cultivation and "flooded" rice production. In the paddy area, about 20 percent is artificially irrigated. About 80 percent of the crop is transplanted. It is estimated that one-third of the national rice production comes from Northeast Thailand of which most is glutinous.

C. Fertilizer.

It is generally recognized that Thailand has a great potential for increasing yields. Thailand has no proven deposits of phosphate, potash, or sulfur requisite to the production of complete fertilizers; thus, must depend on imports for such ingredients. During the past 16 years, fertilizer use has increased from 17 to 20 percent per year. Imported

fertilizers in metric tons since 1950 have been as follows:

1950	9,354
1955	24,280
1960	52,163
1961	54,757
1962	66,465
1963	97,375
1964	108,977
1965	86,617
1966	131,407
1967	217,944
1968	183,214

In 1967, production from Thailand's plant at Mae Moh was expected to come on the line according to the TVA report of May 10, 1966. Capacity of this plant is about 30,000 tons of urea and 60,000 tons of ammonium sulphate annually. The importation of mixed fertilizers can be made free of duty. However, an import ban has been placed on urea and ammonium sulphate. Imported fertilizer costs are about $25 to $30 per ton less than cost of production at the Mae Moh plant.

No specific figures are available on the actual crop uses of the fertilizers. Except for demonstration purposes, distribution is through the private sector. An obstacle to the increased use of fertilizer for rice is the high cost of fertilizer as compared with the price received by the farmer for rice. The import restriction on urea could well adversely affect nitrogen use in Thailand.

D. Water.

Since 1949, there has been a marked increase in the total acreage of irrigable land in Thailand. The area increased from 1,559,000

acres in 1949 to 4,392,000 acres in 1962. A high proportion of this irrigated land is used for rice production. More acres irrigated and better water control in the irrigated areas hold high potential in increasing yields and production of rice in the future in conjunction with better yielding varieties and greater use of fertilizers.

E. Pesticides.

Imports of agricultural chemicals (most of which are assumed to be pesticides) have shown a steady increase in recent years. In 1967, the reported tonnage was 7,578 MT as compared with 4,578 MT in 1963. Of the 40 insects identified, 4 are considered serious as far as destruction is concerned. An RTG pest control program is presently being conducted with AID support to control rice pests, especially gall midge and stem borers. The extent of the use of insecticides in rice production is not known.

F. Equipment.

Since 1957, the annual increase of imports of tractors has averaged about 32 percent. Approximately 5,000 tractors were imported in 1968. Data are not available about the actual numbers of tractors used on rice production. However, the number would be small. Farm equipment dealers are selling most of their tractors and implements to Thai custom operators in the Northeast. Considerable adaptive research is being carried on to make tractors and equipment more suitable for use in land preparation, harvesting, threshing, and storage and handling of

rice. Only a small proportion of the rice producing area is presently suitable to the use of mechanical equipment; but with changes in equipment and better water control, the potential for mechanization in the future is considerable. Recently, engineers of the Rice Department developed the "Iron Buffalo" which has proved practical in paddy cultivation. Water pumps are increasingly being used to good advantage for better water control in seed beds as well as in irrigated rice producing areas.

3. Policies and Prices.

A. Output Prices

1. The "rice premium" is an export tax imposed on export sales of rice. It is levied directly on the exporter and is calculated as a percentage of the world market selling prices. The rate has varied between 35 and 40 percent depending on the grade of rice exported. Government revenues from this source amount to about $50 million annually. In 1967, this source accounted for about 5 percent of total revenues.

The effect of the tax is to keep prices received by producers about 40 percent lower than they otherwise would be based on world prices. Rice prices to domestic consumers likewise are less. Subsistance producers of rice are practically unaffected by the tax.

2. The Government also announces each year minimum support prices to producers for rice. These support prices during the past two years, at least, have been so low that local market rice prices

have been consistently higher than the support levels. Yet without support prices, local prices would have been much lower.

3. Thailand in recent years because of low exports from Burma is second to the United States as an exporter of rice. Their export goal for 1968 is down to 1 million tons, as compared with 1.4 million tons shipped in 1967. Fear of domestic shortage apparently led the government to limit exports during late 1967 and the early part of 1968. Exports during the first 8 months totaled 620,000 tons, down 45 percent from the same period of 1967. The limitation was removed in September 1968. Export prices F.O.B. Bangkok per metric ton, on December 23, 1968, were $192 for white rice 100 percent 1st grade. This was $38 lower than on the same date a year ago.

B. Input Prices.

The following are obstacles impeding increased productivity and incomes from rice production: (1) Shortage of trained manpower, and especially agricultural specialists with practical knowledge of rice growing and proper motivation for field work; (2) Shortage of reasonable priced credit; and (3) Need in the Northeast for more irrigation facilities, roads, transportation, and better means of distribution of supplies and marketing product.

C. Net Return.

Net return to the grower is not available from reliable studies. It is our belief that net return to grower would follow that of corn, i.e. approximately 70% of wholesale market price to grower.

D. Input Availability.

The Government looks largely to the private sector to distribute supplies. A reasonably good system of distribution is functioning. The TVA fertilizer study report indicated that lack of farm credit was a limiting factor in production. This also was emphasized in the report on Northeast Thailand by the Agribusiness Council Survey Team (June 28, 1968).

E. Market Limitations.

None in past. Reduced demand from historical importers could become an export limitation. No zonal barriers to grain movement are known.

4. Institutions.

A. Research and Extension.

As indicated in Section I, the Rice Department of the Ministry of Agriculture has conducted research toward improving varieties of rice. The Department of Agricultural Extension is carrying on demonstration programs to encourage use of fertilizers and insecticides, and higher yielding rice varieties. Individual business organizations providing commodity farm inputs in a limited way also are providing

farmer education through their distributor system. The public and private sector efforts, however, are not large enough to meet the needs. A study report on Northeast Thailand by the Agribusiness Survey Team of the Agribusiness Council, Inc. issued June 20, 1968, indicated that there was need to coordinate the efforts of complementary services. This requirement for coordination could best be met by existing Thai Government extension organizations in collaboration with the private business sector.

Considerable progress has been made in training research and extension workers in recent years. Under various programs, 56 Thai scientists have been trained in the United States and returned to work on various research programs. There still exists a need for more trained research workers; however, it is not the problem that it was formerly. The same is true with respect to extension workers. More than 2,000 are on the rolls working in Thai agriculture. The problem is the existance of a bias toward centralization of planning and direction of program from Bangkok and a minimum of coordination in the field.

B. Credit.

The bulk of credit to the rice farmer still comes through traditional sources. In 1967, farmers received approximate $1,656,597 from the Bank for Agriculture and Agricultural Cooperatives, which was used to finance rice production on 257,788 acres of land.

The normal procedure is for the village merchant to advance to the farmer necessary capital for seed and fertilizer and some living cost credit. In return, the merchant receives a fixed amount of rice from the crop, regardless of the price at the time of harvest.

C. Input Distribution.

Fertilizer and insecticides have been made generally available through local distributors. Many have carried on training programs for dealers and have developed through these dealers a type of extension service for the distribution of their products.

Improved rice seed varieties presently are made available to the farmer in the Northeast through the Ministry of Agriculture at the subsidized price of ฿ 1.00/kg. of cleaned, treated and bagged seed. Thus, the new varieties rice seed are heavily subsidized by government as the farmer receives about ฿ 1.00/kg for paddy rice. Under these circumstances, private company sales of such rice seed cannot compete within the framework of this governmental program. Except for such new seed varieties, most seed is saved back from previous crops, although a small amount is available at village merchant stores.

D. Marketing and Storage.

Thai farmers rely almost wholly on village merchants, middlemen, or local mills for their total market outlet. In some areas, jobbers and brokers operate. They deal directly with farmers in buying

rice and moving it to the interior market for resale to the country merchant. Occasionally, they act as an agent for the country merchant to the Bangkok exporter. The single outlet for the country merchant is the Bangkok market. Exporters are active in this area. Village merchant volume offerings vary from a few 100 kilo bags to truckloads or to barge loads comprising up to 300 tons at a time. Country merchants have developed close relationships with individual Bangkok exporters.

The number of Bangkok exporters is large. A recent count showed 137.

Storage in the country is varied. Some farmer groups have limited storage consisting of up to 50 ton capacity at village locations. While at the Amphoe level storage capacity may reached as much as 400 tons. Local mills also have storage facilities of varying capacities. Other facilities are private godowns in the Bangkok and port areas.

E. Land Tenure and Ownership.

Most farm land (except in the Central Plains) is farmer owned and operated; thus, land tenure present no particular problems in Thailand. There is considerable variation in size of farms. In 1965-66, the average cultivated land per farm was about 9.6 acres. Of this acreage, about 7 acres were in rice.

F. Agricultural Education.

Kasetsart University, University of Khon Kaen, and about

25 Agricultural Vocational Schools are the main training institutions for agricultural training. Within the Ministry of Agriculture, the educational level is considered high in comparison to other developing countries insofar as technical knowledge is concerned.

5. Weather.

Thailand has a tropical climate, warm and moist and is well adapted to rice cultivation. The rainy or monsoon season begins in May and continues through September or October. The annual rainfall averages 40-60 inches in the rice growing areas. Temperatures are high during the dry season, with the central plain having a mean temperature of 98° F. during this period. During the 6-month dry season following the monsoon, little land is cultivated other than that under irrigation.

The highlands, which form natural boundaries with adjacent countries, create a large watershed which drains into the flat central plain and the centrally situated Chao Phaya river system. The sluggish and shallow nature of this river system causes it to overflow during the monsoon, annually inundating some 5,000 square miles of its flood plain. Over flooding has now been considerably reduced through upstream water impoundments.

The Korat Plateau, in the Northeast, consists largely of low fertility sandy soils covered with sparse natural grass vegetation; it supports most of the country's small but expanding commercial livestock

Table II-1: Physiographic Characteristics of Changwads in the Northeast and Central Regions: Area, Rainfall, Temperature and Relative Humidity

Region and Changwad[a]	Area[b] (Square Kilometers)	Rainfall, 1937-1963[c] (Millimeters) Mean	Rainfall, 1937-1963[c] (Millimeters) Standard Deviation	Mean Annual Temperature[d] (°F)	Mean Relat Humidity (percent)
	(1)	(2)	(3)	(4)	(5)
NORTHEAST					
19 Chayaphum	10788	1108	235		
20 Nakhornratsima	19590	1188	185	81.0	70
21 Buriram	10771	1251	268		
22 Surin	8784	1265	294	81.7	70
23 Srisaket	8813	1410	263		
24 Ubonratthani	22758	1555	278		68
25 Nong-kai	7223	1550	293		
26 Loei	10936	1291	526		
27 Udornthani	16605	1503	212	80.3	73
28 Sakonnakhorn	9539	1358	286		72
29 Nakhornphanom	5749	2258	315		
30 Khon-kaen	13404	1198	254		73
31 Mahasarakham	5760	1271	270		
32 Kalasin	7650	1376	247		
33 Roi-et	7856	1407	237		70
CENTRAL					
Bangkok Plain					
1 Chai-Nat	2636	1210	231		
2 Singh-buri	842	1120	278		
3 Lopburi	6588	1276	289	82.6	68
4 Sara-buri	2963	1482	255		
5 Ang-thong	981	1265	232		
6 Ayuthya	2480	1266	336		
7 Nonthaburi	623	1231	226		
8 Pathum-thani	1497	1402	205		
9 Thonburi	450	1408	262		
10 Phra-nakhorn (Bangkok)	1099	1451	199	81.9	76
11 Nakhornayok	2414	2262	431		
13 Samutprakan	934	1337	269		
48 Nakhornsawan	9677	1280	265	83.3	71
51 Suphanburi	5339	1275	234		
53 Nakhornpathom	2170	1257	264		
54 Samutsongkhram	399	1124	254		
55 Samutsakhorn	840	1416	303		
Southeast Coast					
15 Cholburi	4485	1360	270		72
16 Rayong	3307	1388	283		
17 Chant-buri	6052	3177	439	81.2	78
18 Trat	2919	3483	554		
Marginal Plains					
[illegible]kinburi	11795	[illegible]	[illegible]		

[illegible]engsao

Table II-1 (continued)

Region and Changwad[a]	Area[b] (Square Kilometers)	Rainfall, 1937-1963[c] (Millimeters) Mean	Standard Deviation	Mean Annual Temperature[d] (°F)	Mean Relative Humidity[e] (percent)
	(1)	(2)	(3)	(4)	(5)
Upper Plain					
41 Uttaradit	7614	1513	321	82.1	72
43 Sukhothai	6041	1213	273		
44 Phitsanulok	9539	1313	297	82.2	73
45 Kamphaengphet	8334	977	311		
46 Phichit	4530	1370	239		
47 Phetchbun	11176	1336	409		
49 Uthai-thani	6472	1079	183		
Western Highlands					
42 Tak	15699	997	207		
50 Kanchanaburi	19406	1000	318		64
52 Ratburi	5120	1206	250		
Peninsula					
56 Phetburi	6357	1153	293		
57 Prachuap-khirikhan	6373	1130	252	80.7	77

[a]The Central changwads are subdivided to approximate Pendleton's physiographic subdivisions (which did not always follow changwad boundaries). See Pendleton, et al. [II-30, Figure 1, p. 36].

[b]Until 1946 Kalasin was part of Mahasarakham. Other, relatively insignificant changes in changwad boundaries and areas have also occurred in the period of the study, but no systematic records of such changes are available. The area figures which are presented here are those found in Thailand [III-18, Table I, pp. 1-3].

[c]Calculated from data in Thailand [IV-2]. For Kalasin, the series began in 1947 (See footnote b above). For various other changwads, some observations were missing, as is indicated in the data which is presented in Appendix A.

[d]Huttenlocher [II-28, Table 25, p. 40].

[e]Huttenlocher [II-28, Table 27, p. 42].

Table II-2: Mean Monthly and Annual Temperatures in Selected Changwads in the Northeastern and Central Regions[a]

Region and Changwad	Mean Monthly Temperature (°F)												Mean Annual Temperature (°F)	Years of Record
	J	F	M	A	M	J	J	A	S	O	N	D		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
NORTHEAST														
2[illegible] Nakhornratsima	75.0	80.4	84.4	85.8	84.4	83.7	82.9	82.6	81.7	80.1	77.4	73.6	81.0	14
2[illegible] Surin	75.8	80.5	85.0	86.6	85.4	84.6	83.8	83.3	82.6	81.2	77.9	73.5	81.7	8
2[illegible] Chornthani	72.7	77.5	82.6	84.9	84.6	84.0	83.1	82.2	82.0	80.6	77.2	72.1	80.3	13
[illegible] Plains														
[illegible]buri	79.2	83.5	86.2	86.7	85.3	83.8	83.1	82.6	82.2	81.9	79.5	77.2	82.6	13
[illegible]-nakhorn (Bangkok)	78.1	81.0	84.0	85.6	84.9	83.8	82.8	82.8	82.0	81.3	79.5	77.4	81.9	27
[illegible]khornsawan	77.4	82.0	86.5	88.5	86.7	85.5	84.6	84.2	83.5	82.8	80.6	76.8	83.3	13
[illegible]st Coast														
[illegible]nut-buri	79.0	81.0	82.8	83.5	82.9	81.9	81.3	81.3	81.0	81.3	79.9	77.9	81.2	14
[illegible] Plain														
41 [illegible]teradit	75.6	79.3	84.4	87.8	86.4	84.2	82.4	82.9	83.5	82.8	80.2	75.6	82.1	12
4[illegible] [illegible]itsnulok	75.9	80.2	84.6	87.1	85.8	84.2	83.5	83.1	83.1	82.8	80.2	76.3	82.2	14
Pe[illegible]nula														
57 [illegible]rachaup-khirikhan	76.5	78.8	80.8	84.0	84.0	82.6	82.4	82.2	81.9	80.4	79.2	76.1	80.7	11

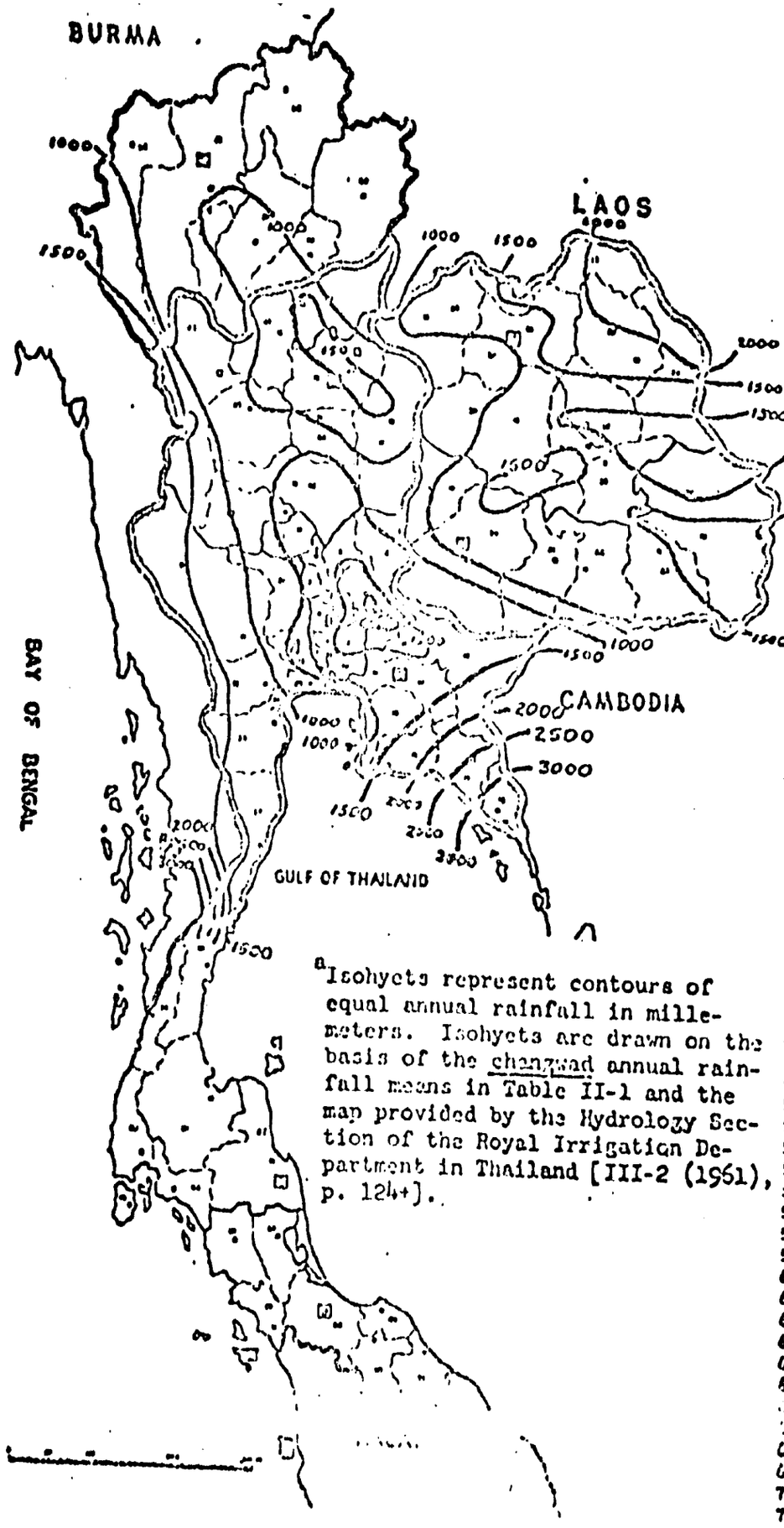
[a]Ibid., [illegible] 28, Table 25, p. 40].

Table II-3: Mean Monthly and Annual Rainfall in Selected Changwads in the Northeastern and Central Regions[a]

Region and Changwad	Mean Monthly Rainfall (Millimeters) J	F	M	A	M	J	J	A	S	O	N	D	Mean Annual Rainfall[b]	Years of Record
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
NORTHEAST														
20 Nakhornratsima	8	30	43	94	185	117	114	144	207	162	40	3	1142	21
21 Buriram	23	35	46	89	228	266	226	208	395	198	63	10	1788	16
22 Surin	3	13	48	68	178	170	185	244	266	165	33	1	1375	21
27 Udorn Thani	13	15	56	129	238	226	155	289	276	117	20	1	1535	13
30 Khonkaen	15	20	77	112	266	251	278	314	447	238	48	1	2070	15
33 Roi-et	8	25	46	119	180	193	203	175	268	68	3	1	1287	12
CENTRAL														
Bangkok Plains														
3 Lopburi	.5	18	38	91	137	142	162	193	236	137	33	3	1195	21
10 Phra-nakhorn (Bangkok)	10	20	38	66	144	150	165	172	304	228	66	10	1374	49
48 Nakhornsawan	5	23	23	43	124	132	142	177	222	160	35	3	1089	20
Southeast Coast														
17 Chant-buri	48	44	76	117	324	496	443	438	477	250	74	15	2287	30
Upper Plain														
41 Uttradit	15	15	38	76	203	213	198	271	317	135	25	15	1503	20
44 Phitsnulok	10	15	28	79	160	203	236	252	294	147	33	8	1463	21
Peninsula														
57 Prachaup-khirikhan	30	30	46	61	99	107	107	86	113	241	150	35	1103	27

[a] Nuttonson [II-28, Table 26, p.41].

[b] The mean annual rainfalls in this column are not identical to those presented in Table II-1 because of the different years of coverage. The anomalies between this table and Table II-1, even so, are quite large for Buriram, Khonkaen, and Chant-buri. Since Nuttonson uses the same primary source as does Table II-1, such large discrepancies are surprising.



[a] Isohyets represent contours of equal annual rainfall in millimeters. Isohyets are drawn on the basis of the changwad annual rainfall means in Table II-1 and the map provided by the Hydrology Section of the Royal Irrigation Department in Thailand [III-2 (1961), p. 124+].

Changwads:

1 Chai-Nat
2 Singh-buri
3 Lopburi
4 Sara-buri
5 Ang-thong
6 Ayuthya
7 Nonthaburi
8 Pathum-thani
9 Thonburi
10 Phra-nakhorn
11 Nakhornayok
12 Prachinburi
13 Samutprakan
14 Cha-choengsao
15 Cholburi
16 Rayong
17 Chant-buri
18 Trat
19 Chayaphum
20 Nakhornratsima
21 Buriram
22 Surin
23 Srisaket
24 Ubonratthani
25 Hong-hai
26 Loei
27 Udornthani
28 Sakonnakhorn
29 Nakhornphanom
30 Khon-kaen
31 Mahasarakham
32 Kalasin
33 Roi-et
34 Mae-hongsorn
35 Chiengmai
36 Chiengrai
37 Lamphun
38 Lampang
39 Phrae
40 Nan
41 Uttaradit
42 Tak
43 Sukhothai
44 Phitsanulok
45 Kamphaengphet
46 Phichit
47 Phetchbun
48 Nakhornsawan
49 Uthai-thani
50 Kanchanaburi
51 Suphanburi
52 Ratburi
53 Nakhornpathom
54 Samutsongkhram
55 Samutsakhorn
56 Phetburi
57 Prachuap-khirikhan
58 Chumphorn
59 Ranong
60 Phang-nga
61 Surat-thani
62 Nakhornsithamrat
63 Phuket
64 Krabi
65 Trang
66 [illegible]
67 Songkhla
68 Pattani
70 Yala
71 Nara-thiwat

industry. The river valleys in the Northeastern region, containing dark clay soils overlaid with alluvial deposits, are cultivated with double cropping of rice in combination with other crops such as upland rice, soybeans, kenaf or peanuts.

II. Assessment of Causes

1. Aggregate Statistical Relationships

To our knowledge, no significant time series statistical studies have been made. Over a period of years, rice production has increased at a rate adequate to take care of increased population and domestic consumption in Thailand plus approximately one-fifth of the crop for export.

2. Input Co-efficient Studies

To our knowledge, no such studies have been made.

3. Judgmental Assessments

As discussed under Section I (Record to Date), the Thai Government strategy has been to: (A) Study and improve their native varieties of rice rather than adopt and promote IRRI and Taiwan short-stem developed varieties; introduced high-yielding varieties are being used in hybridization programs for rice improvements;

(B) Put considerable emphasis on improved irrigation and water control;

(C) Use rice as a source of government revenue through the export tax.

There has been a good reason for attempting to stress improving their own adapted long-stem varieties rather than quickly promote outside developed short-stem varieties. Until more effective water control and irrigation is available to larger numbers of farmers, it would be unwise to quickly promote short-stem varieties. Also increased use of fertilizers and insecticides, which are costly inputs, are necessary components to realize the increased yields from the short-stem varieties. Crop losses from uncontrollable flooding of crop areas could be disastrous. Premium prices received for Thai high quality rice preclude the promotion of short-grain, inferior quality varieties.

The rice production program in general appears to be very sensible. Emphasis on increasing and improving irrigation and water control and diversification in agriculture appear to be sound developments.

III. U.S. Role

1. Policy Influence

U.S. strategy has been to assist the Thai government to speed up development of those programs considered sound in its economic development. In Thailand, this has been done mainly through supporting assistance and technical assistance, but also involves some development loans. Emphasis generally has been to encourage self-help programs.

Thailand has had a long history of rice production as a single basic crop. One of the first agricultural programs supported by A.I.D.

contributed to road development, clearing of new lands for cultivation, development of Community Development and Agricultural Extension programs, and technical assistance in the formation of credit and marketing cooperatives.

2. Physical Inputs

A. I. D.'s contribution has been in commodities, equipment and advisors to assist the Thai government in combatting its insurgency problems.

By 1963, some 17 U.S. Agricultural advisors had served with the crop development program for a total of 41 man-years. In addition, U.S. had provided training in the U.S. for 6 months or more for 43 Thai participants and an additional 60 participants had received short term third country training. Approximately one-third of U.S. dollar input was spent for commodities such as transportation, equipment, and scientific materials.

3. Technical Assistance Inputs

In rural development, A. I. D. has helped the Thai government focus attention on the Northeast and North where assistance was most needed. Support has been given in both long-term activities such as agricultural research and extension, agricultural credit, the development of small industries, and soil conservation programs and short-term impact projects such as wells, small ponds, and rural feeder roads.

As previously stated, some 41 man-years of technical assistance of U.S. experts have been provided. These people were primarily responsible for increasing emphasis on variety improvement and initiation of agronomic practices such as spacing, cultivation, fertilization, time of planting, etc., which have led to improvement in yields and production. They further were largely responsible for the change of emphasis to diversification.

4. Overall Effectiveness

The overall Thai economic development performance has been impressive. Since 1963, the average growth rate of the Thai economy has been 8 percent a year.

IV. Economic, Social and Political Ramifications

1. Differential Adoption of New Technology

Thailand developed varieties apparently are experiencing no problem with respect to acceptance by farmers. At the government subsidized distribution price at ฿1.00/kg (about the same price as rice paddy) the government has had no difficulty in distributing its research developed varieties to farmers. We have no evidence that size of farm has had any affect on acceptance of new rice varieties. Size of planting on most farms probably is more closely related to availability of land and labor at time of planting than to other factors.

2. Differential Availability of Inputs

None are known.

3. Income Distribution Effects

Larger farmers generally have the advantage of better and lower cost credit for use in procuring fertilizer and equipment used in production. They also are less at the mercy of the merchant middlemen with respect to the time and sale of their rice crops than are the small farmers. They may also do custom work with machinery for small farmers and thereby further increase their farm incomes. Farm machinery procurement comprises an important use for additional income.

4. Employment Effects

Rice production currently is primarily a wet season crop. Timeliness of planting and cultural operations are important factors affecting yields. Increased mechanization, especially in land preparation, makes it possible to farm more acres with a limited labor supply during the critical season of planting.

5. National Aggregate Economic Effects

In 1967, approximately 1.5 million metric tons of rice were available for export. In addition, to providing the bulk of the domestic food supply and revenue for the government, rice also is one of the country's most important foreign exchange earners.

6. Inter-Sectoral Effects

Increased rice production has resulted in increased purchasing power of the agricultural sector for fertilizers, farm machinery and pesticides thereby increasing agribusiness in the country. Imports of fertilizers and farm machinery have increased steadily.

7. Political Effects

There has been little change in political organization or expression during the period of study. There has been a buildup of the communist inspired action in the Northeast. The impact of the rice production program in counteracting this buildup has not been estimated or measured.

V. Production and Demand Projections

1. Domestic Demand Projections

Exports of rice could be expected to continue to grow over the next five years. With more irrigation and better water control and cultural practices, yields may be expected to increase considerably. Production and yield per unit are going up because of the RTG's price support and to a favorable cost/price nitrogen fertilizer ratio. Domestic demand for rice is expected to continue to rise with the growth in population.

2. Production Prospects

Rice production goal of 13.7 million metric tons was established for 1971 by the Government of Thailand in its "Second National Economic and Social Development Plan 1967-71." This goal has already been reached.

VI. Requirements for Production Projection

1. Physical Input Requirements

The rice production potential increase is tremendous over a period of time. Most of the present production occurs during the wet season. It is estimated that production could be tripled within 15 years with better controlled irrigation, improved varieties and increased use of fertilizers.

2. Institutional Requirements

As the TVA report states --lack of credit to farmers is an obstacle to increased use of fertilizer by farmers and hence to increased production. It is questioned that additional infrastructure in extension and research is required. Upgrading program, both in technical skill and decentralization will be more fruitful.

3. Policy Requirements

There are a number of changes in policy recommended by Raskin to increase the production potential. Such moves as increased storage and drying facilities, and better price and market reporting are all desirable. The import ban on nitrogen fertilizer to protect the high cost Mae Moh Complex is detrimental to improvement and rapid development of the rice industry.

4. Input Availability

The Thailand Mae Moh plant has a capacity potential of putting out about 30,000 tons of Urea and 60,000 tons of Ammonium Sulphate.

According to the TVA study report, this is a relatively high cost facility as compared with imported ingredients. Thailand still needs to import phosphate, potash and sulfur--requirements to the production of complete fertilizers. Government action limiting the import of bulk fertilizer to protect the investment at Mae Moh and possible regulations against the import of mixed and bagged fertilizers could hold back development. If and when the import restrictions are overcome, adequate inputs appear to be available for current production needs.

VII. Self-Sufficiency, Exports, and Diversification

1. Estimate of Likelihood/Date of Self-Sufficiency

The country is presently an important exporter of rice.

2. Possibility of Comparative Advantage for Export

Even at low prices to producers for rice and high cost of fertilizers, Thailand has been and still is important in rice export trade, especially in the Far East. The export market has been an important concern affecting rice production. If import restrictions on fertilizers were eliminated and fertilizer costs reduced, this would provide further impetus and comparative advantage for increasing rice output.

3. Possibilities for Diversification

Corn has been an important crop for diversifying agriculture in Thailand, as a feedgrain for export. Other crops which also have been increasing are: cassava, sugar cane, kenaf, and rubber. But these crops

cannot be grown successfully in the alluvial soils of the Central Plains.

4. Policy Commitment to Above Options

Not applicable.

5. Choices If Full Input Import Requirements Not Met

Lack of fertilizer imports to keep present lands in full production could result in the unwise opening of new lands on steeper slopes. This would run against government efforts toward lessening of erosion and better control of forest lands.

VIII. Future U.S. Role and Choices

1. Policy Influence

Policy influence by the U.S. on this program should continue to be light. Most needed and probably most effective U.S. involvement in the program should be the encouragement of an improved credit availability program for the producer. This is needed for all agriculture in the country.

2. Aid Requirement

Includes continuing interest in and contribution to the credit program (one advisor) and continuing assistance in improving the performance of the extension program. The necessary research is in good hands.

IX. Future Research Needs

1. Technical

Continued varietal testing and development are required. This includes field testing for location adaptation. Along with this is required continued testing of fertilizer, pest control and cultural practice requirements.

2. Economic and Social

Empirical research is already underway relating the effect of irrigation on the people of the Northeast, and the effect of dams on cultural habits and industries, etc. Further research now recommended is to review that already done and attempt to put it to use.

X. Economic Social and Political Implications

Much of the social and economic life of Thailand is centered around rice. It is the basic staple food, it occupies much of the farmers time and a great deal of his social life is built around the crop, i.e. harvest boons, group plantings, threshing, etc. As one of the leading exports, rice is responsible for a good share of Thailand's FX. Its milling, storage, transport and retailing would probably be one of the largest private businesses in the country.

To greatly increase the price of rice to the consumer could have grave political repercussions. To the poorer urban dweller, the price of rice might be a very important factor in the way his total income is

disposed of. In retrospect, the gradual but paced increase in rice prices both to the grower and the consumer do not appear to be bad Government policy. It has provided something for both.

The policy of developing the Thai varieties instead of using the new varieties again appear relatively sound. The problem of water control in the major rice producing areas could cause serious loss to the short stemmed varieties. Also, the policy of trying to stick with long grain, high taste, milling and cooking qualities is beginning to appear sound. This is especially true in the face of presently dwindling markets for export to the traditional deficit producing countries. With its past policy of slow but steady improvement, Thailand will be in a position to compete on the quality market after the quantity market is gone.

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : EA/TECH/ARD, Mr. Don Davis DATE: April 7, 1969

FROM : PPC/POL/ES, Edward B. Rice

SUBJECT: Thailand Rice Paper

(1) The Thai rice story is a control case, as is the Thai corn story, but it differs from the latter in that the new technology (IRRI and domestic HYVs) is not being rapidly adopted by rice farmers. The important job for us is to explain why adoption rates are low. We would like to compare Thailand with India, Pakistan, Vietnam and the Philippines -- where adoption rates are high -- and identify the factors which were missing in Thailand. The obvious answer is that Thailand was the only surplus rice producer in the group and had no compelling reason to increase yields. But we need to substantiate this conclusion by showing either (1) that institutions, technology, fertilizer and the other physical inputs were no less available in Thailand than they were elsewhere and that the decisive difference was the lower profit margin or (2) if the profit margin attributable to HYVs was not lower in Thailand than elsewhere, at least that the GOT made much less effort to encourage adoption than did governments of the deficit countries.

(2) One problem in the Paper is that it never clearly identifies the country crop experience as a "failure" of adoption. I had to re-read it before I realized that you were discussing a situation in which the superior IRRI and domestic varieties were not popular and that most rice farmers were still using traditional types. This ambiguity can be easily cleared up in the introduction, but you should also provide a table giving an estimated breakdown of rice acreage devoted to the different varieties.

(3) I've itemized below the principal omissions in the Paper, arranged as in the Paper's outline. *I'll need your judgment as to how much of the missing material can be secured and how soon.

TO: Edward B. Rice, PPC/PDL/RS
FROM: Don Davis, EA/TECH
SUBJ: Thailand Rice Paper

Time does not permit a detailed point by point discussion of the questions you have yaised on this paper. I will attempt to answer the primary questions in the following summary.

1. Why have not the short stemmed, high producing new varieties from IRRI and other countries been produced in quality in Thailand?

The answer to this is relatively simple. They have not been released to the farmers for production. The reasons why they have not been released are a bit more complicated. I do not know all the reasons but some of them follow:

A. The Rice Department of the Ministry of Agriculture is headed by Dr. Sala Dasanades. Dr. Sala is a member of the board of Directors of IRRI. As such, he has known of the new varieties from there since their inception. These varieties have been tested in the various research stations in Thailand. Here, they have produced as well as in other locations. However, in the testing process, Dr. Sala took note of several inherent weakness in the varieties--ie--medium grained with a high concentration of amalose on the under side, a high % incidence of bacterial leaf blight, the short stem giving height of less than one meter when mature, the requirment of relatively high applications of fertilizer to reach high production. The tendency to form cracks in the underbelly of the grain due to the high accumulation of amalose thus giving a very poor milling recovery of unbroken grains. Dr. Sala has told me that when he balanced these defects against actual conditions in the T[illegible] rice growing countries areas, it was the Decision of the Ministry not to release the varieties for production. Hence, they have not been available to the growers.

B. The major rice producing areas of Thailand are the central and southern plains. In these areas, which lie very flat with a limited gradient toward the sea, water depth in the paddy is difficult to control. Water depth may be controlled during a part of the season through the irrigation structures when the systems are operated to flood the paddy lands. However, during heavy and prolonged rains, these very flat plains simply cannot get rid of the excess water fast enough to prevent backing up and flooding. Both these areas are surrounded by sloping mountains feeding runoff water into the lower areas and complete water control of this runoff has simply not advanced far enough within budget and engineering limitations. This is being worked on but is not as yet an accomplished fact. Thus, at the present time, the short stemmed varieties are unsuited to the major rice production areas.

C. The north and north east of thailand are areas where irrigation systems and natural terrain would allow the production of the new varities. These areas, however, are producers and consumers of glutenous rice. They prefer these varities for local consumption. These areas are also more remote from the main port of entry for moving in the required imputs of fertilizer and hence the production of the varities would be more costly. Further, these areas vary from surplus producing one year to deficit areas the next and are not an integral part of the export trade pattern in rice. The Rice department has developed two very good varities of glutenous rice which they are pushing in these areas since there is a ready but limited market for export of glutenous rice to surrounding areas and to Japan. IRRI has been working on a glutenous variety and has one very promising one with most of the response factors found in the other released varities from there. It has not as yet been released for production.

C. This is conjecture but based on several conversations with Dr. Sala and other Thai officials. Thailand has for many years been an exporter of rice. In fact, rice has been its leading export FX earner. They have seen and taken note of the efforts in other countries to become self suffecient in rice, especially those in the traditionally rice consuming nations of Asia. They have seen that as the programs toward self suffeciency would become effective, the markets they had traditionally enjoyed would be reduced, especially for the less than number one export quality rice. Thus they have concentrated their research efforts on developing a variety which would meet the more exacting standards of a highly competitive market--ie--a long grained, high milling quality rice that was higher in protien and less in starch so as to get a cooking quality of fluffy, single grain end product that would grow under Thai conditions. They were perfectly willing to sacrifice some quanity for this quality. In addition, there was no real need for increasing production. The export market was relatively well established at around 1.5 million tons per year. This could be produced without undue strain under existing conditions.

The fact of the Thai wisdom, if it is realy such, is coming home this year. The market for poor quality rice is very poor and the Thai quota for exports is moving slowly. (See Sam Wort reports attached).

2. One other basic point which needs futher clarification is that of the export premium on rice which many people credit for the lack of any marked increase of rice production per unit of land in the crop.

I have attached four pages from a report of conversations between the Thai Government and the AID after their survey of agriculture in Thailand. These cover rather well the premium picture and touch on other points I have raised here.

As one authority who has been around the Thai scene for some time, Dr. Sum Work, Agric. Attache does not believe that the premium on export has been as bad as pictured. He reports that the premium has definetly been used to control consumer price of rice. However, he states that it has been Government policy to so manage the premium as to allow for a steady ϕ% increase in price to the farmer each year over the past five years. This, he claims has allowed for a steady progress toward increased incentive plus keeping domestic markets in line with the advance in consumer earnings. (Two communications from Dr. Work to Washington are attached).

and cropping patterns in different areas where facilities are, or would be available for year-round water control on the farms. Also high on the priority list for applied research is the field technology of irrigation and drainage in accordance with soil, crop, and farm management requirements under various circumstances.

(7) Regional disparity -- Irrigated land presently constitutes 65% of the total rice area in the Central Plain, but all except 4%, 10% and 14% of the rice lands in the Northeast, South and North, respectively, are still rainfed. This fact gives indication both of the potential needs of water resources development, and of the possible trends of land use readjustment in different parts of the country.

II. Seed and Fertilizer

The Survey Team gave full recognition to the great significance of the recent varietal breakthrough of rice and other foodgrains which has provided a technological base for agricultural modernization and promised an early attainment of food sufficiency in the region. Experience in the past few years indicates that assuming the minimal infrastructure and adequate pattern of price incentives, seed of a truly fertilizer-responsive high-yielding variety in combination with adequate fertilizer supply can be all that is needed to generate among farmers an enthusiasm sufficient to break age-old lethargy and deep-rooted traditions. On the other hand, if the stagnant growth of productivity in the food agriculture of tropical Asia can be traced back to any single cause, it would be the biological characteristics of the crop varieties evolved under the conditions of traditional farming, which set a low limit to the maximum yield obtainable under more favorable conditions.

Intensive efforts in rice breeding were initiated by the Thailand Government in 1950 and have been continued over since. Lack of adequate water control in the Central Plain has been a serious constraint through the years. Special consideration was given to the ability of rice plants to survive rapid increase in water level in the paddy fields,

as two thirds of the rice area in the Central Plain were broadcast with floating rice, and only in the last three years was there a steady increase of transplanted-rice acreage from 35% of total rice area in 1964 to 42% in 1967. Particular emphasis has to be placed also on the grain quality so that the reputation of Thai rice in the export market is not affected. While the well-known IRRI varieties IR8 and IR5 have given higher yields in recent trials over the recommended local varieties, neither can be adopted for general use because of their shorter stature and lower eating and milling quality. However, satisfactory results have been obtained by Thai breeders from backcrossing the IR hybrids to the local strains, and new high-yielding varieties with desirable quality and sufficient adaptability to local environments are expected to be released very soon. Photoperiod-insensitive varieties suitable for off-season cultivation are also available.

Introduction of an improved golden flint variety developed in Guatemala contributed materially to the rapid expansion of maize growing in the late 1950's. More recently satisfactory progress has been made on maize and sorghum breeding through the Inter-Asian Corn Improvement Program sponsored by the Rockefeller Foundation which was transferred to Bangkok in 1965. However, full benefit from the new improved maize varieties will only accrue with the transition from shifting cultivation on newly-opened lands to regular rotational cropping in irrigated areas. Varietal improvement of other major crops including rubber, cassava, kenaf, cotton, soybean and mungbean can be further strengthened.

In spite of rapid increase in fertilizer imports from around 90,000 tons in 1965 to 198,000 tons in 1967, which is partly attributable to the rise in rice price since 1965, rate of consumption in Thailand (about 5.0 kg. of nutrients per hectare of cultivated land) remains at the lower end among the regional countries. A government survey during 1967 revealed that only 20% of all cultivated land received fertilizer. Major constraints to a greater usage are: (1) low producer price of rice, (2) lack of water control in the field, and (3) absence of fertilizer-responsive high-yielding varieties. Still, large-scale

trials in Central Plain has indicated substantial yield increases from fertilizer application, and the Government has given generous support to induce a greater usage of fertilizers by allowing duty-free import and using the Farmers Aid Fund (generated by the rice premium) for financing the distribution on credit of about 20% of current imports via government departments to farmers groups, with transport expenses fully subsidized. Also, the private sector has taken steps to set up large plants for fertilizer production, and planned to organize its own extension and sales network throughout the country, with due consideration to meeting the credit needs of small farmers. It remains a problem, however, whether the rice price could be made sufficiently attractive for a favorable product/factor price ratio which, probably more than anything else, will determine the extent and rate of expanded use of fertilizers. Since supply of fertilizers and agricultural chemicals will be one of the main functions of the multiple-purpose farmers' organizations, the distribution costs can be minimized by channeling them through these organizations.

III. Price Policy

The Survey Team was convinced that agricultural prices should be held at a level that will provide the farmer with the incentive to innovate, to invest in the productive capacity of his farm, and to undertake the risk and costs of learning to use new agricultural techniques. It had the satisfaction that price incentives did exist in many countries of the region which provided necessary impetus for the successful spread of various agricultural intensification programs during the recent years.

A predominant feature of the price policy in Thailand is the rice premium which is a variable ad valorem tax on exported rice set by the government and paid by the exporter or miller as the basis of the Bangkok f.o.b. price. For some time until very recently, it has been set at 30% of export price for high quality rice and 25% of export price for low quality rice. Because of its profound depressing effect on the domestic rice price and because of its import-

ance as a government revenue, the rice premium has been a subject of extended controversy. Most observers now agree, however: (1) that the rice premium is a highly useful tool for maintaining Thailand's competitive position in world rice trade; (2) that it has become a major source (about 10%) of government revenue, and therefore a mainstay of government operations; (3) that its function of price (hence wage) stabilization at an arbitrarily low level, although not easily justifiable on the basis of the low degree of urbanization, the income gap between urban and rural families, or the rice consumption patterns in the country, would nevertheless be expected to benefit the industrialization process in its very beginning; (4) that it can be operated to ensure adequate domestic supply of rice, although an export quota can be even more effective; (5) that its powerful stimulating effect on product and export diversification must be weighed against its being a major constraint to the expanded use of purchased inputs and productivity improvement in rice farming, as shown by the fact that Thailand has failed recently to take full advantage of the rice export potential despite very high world prices; (6) that basically it is a regressive tax and it discriminates against rice growers; and (7) that while it could not be immediately and totally abolished, it should be gradually reduced as compensatory measures are phased in, to the extent that producer prices become an incentive to modernized rice farming, and increases in productivity and production of the rice industry could result in an equal contribution to the government revenue. There has also been a suggestion to use the rice premium for building up a "rice price stabilization fund" for the benefit of the producers.

IV Farmers' Organizations

The role of farmers' organizations in the implementation of agricultural development programs was stressed in the Survey reports on the ground that the success of any development program is first of all conditioned by the extent of true appreciation and active participation or support of its beneficiary. In the context of a small-farm agriculture, it would be most difficult for the full impact of a development effort to reach the mass of individual producers, if they are not adequately organized.

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FOREIGN AGRICULTURAL SERVICE

APR 1969

FROM: American Embassy, Bangkok

March 27, 1969
DATE

TO : DEPARTMENT OF AGRICULTURE, WASHINGTON

TH 9044
NO

REF : Code 24V; 11V; CERP-D

CHECK ONE.

SUBJECT: THAILAND: New Minister Economic Affairs Explains His Rice Export Policy

AA | OL |

H. E. Bunchana Atthakorn, formerly Thai Ambassador to Washington and now the new Minister of Economic Affairs, explained the rice export policy of the New Administration to the press on March 25.

Xerox copy of The Minister's statement in the Bangkok World is enclosed as part of this report.

Comment

His Excellency's comments confirm our previous reporting that the Thai do not willingly plan to reduce the export price of rice. For the current crop at least, the quantity of No. 1 100% and 5% is reduced from previous years due poor quality of the last harvest which results in an excess of brokens upon milling. This puts higher grades at a premium but brokens at a very low price. It emphasizes the concern of the RTG to move more rice in G-to-G sales to India and Indonesia which usually purchase mixtures containing 25% to 60% brokens.

In CY 1969 Thailand hopes to export 1.2 million metric tons milled rice. This is the official target. The National Statistical Office, however, has reported that the 1969 exportable surplus will reach 1.6 million metric tons of milled rice. In view of current world rice stocks Thailand, as may other nations, could find itself in a "long" carry over position by year end.

So far in CY 1969 Thai exports have averaged out at the rate of around 100,000 metric tons per month. The official target can be reached if shipments continue at this rate throughout the remaining nine months of the year--but not unless there are sizeable sales of brokens mixtures.

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UNITED STATES DEPARTMENT OF AGRICULTURE

FAS-154
(8-68)

Foreign buyers are holding off hoping the New Administration will reduce the present export premium rate which is due to expire by March 31. As of this writing no official announcement of change in premium has been made. Our contacts in trade and government are not anticipating a reduction; and in all probability the current rate will be continued.

To lower the rate would move more rice--but at a lower level of exchange earning. Also it could operate to reduce farm price (and increase domestic price) of top grade if export flow became too rapid.

With a very active Parliamentary opposition under the new constitutional regime the Administration is not likely to countenance low farm price. This has been demonstrated already by the fact for the first time since the price of paddy has been supported the Government is building a stockpile by farm purchase to maintain the price. This depletion of the budget cannot long continue unless these government stocks can be moved either internally or externally. Externally they can only be moved if there are new G-to-G contracts.

The Minister's reference to "interference" by the RTG in relation to foreign competition is a very definite statement of the policy of the RTG with regard to U.S. PL 480 sales. What sort of "interference" will be made is unknown, but already the RTG has made known its position on U.S. proposals to move rice to India and Indonesia.

One way of so doing would be to lower premium rates to permit export at a much reduced price. Despite the Minister's statement of exporting "at the highest prices and that always reiterated by Khun Nam, Director General of Foreign Trade, that Thailand does not wish to undersell viz-a-viz the U.S., the possibility does exist this could occur. Past experience over the last seven years demonstrates what the Thai can and will do regarding world rice price if forced to. Any lowering of the Thai price below current levels would put the U.S. budget under even greater strain through the need to increase export subsidy to the much higher levels existing several years back.

The actual working out of new rice export policies will be reported as information is obtained.

S. H. Work
Agricultural Attache

Enclosure

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FOREIGN AGRICULTURAL SERVICE

APR 8 1969

FROM: : American Embassy, Bangkok

April 3, 1969
DATE

TO : DEPARTMENT OF AGRICULTURE, WASHINGTON

TH 9056
NO

REF : Code 11RV; CERP-D

CHECK ONE.

SUBJECT: THAILAND: RICE--Revision of Customs Export Duty Assessed Prices as of April 1, 1969. Mixed up and down in new rates when compared to superseded rates but, with the exception of glutinous white head, all are under the corresponding period of last year. A [X] B [ ]

The Thai Customs Department announced the Department's revision of customs export duty assessed prices on rice for exports as of April 1, 1969 superseding the previous one of January 1, 1969. (See AGR TH9003 of January 3, 1969) The enclosed table shows comparison of this revision with that of January 1, 1969 and with the corresponding period of a year ago.

Comment

Upon the new assessed prices fix we see the movement on high quality rice grades both heads and brokens. All were raised when compared to the former rates. This is with the exception of glutinous rice. The Customs Department tries to fix the rice assessed prices for exports in line with the current market conditions. It was reported in TH9052 and TH9053 that the higher grade prices would brisk-up in latter part of this year. The new assessed export prices indicate the trend predicted.

It is to be noticed that the Department is now resuming the usual quarterly change since it has not been made from January 1, 1968.

S. H. Work
Agricultural Attache

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CLASSIFICATION

FAS-184
(6-61)

UNITED STATES DEPARTMENT OF AGRICULTURE

THAILAND: RICE--Customs Export Duty as of April 1, 1969, superseding the earlier one as of January 1, 1969.

	% Export duty on Customs Assessed Prices	Customs Assessed Prices			Calculated Export Duty		
		1/4/69	1/1/69	Year Ago	1/4/69	1/1/69	Year Ago
		1/Baht per Metric Ton			1/Baht per Metric Ton		
MILLED							
White Rice							
Whole Rice							
100%, 5%	4.2	4,200	4,000	4,800	176.40	168.00	201.60
10%, 15%, 20%	4.2	3,500	3,450	4,400	147.00	144.90	184.80
25%, and lower	4.2	3,350	3,350	4,100	140.70	140.70	172.20
Brokens							
A.1 extra super ...	4.4	3,500	3,400	4,000	154.00	149.60	176.00
Others	4.4	2,500	2,700	3,320	110.00	118.80	146.08
Glutinous Rice							
White, all grades	4.2	3,700	3,750	3,500	155.40	157.50	147.00
Broken, all grades	4.4	2,300	2,450	2,500	101.20	107.80	110.00
Parboiled Rice							
Whole rice, all grades	4.2	3,150	3,200	3,770	132.30	134.40	158.34
Brokens, all grades	4.4	2,200	2,240	2,640	96.80	98.56	116.16
Cargo Rice							
Whole rice, all grades	5.4	3,650	3,500	4,300	197.10	189.00	232.20
Brokens, all grades	3.75	2,200	2,250	2,900	82.50	84.37	108.75
ROUGH (PADDY) 2/							
All types and grades	7.0	2,520	2,400	2,880	176.40	168.00	201.60

1/ U.S. $1 equals approximately 20 baht.
2/ Under export ban. Cabinet approval required for export.

AIRGRAM

DEPARTMENT OF STATE

CLASSIFICATION

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TO - AID/W TOAID A-576

FROM - ANGKOK

SUBJECT - Spring Review of New Grain Varieties
Supplementary Message

REFERENCE - (A) TOAID A511
(B) STATE 130015

DATE SENT 4-23-69

Indicated in a note in REF A there follows a supplementary message to REF B.

(1) The importance of rice and corn production in Thailand's economic development is significant, although relatively less important than in the early sixties. As a percentage of Gross Domestic Product (GDP) the contributions from these two grains has fallen from 33% in 1961 to 27% in 1967 as indicated in the table below: (See Enclosures 1 and 9):

Enclosures:

1. National Income of Thailand, 1967 Edition
2. The Rice Balance Sheet and the New Series for Rice Production -- Appendix A, from 1965 Edition of National Income of Thailand
3. The 1963 Census of Agriculture and the National Income Accounts -- Peter Gajewski, USOM
4. The Rice Balance Sheet -- NEDB
5. Paddy Production Data Comparisons
6. The Thai Rice Premium -- Vincent D. Taylor, RAND Team
7. Proposed Stabilization Policy for Rice Prices -- Dr. Snoh Unakul, NEDB
8. The Econonics of the Rice Premium, D. Usher
9. Effects of Population Growth on Economic and Social Development in Thailand -- USOM.

Alt to AWOH 4-28

PAGE 1 PAGES OF

DRAFTED BY	OFFICE	PHONE NO	DATE	APPROVED BY
PGajewski:mot	P/EC	271	4/18/69	C. J. Stockman Acting Deputy

AID AND OTHER CLEARANCES

AD/AG: RE Patterson: date

[illegible]: date 4/1

CLASSIFICATION UNCLASSIFIED

AID-5-39 (11-68) (Do not type below this line) PRINTED 3-67

PER CENT OF GDP AT CURRENT PRICES

Sector	Agriculture		Trade		Manufacturing		TOTAL	
	1961	1967	1961	1967	1961 p	1967	1961	1967
Rice	34	37	13	13	24	18)	33	27
Corn	2.4	3.1	.8	1.1	NA	NA)		

Rice constitutes a major part of the diet of the population, accounting for 15.6 % of personal consumption expenditures in 1961 and 15.0% in 1967 (based on 1962 constant prices). Statistics indicate that demand is highly inelastic. Corn, on the other hand, is principally an export item which as yet has limited use as a feed grain. Foreign exchange earnings from rice and corn exports are below:

FOREIGN EXCHANGE EARNINGS
FROM RICE AND CORN EXPORTS
(Value in million baht)

	1961	1962	1963	1964	1965	1966	1967	1968
Rice	3,598	3,240	3,424	4,389	4,334	4,001	4,663	3,827
Corn	597	502	828	1,346	969	1,[illegible]	1,356	1,527
% of Total FX Earnings from Comm. Exports Only	37	34	37	40	33	28	27	24
	42	39	44	46	41	39	43	39
TOTAL	4,195	3,742	4,252	5,735	5,303	5,521	6,019	5,354

As can be seen from the table above, the share of foreign exchange earnings from rice and corn exports has fallen from 37% to 24% in the past eight years, partially reflecting the invisibles from tourism and the Viet Nam war effort.

(2) Rice and Corn Output and RTG development and security Priorities: Since the RTG development program is a significant counterinsurgency tool, large RTG resource inputs are in the process of being injected in marginal rural areas of the Northeast and North. Some of these efforts have USOM resource support. Since the Northeast is basically a poor area for rice production and generally produces only a subsistance level for its 11 million inhabitants, RTG development strategy, which US supports, aims to diversify agriculture in the Northeast into products with a greater comparative advantage, like kenaf, cassava, sorghum and livestock; and at the same time, increase yield in the Central Plains to substitute for production which would be lost when some land would be taken out of production in the NE.

The RTG program for increasing rice yields has met with limited success. Partially due to lack of coordination among development agencies and partly for lack of an adequate extension program. For example, the Ministry of Interior has responsibility for promoting the second rice crop and the Ministry of Agriculture the first.

(3) Rice Price Support Program is currently not fully operative because RTG insists that they will purchase directly from farmers only, and not deal with "Chinese middlemen". These traders are the only ones who have the facilities to trade in rice and, therefore, a very small volume has received price support, although some traders have used farmers' names and sold to the RTG.

(4) The Price Premium is an export tax on rice which is paid by the exporter. Its impact is that the surplus producer in the Central Plains bears the burden of the tax. The subsistance farmer is not affected by the lower price except during time of crop failure when he benefits by the tax's consumer subsidy feature. Revenues from the rice premium account for about 5% of total RTG revenues. In Thai F Y 1968 it was 1.1 billion baht as compared to .7 billion in 1961.

One major impact of the rice premium is to make the cost of fertilizer five times more expensive to Thai farmers than to Japanese farmers in terms of amount of rice required to buy a unit of fertilizer. (1963 data for comparisons). More recently, fertilizer prices in Thailand have remained at high levels because of an obsolete urea plant operation which is protected by high import tariffs.
For a detailed discussion of the rice premium and some policy alternatives see attachments 6, 7, and 8.

(5) Specific supplemental information pages refer to REF A:

P. 64 Storage capacity estimated by NSO exceeds 10 million metric tons. Fluctuations in inventories are significant. See enclosures 4 and 5.

P. 71 1. Aggregate Statistical Relationships -- A time series statistical study has been made by the NEDB. (See enclosures 4 and 5.) Also attached is an analysis of the 1963 Agriculture Census results (enclosures 3 and 5). The Census indicated underestimation by the NSO of the rice crop. Subsequently the NSO has undertaken official responsibility for publishing rice production statistics based on crop cutting surveys. The NEDB's National Income Accounts reflect estimates

which attempt to link the past series from the Ministry of Agriculture with the 1963 Census and the current NSO series.

2. A typing error -- production goal of 13.7 million M.T. is for 1971, the terminal year of the Second Economic Development Plan.

UNGER