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MAIZE OIL AND FEED*

An agro-industrial pre-feasibility study

Prepared by a consultant for the Office of the
Board of Investment, Government of Thailand

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I. INTRODUCTION

In a determined effort to promote and diversify investment in the agro-industrial sector, the Government of Thailand has undertaken a series of studies relating to prime agricultural commodities being currently produced in the country, from which a number of selected products have been examined in some detail and presented as investment opportunities to encourage the interest of potential foreign and domestic investors.

This report provides a source of information concerning the availability, suitability and cost of raw materials to produce a specific product, the cost of operating in Thailand and a market analysis for the product either for local consumption, import substitution and/or export. Investigations were carried out to assess the economic viability of the project, it's impact on the economy of the country and the possibilities it offers for the creation of employment opportunities.

Consideration has been given to the requirements of this particular project for investment incentives in order to show a sizeable net return on invested capital.

Information has been provided about Thailand and it's economy with a summary of the current Five Year Plan, the investment climate and related laws, and other basic information to assist a potential investor.

As an annex to this pre-feasibility study, there is a Product Area Report that identifies a wide range of possible processed and semi-processed products, and in general, evaluates the domestic and foreign markets for them.

In selecting the product to be given priority for study as an investment opportunity, the socio-economic effects, technical feasibility, availability of labor supply, availability of, or plans to provide, the required infrastructure, together with restraints on pollution of the environment, were taken into consideration.

This pre-feasibility and product area study is only intended to bring this potential opportunity to the attention of an investor, who it is anticipated would use it as a base to launch a more detailed feasibility study that would be required before making a decision to establish or expand this product industry in Thailand.

These studies have been funded in part by a loan from the United States Agency for International Development, (USAID), and the Board of Investment under whose direction they are being carried out. The BOI is being assisted by Chemonics International Consulting Division of Early California Industries Incorporated in association with Checchi and Company, both of Washington D.C. The Board of Investment would like to take this opportunity to thank the team of Consultants and USAID for their assistance in carrying out these studies.

This pre-feasibility study and annexed product area study, was prepared by Amos H. Fint Jr. (Maize Products Specialist), Frank L. Turner (Feasibility Analyst), Alfred A. Strauss (Financial Analyst) and Peter M. Amcotts (Project Manager).

Grateful acknowledgement is made of the assistance given by many Thai Government officials, United Nations and U.S. offices and libraries, and by industrialists and others in the private sector.

II. SUMMARY AND GENERAL PROJECT DESCRIPTION - MAIZE OIL AND FEED PROCESSING.

In the maize products area study accompanying this Pre-feasibility report, an answer has been sought to a question that has perplexed Thailand since the early 1960's. "How can maize be processed locally to create more value added?" By implementing this proposal, and other similar projects, Thailand could start to shift from the export of raw maize to the export of valuable down stream products derived from maize.

By any measurement standard, maize has become a major agricultural asset to Thailand. It's growth over the first decade has been paralleled by cassava- a crop that directly competes with maize in industrial user and feeding applications.

The area planted to maize has increased from 328,000 hectares in 1962 to 1,312,000 ha in 1975 - a four hundred percent increase. Maize plantings now represent almost 10% of the total area planted to crops. (1.3 million ha planted in maize/13.8 million for all crops.) Only to rice and rubber (8.9 million and 1.4 million ha respectively) is more land devoted than to maize.

The total contribution to Gross Domestic Product of Agriculture, Forestry and Fishery Products based on farm gate prices was estimated at US$ 4,681.7 million in the 1975-76 crop year. Of this, the share from maize production was US$ 264.8 million (5.7%). Aside from rice, only swine and the sum of all fruits made a greater contribution. (See Agricultural Statistics of Thailand, 1975-76, Ministry of Agriculture and Cooperatives, 1976, Table 1.)

In value of agricultural, forestry and fishery exports maize ranked only slightly behind the leader, sugar. The US$ 280.7 million export value in 1975 represented 17% of the group's total exports and 12% of the total Thai exports. Exports in 1976 were valued at US$ 283.7 million, but are likely to decline sharply in 1977 to an estimated US$ 142.5 owing to the unusual drought.

Internationally, the major utilization of maize is as an animal feed especially in the production of swine, poultry, milk cows and for finishing beef steers

Significant volumes of maize, throughout the world, are used to recover the starch by the "wet process." This refined product has wide application as a sizing material and as a binder (adhesive) The starch can also be converted to sweetners (glucose, dextrose and/or high fructose syrup). Lesser volumes of maize starch grits are flaked and toasted or extruded to produce breakfast cereals and snacks. However, the findings of this report are that the potential market for breakfast cereals and snacks is too limited to support an economic size processing facility. These are relatively high priced items with taste and cultural appeal limited to North America and Western Europe. Processing facilities in the U.S. and Europe presently operate at less than capacity, precluding export opportunities for Thailand.

A substantial domestic market does exist for starch products. However, the competition from cassava starch in these applications is such that it was concluded through proforma cost analysis that a maize starch processing facility is not an economically viable investment risk at this time. The factors contributing to this conclusion included all facets of such an endeavor from raw material supplies through marketing, including export opportunities. In almost every comparable detail, cassava was found to be the most advantageous raw material to process for these particular end products.

Cassava is an easier and less costly crop to grow than maize. It's yield (kilos fresh roots vs kilos shelled maize) is 6 times that of maize per ha, so even at one fourth the value of maize per kilo the return to the farmer per ha favours cassava over maize.

The processing costs per unit of starch for maize are at least 50% greater than those for cassava. (See "Manufacturing Expenses in Table 1.) This is mainly due to greater fuel and energy demands and the cost of equipment maintenance.

The capital investment requirements per unit of starch throughout for maize processing is about double that per unit of cassava.

The recovery of valuable by-products - oil and high protein animal feeds is not enough, under present conditions, to balance the above cited cassava advantages.

For industrial use, there are no distinct, specific, over-riding advantages in cassava starch compared to maize starch. For these reasons - cassava competition to produce starch and the limited market for cereals and snacks - maize has not been industrialized in Thailand up to the present time.

There does, however, appear to be the opportunity to process maize for the recovery of crude vegetable oil and animal feeding ingredients. These products would add value to the maize and could penetrate both domestic and export markets.

It is proposed herein that maize be dry milled to separate the germ from the remainder of the kernel. This process would yield one product and two by-products:

(a) From the germ fraction, the crude maize oil would be mechanically expelled. The value of the oil (per unit weight) is 4 to 5 times that of the maize.

(b) A mid-protein meal would be left after oil expelling. The value of the maize oil meal is conservatively estimated at 160-165% that of maize.

(c) The remaining fraction, the equivalent of milled maize, in estimated to have a value somewhat less than the original maize on a unit weight basis.

The key to profitability in extracting oil as a main product, is a maize with two to three times the normal (4-5%) oil content of average maize, i.e. 8 to 15% oil content.

The development of such a variety is considered feasible within a two year period by the Thailand Department of Agriculture Genetisists and is supported by the Agricultural Faculty at Kasetsart University. The breeding would be from native varieties already adapted to the specific Thailand environment. High oil maize (over 20%) nas been obtained in the United States through cross-breeding.

Processing a high oil (12%) maize appears to be a most attractive opportunity for those individual enterprises oriented to agricultural commodities. This would include the entire range of companies presently engaged in the seed, feed and/or commodity trading industries, as well as those who desire to enter such basic industries.

Processing facilities for 100 tons per day maize will require an initial investment in fixed assets of about US$ 1.3 million dollars. The economic size is based upon capital investment requirements, standard equipment capacities, operating costs and projected profitability.

Profitability is a function of the precise oil in maize content which is targeted at 12%.

On that basis the annual return on total investment will be of the order of 30% to 35%. (Assuming relatively long range price levels for the products which will be generally lower than the present price levels.

The project plan proposed herein provides additional financial and operating data for the alternatives of an 8%, 12% and a 15% oil in maize. The former represents a raw material that could be obtained within a year. The latter represents an oil in maize that appears likely through continued breeding efforts. These three alternatives are referred to as A, B, C in ascending order of oil content.

It is recommended that this maize processing facility be located in the maize belt for easiest access to raw material supplies, and yet closest to the market (feed mixing plants) for the major volume of the output.

The top maize producing provinces are:- Petchabun, 665,000 tons; Nakhon Ratchasima, 300,000 tons; Lop Buri, 294,000 tons; Nakhon Sawan, 270,000 tons; and Saraburi, 260,000 tons -- all figures are for the 1976-77 crop year (See Figure 1).

III. RAW MATERIAL

A. Description and Technical Discussion

According to the official analysis as supplied by Dr. Sutat, Kasetsart University, the Guatamala variety of maize, (the major variety in the country), contains an unusually high oil content. (Exhibit A, "The Status and Outlook for Maize etc.)

The analysis of this variety compares with representative maize produced in the United States as follows:

TYPICAL RAW MATERIAL ANALYSIS

Wet Substance Basis

	American Maize	Thailand Maize
% Moisture	16.2	14.5
Starch	59.7	58.1
Protein	8.2	7.7
Oil	4.0	6.8
Fiber	2.2	2.1
Ash	1.2	2.0
Sugars	2.2	(8.8
Remainder	6.6	(
	100	100

Dry Substance Basis

	American Maize	Thailand Maize
% Starch	70.9	67.9
Protein	9.8	9.0
Oil	4.8	7.9
Fiber	2.6	2.4
Ash	1.4	2.3
Sugars	2.6	(10.5
Remainder	7.9	(
	100	100

Source: Corn Refiners Association (U.S.) and Exhibit A. See Technical Appendix for additional analyses of Thai maize.

Recognizing the very wide fluctuations in the composition of individual kernels on the same ear, it is apparent that (through careful selection) a higher oil variety can be bred. A total oil content in the magnitude of 11-13% would represent an industrially viable maize to process for oil recovery. (One of the world's major oilseeds, soybeans, contain 18% oil).

In the opinion of Dr. Sutat, Dr. Chamnan and other Thai geneticists, significantly increasing the oil content (12-15%) is a feasible project that could be accomplished within a two year period. This would not entail cross breeding but merely kernel selection. Table 2 summarizes maize analyses for oil content made by the Department of Agriculture, Corn and Sorghum Branch. These results demonstrate the lead time advantage in developing a high oil maize strain in Thailand.

Equipment can be purchased (Nuclear Magnetic Resonance Spectroscope or "NMR") that analyses individual kernels for oil content without destroying the kernel. Through a procedure of selecting planting seeds based on this analysis, a high oil variety - still with the superior native yield and disease resistant characteristics - should be able to be developed in four generations. For seed propogation, two generations per year can be grown in Thailand (The estimated C.I.F. cost of the NMR is about $10,000).

High oil hybrids (from the United States) were experimented with, but no more successfully than other foreign hybrids. Those particular hybrids do, however, demonstrate that specific characteristic can be bred into the maize.

It is a characteristic of high oil maize to contain a higher than normal protein content because of the its distribution in the kernel. As the oil content is increased, the starch content is decreased. Other changes include an increase in fiber and non-starch carbohydrates such as "reducing" sugars. Based upon experience with hybrid high oil corn the following analyses can be expected.

PROBABLE ANALYSES OF THREE VARIETIES OF MAIZE
(Dry Substance Basis)

	A (8% Oil Maize)	B (12% Oil Maize)	C (15% Oil Maize)
		(Percent)	
Fat	8.0	12.0	15.0
Starch	68.0	62.5	58.0
Protein	9.0	9.5	9.8
Fiber	2.7	3.2	3.8
Ash	2.3	2.5	2.6
Remainder	10.0	10.3	10.8
Total	100.0	100.0	100.0

Source: Amos Flint, Maize Breeder.

B. Availability under Present Conditions

The raw material will have to be developed in order to insure a minimum oil content in the maize that makes oil recovery a viable process.

This report suggests a program to increase the oil content by selecting seed (using the NMR) to 12% or higher. As mentioned, this would require four seasons or two years.

C. Changes in Production of Maize

This suggests a raw material procurement strategy in which the processor provides the proper high-oil seed to contract growers who would then produce to meet the processor's maize requirements. The contract may be directly with the farmer, or more likely through a middle man.

It should not be necessary to pay a premium for this grain over the average market price for maize. This is due to the fact that with selected seed, its quality in germination and development should insure yields per ha far superior to the national average. Thus at the market price, the better yields produce an improved return per ha. Details of contract growing agreements will vary with particular circumstances and general agricultural environment. Certain premises, however, are valid to all conditions for a successful long-term agreement with growers. These are:

1. The farmer must be assured a market for his entire output.

2. The farmer must receive no less than the general market price for his maize.

3. The carrying costs should be shared by the processing plant and farmers.

Because the same characteristics (high oil, higher protein) that promotes the grain as an oil seed are also those that are basic to animal feed quality, the value of the maize does not diminish for other uses. The general acceptance for planting of a high-oil maize variety would enhance Thailand's ability to penetrate world markets for maize oil.

The cost for producing the high-oil maize should approximate that which is now normal to maize production in Thailand. Based upon Kasetsart University studies, these costs are as follows (1 rai is 0.4 acre or 0.16 hectare):

	Baht/rai	US$/rai	US$/ha
Seed (15.6 kg/ha)	5	.25	1.56
Cultivation	51 - 56	2.55 - 2.80	15.94 - 17.50
Planting	13 - 16	.65 - .80	4.06 - 5.00
Weeding	41 - 44	2.05 - 2.20	12.81 - 13.75
Harvesting	21 - 25	1.05 - 1.25	6.56 - 7.81
Drying	3 - 4	.15 - .20	.94 - 1.25
Shelling	12 - 14	.60 - .70	3.75 - 4.38
Transport	12 - 23	.60 - 1.15	3.75 - 7.19
(Operating costs Sub-total)	(158 -187)	(7.90 - 9.35)	(49.37 - 58.44)
Land rent	96 -102	4.80 - 5.10	30.00 - 31.88
Land tax	2	.10	.63
Depreciation	4	.20	1.25
Other cost Sub-total)	(102 -108)	(5.10 - 5.40)	(31.88 - 33.76)
Total Costs	260 -295	13.00 -14.75	81.25 - 92.20
Yield/kg/rai	353 -736		
Yield/kg/ha	2,206 -4,600		

It is presumed that fertilizers, pesticides and irrigation are not used. While these particular inputs improve yields, the present cost in Thailand of these inputs hardly justifies their expense. The better emphasis at this particular stage in programs for yield improvement appears to be in the seed quality.

As this latter factor is inherent to the proposal herein, one might expect yields from the high-oil maize to be about 2,812 kg/ha. This is based upon performance at the agricultural research center of the Department of Agriculture.

Based upon current farmer maize prices (฿ 1.55/kg) (US$ .077/kg) this would represent a gross return of ฿ 697/rai (US$ 218/ha) or a net return of about ฿ 420/rai (US$ 131/ha).

This return to the producer, coupled with the assured market for the harvest, is such that no difficulty should be encountered in gathering necessary supplies.

Assuming a manufacturing facility sized at 100 tons per day, operating 300 days per year, a processing unit would require 30,000 tons of maize annually. Based upon the projected yields, some 45-70,00 rai (7,200 - 11,200 ha) will be required to produce the 30,000 ton required volume.

This area represents less than 1% of the land presently planted to maize (70,000 rai/8,200,000 = 0.8%). (11,200 ha/1,312,000) It indicates no particular competition for the land, and suggests that even a five-fold expansion would be possible before maize plantings compete significantly with other crops.

IV. MARKET STUDY.

A. Vegetable Oils.

1. Domestic Market.

Presently Thailand is a net importer of fats and oils in order to satisfy domestic consumption demands. Imports of fats and oils have increased dramatically during the past three years with the increase being almost entirely in the oil sector. (See Table 4A and B)

Domestic fat and oil consumption at 3.38 kg per capita per annum emphasizes the deficiency of this high energy food in the average diet, (See Annex Table A). Doubling the per capita intake is necessary to provide a minimum balanced diet, (per capita intake in the industrialized countries is about 30 kg).

The Kingdom is a consistent exporter of groundnut oil extracted from local production. As groundnut oil usually commands a premium price, (one to two cents per pound over maize oil) in world markets, a policy of exporting that particular oil and replacing it with lower priced oil, (palm), that is imported for domestic requirements is an economically viable practice.

Examination of the import/export oil balance indicates a certain amount of crude importing and the exporting of refined oils.

The oil balances for the past three years have been as follows (See Tables 3 and 4):

	1974	1975	1976
Export (Tons)	2,041	3,476	3,044
Import (Tons)	1,109	3,502	8,238
Balance (Net)	+ 932	- 26	- 5,194

(Source: Tables 3 and 4)

This pattern indicates opportunities for both domestic and export sales.

It is presumed that fertilizers, pesticides and [illegible]rrigation are not used. While these particular inputs [illegible]rove yields, the present cost in Thailand of these inputs [illegible] justifies their expense. The better emphasis at this p[illegible]lar stage in programs for yield improvement appears to [illegible] the seed quality.

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The target oil production of 2,400 tons of maize oil for the project proposed herein can be readily absorbed in the domestic market. As an exported commodity it compares with the 1,000 - 1,500 tons of ground nut oil exported annually from 1974 to 76. This demonstrates adequate volume to be attractive to overseas importers (Japan, Taiwan, Hong Kong and Singapore representing countries with preference for the superior qualities inherent in maize oil). While both ground nut oil and maize oil are primarily cooking oils, they are not directly competitive in the consumer market. The distinctive taste of the ground nut is preferred for some cooking applications while the bland, high poly-unsaturated maize oil is preferred in others. The availability of maize oil for export in no way threatens the ability to export ground nut oil.

The average value of all imported oils presently is about the same as was the average for the entire part year (1976) or US$ 720.00 per ton (฿ 14,400). Table 4-C,(฿16,000 x 0.90 is conversion from kiloliters to tons.)

The groundnut oil exports in 1976 had an average value of US$ 745.00 per ton (฿ 14,900). While this unit value properly reflects a present value for maize oil, a selling price of US$ 440.00 (฿ 8,800) per ton of crude maize oil is suggested in the project proposed herein. Current world harvests indicate a return to a more normal world supply/demand balance for soybeans and a continuation of the recent growth rate in world palm oil production which will reduce current price levels over the forthcoming five years (The U.S. and Brazil have record soy bean crops in 1977 and more Malaysian and Indonesian plantings of palm oil trees are maturing each year.)

As supplies of total fats and oils become better balanced with demand, the impact of such balances will be less upon maize oil than upon other oils and fats because of the maize oil's acceptability as a health food, (high poly-unsaturated content and low saturates).

2. International Market

By contrast with other edible oils, maize oil does not move in large volumes in world trade. This is because countries that use maize oil prefer to produce their own supply from imported whole grain, and because of the several U.S. cents premium per pound on maize oil over cotton seed or soy bean oil.

However, the growth in maize oil imports by the industrialized countries as between 1970 and 1975 was very rapid, more than tripling in five years from 2,000 to 7,000 tons (These data are based on a survey of imports of the EC countries, Japan, United States, Singapore and Hong Kong.)

Despite the slightly higher cost of maize oil, users are increasingly coming to appreciate the health properties of maize oil which contains 11% saturated fatty acids in contrast with 76% in coconut oil, against 76% in palm kernel oil and 47% in the case of palm oil.

Thailand can find an export market for maize oil, especially if shipments are made in bulk in the "deep tanks" of general cargo vessels that can accommodate 40 to 60 tons. Shipping in drums however would double or triple the freight rates.

B. Animal Feed Ingredients

1. Domestic Market, Volume and Value

Animal feeding, especially with compounded rations, in showing steady growth. Thailand's feed mixing industry has a current effective capacity of 600,000 tons annually, (See Annex Table C). As the major uses for the complete feeds are swine and poultry the base ingredient is maize (usually in the form of ground whole kernels). The indicated domestic maize consumption as feed for the 1976-77 crop, (450,000 tons), confirms this estimated feed mixing capacity. The annual growth rate in the consumption of maize per feeding over the past six years has been 27%, (Table 5). People in the industry (compounders and exporters) believe this rate of growth will continue over the next five years. A parallel expansion can be expected in the feed mixing industry. Evidence of this is the advice by the Bangkok Feed Mill Co. Ltd. that they are building another compounding facility in the maize belt. Also, in early October, the BOI approved two feed mixing projects totaling 93,200 tons mixed feed production per year. This new capacity is about one sixth of current mixed feed output of 600,000 tons referred to above.

Based upon an indicated compounding capacity of at least 700,000 tons, the 26,000 tons of feed ingredients proposed in this project will amount to less than 4% of the mixing requirements.

The feeds are mixed to specific analyses of protein, fat, crude fiber and energy. A variety of ingredients may be used, but the basic components are maize (for energy), soybean meal (for protein) and fish meal (also for protein). A variety of other ingredients are also used:- Soybean groundnut oil cake meal, kapok seed cake, rice bran, rice bran oil cake meal, coconut oil cake meal, wheat bran, rice and molasses.

The selection of ingredients is based upon price correlated to the contribution of each ingredient to protein, fat and/or energy.

Cassava chips and pellets are potentially a feeding ingredient but are <u>not</u> used in the modern sophisticated Thai mill because of their unreliable moisture content and high adulteration with sand especially in ruminant feeds, (sand is referred to as "silica" by the Tapioca Trade Association).

The feed mixing mills in Thailand produce both a complete feed and a concentrate. The concentrate consists of the very high protein fish meal, fortified with vitamins and mineral traces. Its market is represented by the large feeders (of swine and poultry) whose operations are of such magnitude that it is more economical for them to purchase the concentrate and mix the maize, soybean meal and filler ingredients themselves in order to produce the complete balanced mixed feed.

Smaller feeders purchase the complete mixed feed. The two by-product feeds to be produced by the project proposed herein are particularly well adapted to the requirements of the feeding industry. The two feeds are (a) maize oil meal and (b) milled maize.

2. Maize Oil Meal

The feed ingredient produced from expelling the maize oil is a mid-protein (20% dry basis) commodity with a nutritional value superior to defatted rice bran, rice bran or wheat bran. Comparative analyses are as follows:

COMMERCIAL FEED INGREDIENTS

	Maize Oil Meal	Rice Bran	Defatted Rice Bran
Moisture %	10.0	10.0	N.A.
Protein %	18.0	12.0	10.5
Oil %	4.4	13.0	1.5
Ash %	6.5	9.0	7.5
Crude Fiber %	9.2	N.A	11.0

Sources: Annex Table B, for maize oil meals from 8% oil content maize; rice bran data are from D.F. Houston, <u>Rice Chemistry and Technology</u>, 1972.

Wheat bran is not dissimilar to defatted rice bran. While small quantities of wheat bran are locally available, the supply is unreliable. The flour millers in Thailand prefer to export their bran and middlings in order to obtain the duty draw back against the imported wheat. Export and domestic prices of bran and middlings tend to be equal, so the duty draw back is the equivalent of increased revenues for the wheat millers. This particular pattern supports the concept of a ready export market for a quality mid-protein feed ingredient exported to Japan, Taiwan, Hong-Kong or Singapore.

Rice bran and wheat brans both are currently priced at about US$ 150.00 (฿ 3,000) per ton. Although the maize oil meal is a superior feeding ingredient, permitting a greater reduction of high priced (US$ 300.00/ton)=(฿ 6,000) soybean meal in the rations, this report conservatively projects the selling price at parity with rice bran and wheat bran.

All of these mid-protein commodities are price sensitive to the maize price. As the maize oil meal is derived from maize, the cost/price relationship is preserved and the product profit margins are protected.

Thailand's shortage of feed ingredients can be seen in recent import patterns. From 1974 through 1976, Thailand imported four principal ingredients: groundnut cake, soy bean cake, sweetened forage, other oil cake. The volume of these feed ingredient imports rose from 21,300 tons in 1974 to 44,000s in 1976, that is doubling in three years. The value of these imports rose from $7.6 million in 1974 to $11.8 million in 1976, an increase in value of 55%, according to the official import data of the Customs Department.

3. Milled Maize.

The bulk of the by-product feeds from the proposed project is a milled product closely similar to maize itself in analysis. The comparison with ordinary maize and cassava pellets is as follows:

	Milled Maize By-Product Feed	Ordinary Maize	Cassava Pellets
Moisture %	13.0	14.7	12.0
Starch	71.3	60.5	85.5
Protein	6.4	8.3	2.5
Fat	1.7	4.1	1.0
Fiber	1.3	2.2	2.0
Ash	2.0	1.2	1.0
Remainder	4.3	9.0	-
	100.0	100.0	100.0

Source: These data are from standard starch chemistry text books; the cassava data are world-wide and not necessarily applicable to Thai cassava. The milled maize data comes from the material balance shown in Section VI.c. of this pre-feasibility study.

The lesser protein and fat contents in the milled maize compared to the whole grain is offset by its higher dry substance content in so far as economic feed value is concerned.

The most likely market for this product is in the feeding of domestic animals (swine and poultry). Milled maize represents a replacement of whole maize, sorghum or broken rice in the feed ration formulas.

The large scale compounders are likely to purchase this ingredient at a parity price to maize because of its lower moisture content - a most sensitive factor in their purchasing policies.

The large scale up-country animal feeders who do their own mixing presently are paying a 5 to 10% premium for milled maize over the whole grain. This is because the milled maize allows them to avoid the milling operation themselves and also affords better control in mixing to the desired ration balance. Further, the milled maize tends to be more uniform in moisture content than the whole grain maize itself.

Despite these indications of a price parity, or even a premium to whole grain maize, this report projects a product price equal to 25% that of maize. As in the case of the maize oil meal, this product price is sensitive to the cost of maize and so permits protection of the indicated net revenues.

4. International Market.

The potential for an export outlet for the milled maize byproduct is dependent upon unforeseen developments. During periods of general world maize supply/demand imbalance in which maize is in short supply, there would exist opportunities to export to the usual maize importing countries at maize prices.

Due to the product modification of whole grain arising during the processing, it may be possible that this product could find access to the EC under the same duty preference that is accorded to cassava pellets or maize gluten feed. Either in the case of a world shortage of feed, or in case Thailand has access to EC markets, the price of the milled maize byproduct would command a premium over the maize whole grain. This is because in times of maize shortages, substitution commodities always enjoy a premium over the original raw material. In regard to access to the EC market, the amount of the premium would be in direct proportion to the negotiated customs duty (levy) versus the variable levy on maize.

The customs duty on maize levied by the EC is variable and rises when the world price of maize declines; converseiy, the duty is lowered when the world price of maize goes up. The EC duty on raw maize in the summer of 1977 was US$ 80 per ton. The customs duty levied by the EC on gluten feed is low, probably one fourth of the duty on raw maize. The variable duty is largely a device to protect French maize growers.

The EC countries are importing major volumes of feed materials including 2.9 million tons of maize and other vegetable residues worth US$ 359 million in 1975.

The delivery and distribution of the oil and feed products is relatively simple and uncomplicated. In all instances the potential customers are volume buyers.

5. Distribution and Marketing.

Domestically, the oil customers are the vegetable oil refiners who would receive the crude maize oil in tank trucks. The export customer is most likely to be one of the major multi-national grain traders with a branch or subsidiary in Bangkok. The choice of customer is made on the basis of which buyers bid the higher price.

The market outlet for the feed products is similar. The product is sacked without pelletizing, and delivered by truck to either the complete feed compounders or the large animal feeders in Thailand. Offers to the multi-national grain or commodity trades would be as pelletized feed. This is because the domestic buyer does not want to mill pellets, but the exporter wants pellets to facilitate bulk handling and because the freight rate for pellets is less. Price would determine the choice of customer as there is little of no product loyalty common to this industry.

The merchandising efforts for both the oil and the two feed byproducts are the same as those in selling all commodities. The necessary contacts with the potential customers are established and offers are kept updated. Terms of sales would include (a) price per ton, (b) quantity, (c) delivery schedule and (d) quality specifications. It is common practice in the industry to sell for forward shipping periods. It is recommended that a pattern of volume rates negotiated in the normal trading practice procedures be the merchandising policy. This limits selling expenses to a minimum and promotes the most economical operating schedules. It is normal that sales be made on a FOB factory basis placing the distribution burden upon the customer. All prices used are based upon this premise. If the products were to be delivered to a customer's facility, transportation costs would need to be added.

V. OPTIMUM PROJECT SIZE.

A. Raw Material Considerations.

The initial restraint to facility size is the availability of raw material. It has been noted above that the project will require a special maize high in oil contents. Once there is demonstrated viability in the commercialization of the variety, an increase in production would naturally follow.

It is estimated that no difficulties will be encountered in the procurement of 30,000 tons of the special maize per year. This volume could be grown on 11,200 hectares, or less than 1% of the land now planted in maize. This suggests a processing facility of 100 tons per day of maize. Such a daily capacity is compatible with standard equipment capacities for the various process functions. A lesser daily capacity requires a capital investment intensified to such an extent that profitability would be impaired.

There are no marketing restraints that are foreseeable other than availability of raw material supplies.

B. Capital Investment Considerations.

The physical facilities required are capital and energy-intensive as demonstrated by the proforma schedule of processing costs which follows in Section VI of this report. These factors preclude opportunities for "village" or "cottage" type processing units and suggest the minimum size of 100 tons per day. Larger sized units are feasible within the assessment of market demand in this report, but increased capacity will not necessarily have a major impact upon the fixed asset investment requirements per ton of daily input. Expansion in capacity will generally require additional equipment units at each operating station. In other words, economies of scale would not follow to any major extent if more equipment is added. In fact, if the capacity is expanded too much, there is a potential loss of operating or management control.

VI. THE PROJECT.

A. General Description and Types of Potential Investors.

The project pro[illegible] is double-edged. It includes (a) the development of a[illegible]able raw material (high-oil maize) and (b) processing that commodity for its crude vegetable oil and two byproducts. Valuable animal feed byproducts are a residual from the oil processing.

Appeal to prospective investors is not compromised by the two fold approach. Almost all multi-national seed companies are either commodity processors themselves or are subsidiaries of agribusiness complexes. The range of the latter is extremely broad and includes several major multi-national grain trading firms already established in Thailand.

If necessary, joint ventures are a viable alternative.

This project will appeal to those corporations and companies that are commodity-oriented rather than retail, consumer-oriented. A brief sample of the kind of companies which would find the project compatible with their present business would include the Japanese Trading Companies (Mitsubishi, Mitsui, C. Itoh, Marubeni, etc.), multi-national grain trading corporations (Tredex, Continental Grain, Bung, Toepfer, etc.), multi-national feed mixers such as Ralston-Purina and multinational seed companies such as DeKalb, Pioneer and Funk. All of these corporations do engage in commodity processing if and when the processing supports their major activity.

The maize production aspect of the proposed project lends itself to either a trading type operation or an extension of a commercial seed operation in Thailand. As the latter appears so attractive within itself, (because farmers will want to plant the new variety), it is likely that this would be the route an investor might wish to pursue.

B. Raw Material and Plant Location.

To insure an adequate supply of the raw material, the procedure most promising would be that of contract growing with the processor supplying the seed to farmers. Should the seed be supplied free of charge the added cost of purchased maize would be some US$1.00 to 1.25 (฿20-25) per ton of delivered maize.

Assuming a 30,000 ton per year processing input, 140 tons of seed must annually be made available for commercial planting. Seed yield per ha is estimated at 1,875 kg lower than commercial production due to the subsequent selection of kernels that would be of seed quality. This requires about 76 ha. Production and seed processing costs are calculated to be about the same as that for the seed now produced by the Department of Agriculture Extension Service and Kasetsart University, (US$.20-.25 per kilo for seed maize).

Because maize is generally a one crop per year commodity, there would be carrying charges attendent to maintaining the maize for which identity must be preserved. Carrying costs identified with storage and preservation of quality during storage, as well as interest equivalent on the inventory value, is calculated along with the processing costs associated with the oil extraction facility.

The composition of the maize will vary from its norm as the oil content in maize is increased. The probable analysis, (influenced by results obtained in corn breeding for high oil content elsewhere*), for maize with three alternative proportion of oil will be:

ANALYSIS OF THREE ALTERNATIVE VARIETIES OF HIGH-OIL MAIZE
(Dry Substance Basis)

	A (8% Oil)	B (12% oil)	C (15% Oil)
Oil	8.0	12.0	15.0
Starch	68.0	62.5	58.0
Protein	9.0	9.5	9.8
Fiber	2.7	3.2	3.8
Ash	2.3	2.5	2.6
Other	10.0	10.3	10.8
	100.0%	100.0%	100.0%

*In the United States, commercial seed companies and some mid-western land grant colleges have already developed varieties ranging as high as 20% in oil content. This is higher than the oil content of soy beans, which is 18%.

A processing plant to produce maize oil, maize oil meal and milled maize should be sited in the areas producing the largest volumes of maize but as close as possible to the major feed mills. The top producing provinces and the location of major mills is shown in Figure 1.

Rank as Maize Producer	Name of Province	Maize Production in 1976-77 crop Year	
1st	Petchabun	665,000	
2nd	Nakohn Ratchasima	300,000	
3rd	Lop Buri	294,000	
4th	Nakhon Sawan	270,000	
5th	Saraburi	206,000	
6th	Phitsanulok	148,000	
7th	Loei	137,000	
	(Subtotal)	(2,020,000)	(75%)
	All other provinces	680,000	(25%)
TOTAL		2,700,000	(100%)

An investor should examine the reputation of farmers in the growing areas to determine the localities where a willingness exists to change traditional planting patterns. Similarly the reputations of local middlemen should be examined to identify those who can play a leadership role in helping farmers to switch from their plantings of ordinary maize to high oil yielding varieties.

C. Processing.

1. Products to be processes.

The contracted maize would be delivered to the proposed dry milling facility for separating the germ (oil bearing) from the remainder of the maize. Crude maize oil is recovered from the germ fraction by means of mechanical expelling (i.e. pressure as opposed to solvent extraction).

The products from this process are: (a) oil, (b) maize oil meal and (c) an equivalent of milled maize sometimes called the milled residue fraction. The latter two may or may not be pelletized depending upon the individual market as explained in Section III above For domestic sales, those products probably would not be pelletized. In serving the export market, the same products should be pelletized to facilitate bulk handling and shipment.

2. Equipment Description.

The process begins with maize received at the plant in trucks. The maize may be in bulk, but most likely would be in 60 or 100 kg jute bags as is the practice at the Bangkok Feed Mill. -- (Process Flow Diagram page 33)

The grain is then weighed and sampled. Payment is made consistant with the purchase terms in respect to both quantity (weight) and quality (chemical analysis). The chemical analysis would require the use of "NMR" equipment and moisture analyzers.

The maize is then dumped into storage facilities.

As needed for processing, the maize flows from storage bins through cleaning equipment for the purpose of removing foreign material and dust. (An election may also be made to clean prior to storage).

The equipment used for this operation is much the same as that in cleaning wheat or other grains prior to processing. The maize is sieved to remove the heavier impurities according to their size (e.g. size of pieces of cob) and weight (e.g. dirt), relative to the whole maize kernel. The screening equipment is aspirated to lift out dust and fine dirt. The broken kernels removed from this operation are added to the feed fractions that are a residual from the germ separations.

The quality of purchased maize should be maintained at a level that limits broken kernels to about 1% of the total.

Ferrous metal is removed through passing the cleaned maize over a magnetic separaror.

The maize is then tempered - lightly humidified and slightly heated - to facilitate milling so that the germs will not be broken.

Milling is done through an attrition mill. The mill consists of two large steel plates, one plate may rotate with the other stationary or both plates may rotate in opposite directions. The adjacent faces of the plates are studded with squat teethlike projections which are arranged so that the moving teeth of one plate pass between those of the other. The plates can be adjusted so that the space between the teeth is variable and thereby control the fineness or coarseness of the grind.

From the mill, the mass is blown to a cyclone where a separation between heavy and light materials is made. By introducing the material to the conical cylinder through a tangential inlet, a centrifugal action occurs that permits the light material to exit at the top with the conveying air stream. The heavier material falls to the bottom and is discharged.

The light material will contain the germ, fine fibers and some endosperm that clings to the germ, plus fine fiber.

Cyclone separation control is a function of its design, rate of output, volume of air and rate of airflow. Cyclone separation would be operated so as to recover the maximum amount of germ in the air exit, while maintaining an oil proportion in the germ fraction of about 35% by weight.

Air separation is not a definitive or precise separation. Efforts to recover the last germ particle from the mass are counterproductive in that such efforts attract a disproportionate volume of non-germ material along with it. This creates expeller operation difficulties and results in high oil losses in the cake.

Efforts to control the germ fraction to a higher proportion of oil, conversely, leaves a disproportionate quantity of grain in the underflow material and reduces oil recovery.

The germ fraction is fed to a mechanical expeller which squeezes out the oil. The cake contains a small amount of residual oil. The expelled oil is settled and the clear fraction syphoned to a plate and frame filter press for the removal of all solid particles. Diatomaceous earth is used as filter aid in clarifying the oil. The tank settlings ("foots") and the filter cake are recycled through the expeller along with fresh germ. (Process flow diagram on page 33).

The cleaned crude oil is delivered to domestic vegetable oil refineries in tank trucks or transported to terminals for export. Export shipments can be made in the deep tanks of any ocean-going general cargo vessel. The minimum bulk shipments in deep tanks are about 40 to 50 tons.

The expeller cake is ground into meal and is either bagged for domestic sole or pelletized for export.

Using three alternative oil contents in maize, of the two fractions resulting from the separation, the germ as a percent of total maize on a dry substance basis is:

	A 8% Oil	B 12% Oil	C 15% Oil
		(Percent of total maize)	
Oil	7.0	10.5	13.5
Starch	3.4	5.1	6.5
Protein	2.7	4.1	5.3
Fiber	1.4	2.1	2.7
Other	5.5	8.2	10.5
Total	20.0	30.0	38.5
Crude oil yield	6.3	9.5	12.2

Annex Table B-1 shows an analysis of the expeller cake. The quantities produced per ton of maize will be:

A 8% oil - 137 kg
B 12% oil - 205 kg
C 15% oil - 263 kg

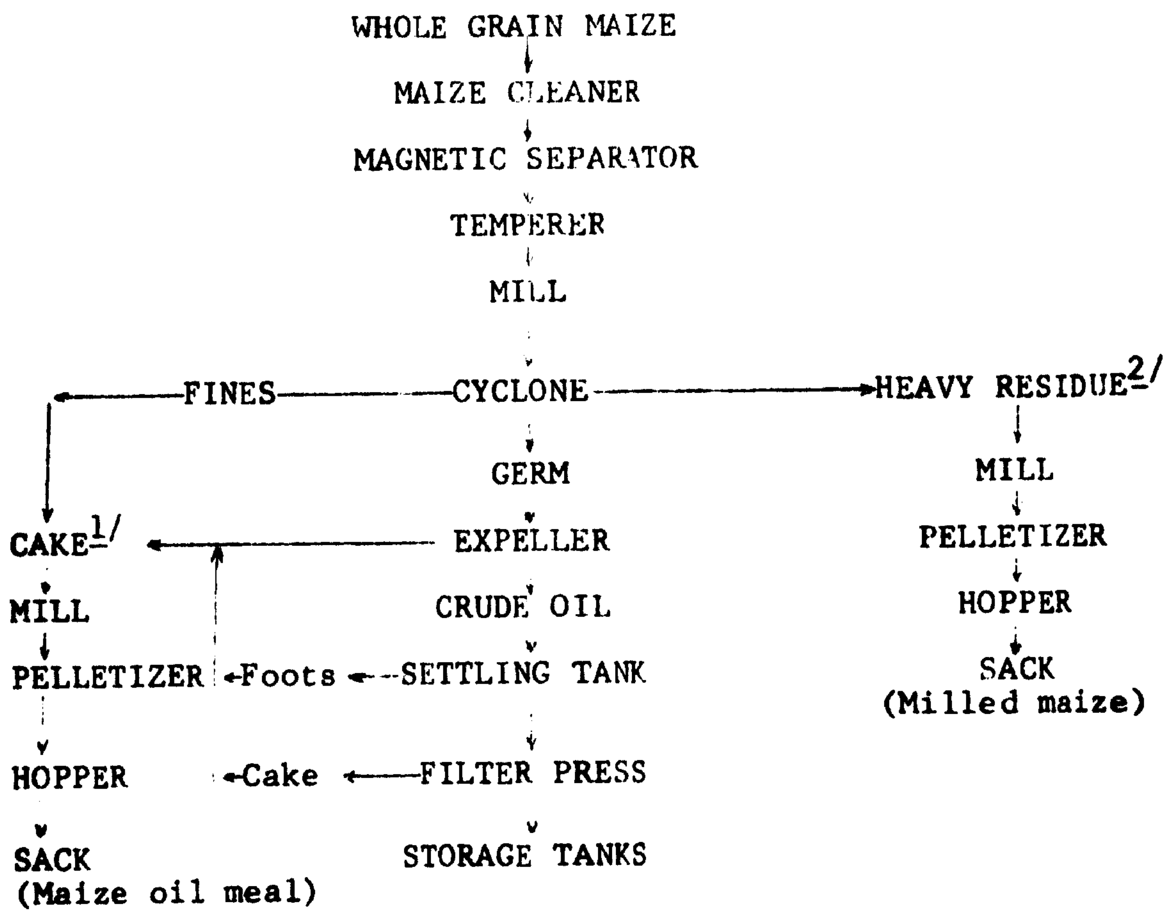
The heavy residue (see Flow Diagram) is a valuable feedstuff after grinding and pelletizing. The product is known in the trade as "milled maize". Milled maize is starchy and is not dissimilar to the composition of maize itself in that the fat content is slightly lower and the protein is almost the same. The fat and protein content is superior to that of cassava pellets and therefore represents a better feed. Moisture of the milled starchy meal will be in the range of 13%. (See Section III for composition of maize, cassava and milled residue). Cleaning and processing frees the product of impurities such as sand, stones, etc. For the reasons of uniform moisture content and freedom from impurities, the product is acceptable in high quality complete feeds where cassava is not unless subjected to a further cleaning process to remove sand (called "silica" in the local trade).

Milled maize as a percentage of total maize:

	A 8% Oil	B 12% Oil	C 15% Oil
	(Percentage of total maize)		
Oil	1.0	1.5	1.5
Starch	64.6	57.4	51.5
Protein	6.3	5.4	4.5
Fiber	1.3	1.1	1.1
Other	6.8	4.6	2.9
Total	80.0	70.0	61.5

Compositions of milled maize and oil meal are shown in Annex Table B-3.

PROCESS FLOW DIAGRAM



1/ After milling, this cake becomes maize oil meal.

2/ After milling this residue becomes milled maize.

D. Capital Requirements.

1. Financial Effects of Using Maize with Differing Oil Content.

Capital investment requirements and operating expenses are a function of the gross input/output of the processing facility. A facility of 100 ton capacity operating 300 days per year has been projected as the economic size in this report.

Total revenues are a function of individual product recoveries that are dependent upon the oil content in the raw material. The targeted raw material is a maize containing 12% oil on a dry substance basis. A number of experimental varieties of maize, native to Thailand, have already been identified having an oil content of 8% (See Exhibit A and Table 2). It is assumed that almost any of these can be readily used as foundation stock for the planting seed. Obviously, these seeds represent the varieties that are the foundation to improving oil content in maize through breeding.

Returns and proforma profit and loss are shown in schedules below for the 8% oil quality raw material as well as the targeted 12% raw material quality. The schedules demonstrate the economic conditions that would prevail if the project were initiated even prior to complete development of the 12% oil; content maize seed. It has been estimated by plant geneticists that the full in-breeding will take four generations, or two years (Dr. Surat Sriwatanapongse and Dr. Chamnan Chutkaew). Proforma financial results are also shown in other schedules below in the event that 15% oil maize raw material is obtained at some future date.

A 15% oil content seed is a feasible goal but may well require more than two years of breeding to obtain.

The three levels of oil content are identified, all on a dry substance basis as:

A - 8% oil in maize.

B - 12% oil in maize.

C - 15% oil in maize.

2. Costs.

Other than the carrying costs of maintaining a one year inventory of seed, no net cost of the seed is included in the project. Under normal contract growing arrangements with farmers, the terms would cover the expense factors such as (a) production, including seed,(b) shelling, (c) hauling, (d) drying, (e) storage and (f) delivery to the processing plant. Except for production costs, these services usually cost 15% to 20% of the wholesale price.

The final receipts for the raw material to the farmer are those which represent the fair market price less the above costs.

The capital investment requirement is self-explanatory in the table following this discussion. The building area will accommodate a modest (50%) expansion. The support investment for laboratory equipment includes a Nueclear Magnetic Resonance (NMR) spectroscope, vital to rapid breeding of the proposed raw material.

In calculating working capital requirements, certain procedural techniques are suggested as follows:

As the proposal is commodity oriented, the practices will be those normal to commodity trading. This includes forward commitments in both purchasing the raw material and in selling the finished product, a policy of cash payment upon receipt of raw material and receipt of cash on delivery of product. In short, there is generally little selling on credit. Discounts are not a custom in the purchasing or selling. Advances are carefully balanced in the pricing to cover the money costs of any advance.

Under these circumstances, this report assumes that inventories will not exceed one week's production. Mechanical stores represent somewhat more than one year's estimated requirements in maintenance parts.

A full year's supply of seed maize must be carried to protect the continuity of operations. In order to provide flexibility in raw material receipts and to accommodate the farmer in producing a special maize, raw material inventories will average two month's production requirements. The actual volume will fluctuate throughout the crop year and be related to the precise contractual arrangements made with the raw material suppliers. The existing 15% - 20% spread between farm gate price and the wholesale price of maize includes an inventory carrying charge. Because the raw material costs are based upon the wholesale value, it is logically assumed that these same patterns will continue. Recognition is given to the fact that identity of the special high-oil maize must be preserved. For this reason, the two month average inventory is assumed. This, in practice, represents a premium to the farmer because it provides greater flexibility in delivery schedules and thus narrows the spread between farm gate and wholesale prices. In other words, the processing plant is sharing some of the costs involved in maintaining the identity of the special high-oil maize, and the plant is willing to pay for maize before the maize is needed.

The schedules below of operating costs, that is administration and management, labor, power, fuel and water are self-explanatory. The process requires only very minor quantities of hot water, as it essentially is only a dry milling operation quite similar to wheat flour milling.

While a maize dryer is included in the capital investment, no operating expenses are assigned to this station. All maize in Thailand is traded on the equivalent basis of 14.7% moisture in the maize. Should the delivered maize contain more than this moisture standard, it is dried to that level in order that the finished product be stable and free from subsequent deterioration.

Maize received at the higher than standard moisture content in discounted in price. The discount is always calculated to cover the dry substance difference, drying costs and a small profit for the drying operation. It is preferable to disregard the inherent profit and assume a wash between discount and expense, as it is impossible to forecast with any degree of accuracy the volume of grain that might require drying. At best this would be a seasonal function, necessary only during the harvesting season, and then only on a portion of the delivered maize.

In calculating annual revenues a relatively long term outlook for world vegetable oil prices was forecast. This represents a somewhat lower price than current levels and is consistant with a U.S. crude soybean oil price level in the range of 15 to 16 cents per pound (current prices are 20-21 cents per pound).

The oil price determination is derived from the correlation of maize/soybean price forecasts adjusted for the price relationship of soybean meal to maize meals. (Schedule C-2).

Current (October 1977) levels for maize, maize oil meal and milled maize are used. The relationships are such that the cost/price/profit relationship is relatively stable at all <u>reasonable</u> price levels for the maize, which is the determinant for all profit calculations.

SCHEDULE A. CAPITAL INVESTMENT

A-1 LAND AND BUILDINGS

Land - 0.5 ha @ US$ 80,000/ha	=	US$	40,000
Process Building, 2 Floors 372m^2	=		111,000
Office & Laboratory 558m^2	=		167,000
Gate House	=		10,000
Sub-Total		US$	328,000

A-2 PROCESS EQUIPMENT (Installed)

Storage, steel tanks, elevators, conveyors.	
(20,000 tons @ US$ 24.00/ton)	US$ 480,000
Dryer, 10 tons/hour	60,000
Cleaner, 10 Tons/hour	10,000
30" Attrition Mill	7,500
Expeller	30,000
Tanks & Piping & Pumps	25,000
Plate & Frame Press	10,000
Magnetic Separator	5,000
Temperer	15,000
Cyclone & Fan	6,000
Hammer Mills (2)	15,000
Pelletizer	10,000
oppers	10,000
Sewing Machines (2)	8,000
Truck Scale	30,000
Boiler (Marine)	30,000
Piping	15,000
Electrical & Wiring	20,000
Transformer	25,000
	801,500
Plus 10% contingency	80,150
Subtotal (rounded)	US$882,000

A-3 INVESTMENT SUPPORTING EQUIPMENT

Laboratory Equipment Including NMR(*)	=	US$ 20,000
Maintenance Tools	=	40,000
Office Equipment	=	30,000
Tank Trucks (2)	=	30,000
Subtotal		US$ 120,000

(*) Needed to test oil content of incoming raw material and seed.

A-4 RECAPITULATION OF CAPITAL INVESTMENT IN FIXED ASSETS

Land (0.5 hectares)	=	US$ 40,000
Building	=	288,000
Machinery	=	882,000
Supporting Equipment	=	120,000
TOTAL Fixed Cap.		US$ 1,330,000

Depreciation & Maintenance = 8% = US$ 106,400/year (Land Excluded)

(Note: The labor portion of maintenance cost is included in staffing costs.)

A-5 WORKING CAPITAL REQUIREMENTS

Finished goods (1 week)	US$ 65,000
Mechanical Stores	35,000
Seed maize (150 t @ 200/t)	30,000
Raw material (5,000 t @ 92.50/t)	462,500
TOTAL	US$592,500

Note: It is assumed that the seed maize inventory and the raw material inventory will be short-term bank financed at an annual rate of 8%. This will create an interest expense of US$ 39,000.00 per year. The finished goods inventory and mechanical stores should be financed through normal operating cash flow.

A-6 TOTAL CAPITAL INVESTMENT

Fixed Assets		
Land	US$ 40,000	
Buildings	288,000	
Machinery	882,000	
Supports	120,000	
Total		1,330,000
Working Capital		
Finished goods	65,000	
Mechanical stores	35,000	
Seed maize	30,000	
Raw material	462,000	
Total		592,000
Grand Total		US$ 1,922,000

SCHEDULE B. OPERATING COSTS

B-1 ANNUAL COSTS SUMMARY

Raw material (30,000 t maize @ US$ 92.50 or ฿1,850/t) =	US$ 2,775,000
Labor (See staffing plan in B-2)	42,000
Administration and management	55,000
Power	82,000
Fuel	15,000
Water	5,000
Depreciation & Maintenance	103,000
Total	US$ 3,077.000
Interest (8% of Seed & Raw Material Inventory)	39,000
	US$ 3,116,000

B-2 STAFFING PLAN

Salaries, wages and number of employees by grade

Title	Dollars/ Year	Number	Total Cost/ Year
Management/Administrative			
Mill Manager	12,000	1	12,000
Administrative Manager	10,000	1	10,000
Plant Engineer	6,000	1	6,000
Chief Chemist	3,600	1	3,600
Sales & Purchasing Manager	3,600	1	3,600
Sales & Purchasing Staff	1,800	2	3,600
Accountant	1,800	1	1,800
Clerical & Record Keeping	1,800	8	14,400
Sub-Total		16	55,000
Production Employees			
Electrician	1,200	3	3,600
Machinist	1.200	2	2.400
Millwright	1.200	2	2.400
Asst. Chemist	1.200	1	1.200
Foreman	1,200	3	3,600
Machine Operator (Expeller)	1,000	3	3,000
Station Operators	900	3	2,700
Mech. Helpers	900	3	2,700
Sackers	900	6	5,400
Drivers	900	2	1,800

B-2 STAFFING PLAN (Cont'd)

Title	Dollars/ Year	Number	Total Cost/ Year
Watchmen	600	3	1,800
Unskilled	600	19	11,400
		50	42,000
TOTAL			US$ 97,000

B-4 OTHER COSTS

Water Costs = US$ 5,000/year
Fuel = US$15,000/year
(Small marine boiler for hot tempering water - humidifying)

B-3 POWER COSTS, Based on 25 days/month or 600 hours operation.

400 hp = 375 kw

Demand charge/month

50 x 60	=	฿ 3,000		
150 x 59	=	฿ 8,850		
175 x 58	=	฿ 10,150		
		฿ 22,000	=	US$ 1,100.00

Energy - 85% of capacity	=	340 x 600		
	=	204,000 kwh/month		
50 x ฿ 0.68	=	34		
150 x ฿ 0.60	=	90		
200 x ฿ 0.58	=	116		
203,600 x ฿ 0.56	=	114,016		
		฿ 114,256	=	US$ 5,712.00

Demand	=	US$ 1,100.00
Energy	=	5,712.80
		US$ 6,812.80/month
		= US$ 81,753.60/year

SCHEDULE C. PRO-FORMA PROFIT AND LOSS

C-1 SUMMARY OF REVENUE AND EXPENSES

US$(000)

	A(8% Oil)	B(12% Oil)	C(15% Oil)
Annual sales revenue (See Schedule C-2 for selling prices)	$ 3,356	$ 3,743	$ 4,077
Total Costs	3,116	3,116	3,116
Profit before taxes	240	627	961
Return on Sales	7.2%	16.7%	23.6%
Return on Fixed Assets	18.0%	42.1%	72.3%
Return on Total Investment	12.5%	32.6%	50.0%

C-2 YIELDS & REVENUES

YIELDS

Product	% Moisture	Kg per ton 14.7% Moisture Maize		
		A(8%)	B(12%)	C(15%)
Oil	0.0	54	81	104
Maize Oil Meal	10.0	130	194	249
Milled Maize	13.0	784	686	603
Loss(*)		32	39	44
Total		1,000	1,000	1,000

ANNUAL REVENUES
(US$ 000)

Product	Price/ton	Annual Production & Revenues					
		A		B		C	
		Tons	Dollars	Tons	Dollars	Tons	Dollars
Oil	440.00	1620	713	2430	1069	3120	1373
Maize Oil Meal	150.00	3900	585	5820	873	7470	1121
Milled Maize	87.50	23520	2058	20580	1801	18090	1583
Total			3356		3743		4077

(*) As oil yield rises, some drying will occur at both milling and expelling stations. More drying occurs in expelling than elsewhere. Therefore, as the proportion of raw material to be expelled increases, the total moisture loss will increase proportionately.

VII. POTENTIAL DOWN-STREAM PRODUCTS.

Both crude oil and the milled maize can be further processed into more sophisticated products. Similar downstream opportunities are not available from the maize oil meal; in short the maize oil meal cannot be further processed except as mixed in a compounded animal feed.

A. Oil. Crude maize oil may be refined to remove its fatty acids. The process consists of neutralizing with caustic soda, washing and centrifuging to remove the coagulated fats, (which are then hydrolized to make animal feed), bleached, winterized, deodorized and cooled, (winterizing means cooling below 60^{o}F to remove waxes.) The refined oil yield from the crude oil should be in the magnitude of 93%. The refined oil recovery is a function of free fatty acid content which averages 2-3%.

From the refined oil, an entire family of consumer products can be produced. These include margarine, mayonnaise, solid salad dressing, pourables (i.e. flavored salad dressings), sauces and spreads. Refining costs are a modest 2½ to 3 cents per pound. The profitability in these products is in their appeal to the housewife for home consumption.

The market for these products, whether in Thailand or elsewhere in the world, is dominated by established private brands. In order to obtain shelf space in the retail outlets, turnover and supply reliability are prerequisites.

The basic economic size for a quality product refinery would be in the magnitude of 15 tons per eight-hour shift, and would require a capital investment approaching US$ 200,000.00. To be economical, the refinery should operate on three shifts.

The crude oil production from the maize facility proposed herein (8.1 tons of crude/day), is too small to meet the necessary conditions for penetrating the consummer market, and is about one sixth of the 3-shift capacity of the minimum size refinery. For example, assuming one percent of the Thailand population could afford these relatively expensive down-stream food items, the production would represent only 5.3 kilograms per capita per year (8.1 t x 93% x 300 = 2,260 t/424,000 people.) This low production volume represents a condition in which the branded product is likely to be out of stock half the time -- a situation that prohibits consistant resales and the development of brand loyalty among the buying public.

These products need promotion and advertising that usually requires expenditures equal to or greater than their bulk cost. Only volume sales, which cannot be achieved because of limited supply, can support the merchandising effort, judging by experience in other countries.

The economic capacity of the refinery is such that it would operate only one shift every other day on the maize oil produced by the proposed plant. To cover costs, other oils would have to be refined. The present vegetable oil refining capacity in Thailand exceeds 39,000 tons per year and more than 40% of that capacity is idle. The opportunity to refine other crude vegetable oils is therefore discouraging.

B. Milled Maize.

The milled maize feed fraction can be further processed to produce a maize flour, maize grits and a slightly more valuable animal feed than the milled maize itself. In this area, as in the assessment of products from the wet milling of maize, the cassava starch competition is such that under current conditions, the processing costs of maize flour cannot be recovered in the sales of the starch end products. The proportion of protein in the maize flour makes such a product considerably less desirable for industrial applications, (which represents the volume outlet for starch), than is the cassava flour. Protein in the starch from maize flour causes undesirable gums which impede operations in the paper and textile industries. (In dry milling, the protein cannot be separated out from the starch for various chemical reasons.)

LIST OF TABLES

ANNEX TABLE A

ESTIMATED CONSUMPTION OF FATS AND OILS IN THAILAND, 1976

(Units: Metric Tons)

	(A) Domestic Production	(B) Imports of Fats on Oils d/	(C) Sub-Total	(D) Exports	(E) Consumption
Coconut	13,400	37	13,437	-	13,437
Palm and Kernel Oil	4,600	6,928	11,528	1,866	9,662
Peanut	9,200	3	9,203	1,039	8,164
Rice bran	15,600	-	15,600	90	15,510
Soy bean	9,700	670	10,370	-	10,370
Cotton seed	1,800	-	1,800	-	1,800
Kapok	4,000	-	4,000	-	4,000
Others	3,500	1,546	5,046	54	4,992
(Domestic Manufacturing Sub-total)a/	(61,800)	-	-	-	-
Domestic tallow	4,000	-	4,000	-	4,000
Domestic Hog lard (Purchased by urban population)b/	12,000	-	12,000	-	12,000
Domestic Hog lard (self-rendered)	59,377c/	-	59,377		59,377
TOTAL	137,177	9,184	146,361	3,049	143,312e/

a/ 1975 Ministry of Commerce data plus 10% growth.

b/ Based on 2 Kg. per hog.

c/ Based on(a) average hog weight of 60 kg. 30% fat (c) annual slaughter of 6,000,000 hogs multiplied by 80% to reflect slaughter in rural areas. (d) 30% loss.

d/ Based on Tables 3 and 4 , showing Customs Department exports and imports.

e/ 143,312 MT divided by 42.4 million population indicates per capita consumption of 3.38 kg.

ANNEX TABLE B-1

SELECTED PARTS OF MAIZE HAVING 8%, 12% AND 15% OIL CONTENT.
(Dry Substance Basis)

	A	B	C
	(8% oil content maize)	(12% content maize)	(15% content maize)
Oil	6.3	9.5	12.2
Oil Meal			
Oil	.7	1.0	1.3
Starch	3.4	5.1	6.5
Protein	2.7	4.1	5.3
Fiber	1.4	2.1	2.7
Other	5.5	8.2	10.5
Total Oil Meal	13.7	20.5	26.3
Total	20.0	30.0	38.5

(Note: This is taken from the material balance in Section VI-C and is on a dry substance basis excluding moisture.

ANNEX TABLE B-2

ANALYSIS OF MAIZE OIL MEAL
(Commercial Basis Including Moisture)

Moisture	%	10.0	10.0	10.0
Oil	%	4.6	4.4	4.4
Starch	%	22.3	22.4	22.2
Protein	%	17.7	18.0	18.1
Fiber	%	9.2	9.2	9.2
Other	%	36.2	36.0	36.1
		100.0	100.0	100.0

ANNEX TABLE B-3

COMPOSITION OF MILLED MAIZE
(Dry Substance Basis)

	A 8% Oil	B 12% Oil	C 15% Oil
		(Percent)	
Oil	1.2	2.1	2.4
Starch	80.8	82.0	83.7
Protein	7.9	7.7	7.3
Fibre	1.6	1.6	1.8
Other	8.5	6.6	4.8
	100.0	100.0	100.0

COMPOSITION OF MAIZE OIL MEAL
(Dry Substance Basis)

	A 8% Oil	B 12% Oil	C 15% Oil
		(Percent)	
Oil	35.0	35.0	35.1
Starch	17.0	17.0	16.9
Protein	13.5	13.7	13.8
Fiber	7.0	7.0	7.0
Other	27.5	27.3	27.2
	100.0	100.0	100.0

ANNEX TABLE C

FEED MIXING PLANTS IN OPERATION AND ADDITIONAL PLANTS BEING PLANNED, RATED AND EFFECTIVE CAPACITY--1977

(Sources are: Business in Thailand, interviews with private firms, Board of Investment, via Bangkok Post of Oct. 10, 1977) It should be noted that the entire industry is operating at about 60% of capacity due to raw material shortages.)

Name of Company	Rated Capacity (000's of/mt)	Assets (US$ millions)	Remarks
Bangkok Feed Mill Co.	290	$ 3.4	Largest mill in operation.
Bentagro Co.	96	$ 1.1(est)	--
Central Food Product Co.	193	$ 3.6	--
Laen Thong Co.	120	$ 5.5	Assets including non-feed operations
Ralston Purina	48	0.6(est)	--
Thai Feed Industrial Co.	75	0.9	--
Sakol Cattle Feed Co.	15	0.5	--
Charoen Pokphand Feed Mill Co.	120	1.8(est)	Affiliated with Bangkok Feed Mill Co. (above)
Srithai Pasak Feed Mill Co.	54	0.4(est)	--
Inter-Industry Co.	40	0.3	--
(1977 Capacity of Operating Firms, Sub-Total	(1,051)	--	--
(Effective Capacity)	600	--	This is based on 9/28/77 interviews with Bangkok, Feed Mill Co.
Thai Central Soya Co.	72	1.4	Promoted by BOI, week ended 10/7/77

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ANNEX TABLE C (Cont'd)

Name of Company	Rated Capacity (000's of/MT)	Assets (US$ millions)	Remarks
C.P. Feed Mill Co.	46	0.9	Promoted by BOI, week ended 10/7/77
Ms. Samak Thanyamasrat	46	0.9	"
Ms. Chaiyong Pongpanwatana	46	0.9	"
Direk Sinpratak	46	0.9	"
Bangkok Feed Mill, 2nd Plant	150(est)	n.a.	

Estimated capacity by 1980	1,457	--

TABLE 1

COMPARISON OF COSTS OF CASSAVA STARCH AND MAIZE STARCH

(in Baht per kilogram)

	CASSAVA	MAIZE
Raw Material Gross Cost	.40	1.40
By-Product Returns (-)	0	.75
Net Cost of Raw Material	.40	.65
Raw Material Cost per kg of Starch	1.33	1.00
Manufacturing Expenses	1.00	1.50
Total Operating Cost	2.33	2.50
Sensitivity 10% raw material price change*	.13	.08

* A 10% change in raw material costs results in a ฿0.13 change in the total cassava starch cost. A 10% change in the maize raw material costs, results in a ฿0.08 change in the total maize starch cost.

TABLE 2

RESULTS OF 24 LABORATORY, DRY BASIS,

TESTS FOR OIL CONTENT OF THAI MAIZE

(Feb., 1976, Oil Seed Laboratory, Dept. of Agriculture, Ministry of Agriculture and Cooperatives.)

Test No.	Variety Code[a/]	Oil Content (%)	Ranking
12	3012	9.16	1st
11	3011	8.87	2nd
20	4008	8.59	3rd
15	4003	7.92	4th
19	4007	7.72	5th
17	4005	7.35	6th
24	4012	7.26	7th
9	3009	7.17	8th
14	4002	7.14	9th
16	4004	6.82	10th
22	4010	6.78	11th
23	4011	6.78	12th
18	4006	6.76	13th
10	3010	6.72	14th
21	4009	6.65	15th
6	3006	6.32	16th
2	3002	6.15	17th
4	3004	5.86	18th
7	3007	5.85	19th
1	3001	5.65	20th
5	3005	5.60	21st
13	4001	4.95	22nd
3	3003	4.92	23rd
8	3008	4.41	24th

a/ Variety code translations are in the files of Corn and Sorghum Branch, Dept. of Agriculture.

TABLE 3-A

QUANTITY OF EDIBLE FATS AND OILS EXPORTED

	1974	1975	1976
(A) Fats (mt)	427	200	5
(B) Oils (kl)	2,268	3,862	3,382
(C) Oils (mt) (Bx 0.9)	2,041	3,476	3,044
Total tons (mt) (A + C)	2,468	3,676	3,049

TABLE 3-B

VALUE OF EXPORTS
(Unit: ฿000's)

	1974	1975	1976
(A) Fats	2,145	1,664	24
(B) Oils	36,315	40,308	34,063
Total A + B	38,460	41,972	34,087

TABLE 3-C

VALUE OF EXPORTS PER KG AND LITER
Unit: ฿/kg or ฿/liter

	1974	1975	1976
Fats, average price/kg	6.028	9.304	4.900
Oils, average price/liter	16.010	10.437	10.071

TABLE 4-A

QUANTITY OF EDIBLE FATS AND OILS IMPORTED

	1974	1975	1976
(A) Fats (mt)	807	934	946
(B) Oils (kl)	1,232	3,891	9,153
(C) Oils (mt) (0.9 x B)	1,109	3,502	8,238
Total Tons (A + C)	1,916	4,436	9,184

TABLE 4-B

VALUE OF FATS AND OILS IMPORTED
(Unit: ฿ 000's)

	1974	1975	1976
(A) Fats	12,948	14,900	15,513
(B) Oils	20,104	47,410	146,468
	฿ 33,052	฿ 62,310	฿ 161,981

TABLE 4-C

VALUE OF IMPORTS PER KG AND LITER
(Unit: ฿/kg or ฿/liter)

	1974	1975	1976
Fats, average price/kg	฿ 16.040	฿ 15.958	฿ 16.399
Oils " " /liter	฿ 16.320	฿ 12.185	฿ 16.002

TABLE 5

MAIZE AREA HARVESTED, PRODUCTION, EXPORTS AND DOMESTIC CONSUMPTION, 1970 - 1977

Crop Year	Area Harvested ha(000)	Yield Ton/ha	Beginning Stocks Tons(000)	Production Tons(000)	Exports Tons(000)	Domestic Feed Tons(000)	Domestic Other Tons(000)	Domestic Total Tons(000)
1970-71	829	2.34	190	1938	1663	105	115	220
1971-72	1019	2.26	245	2300	2111	135	145	280
1972-73	997	1.32	154	1315	1039	140	155	295
1973-74	1044	2.25	135	2350	2131	160	181	341
1974-75	1082	2.26	13	2450	1979	250	200	450
1975-76	1336	2.25	34	3000	2386	350	210	560
1976-77	1400	1.93	88	2700	2000	450	250	700
Annual average growth, 1970-76		-3%	+9%	+7%	+3%	+27%	+14%	+21%

Source: United States Department of Agriculture Foreign Agriculture Service.

EXHIBIT A. THE STATUS AND OUTLOOK FOR MAIZE PRODUCTION IN THAILAND, TRANSLATION OF EXCERPT FROM A PAPER PREPARED BY THE MINISTRY OF AGRICULTURE AND COOPERATIVES, 1977.

Conclusions regarding the Characteristics of Maize Variety.

From the results of experiments, discussed earlier in this paper, and judging by the findings of several studies in different localities in Thailand, we conclude that the Phra Buddhabat No. 5 variety (also known as "Guatemala"), can be readily grown in any tropical lowland area. The variety has been found to be open-pollinated, and to posses characteristics that make for flexibility in breeding, that is to say variations in the composition of the maize can be readily achieved by cross-breeding.

The stalk of this maize variety tends to grow tall, about 220 to 250 centimeters above the ground while the ear is usually about 134 to 155 centimeters above the ground surface. The stalk is comparatively thin and moderately strong with an average skin thickness of 1.65 millimeters. There are usually 15 to 20 leaves per stalk, and the leaves tend to be narrow and dark green in color.

The elapsed time from sprouting to maturity (when the kernels contain about 20% moisture) is from 110 to 115 days. There is usually only one ear of maize per stalk. The husk remains tightly wrapped around the ear even when the ear has fully matured. Each ear will have 12 to 14 rows of kernels, and the weight of an ear, grown with proper spacing between stalks, ranges from 140 to 160 grams. The kernels cover about 80% of the surface of the cob. Kernels with a 14% moisture content weight 15 kg per basket of 20 liters capacity;

EXHIBIT A. (Cont'd)

4,000 kernels will weigh 1,000 grams or 1 kg. The kernels are typically orange or reddish-yellow in color and are the flint type; the majority of kernels tested contain "hard" or "corny starch" and less than half contained "soft" starch in the endosperm.

The average chemical composition of the Phra Buddhabat No. 5 is as follows:

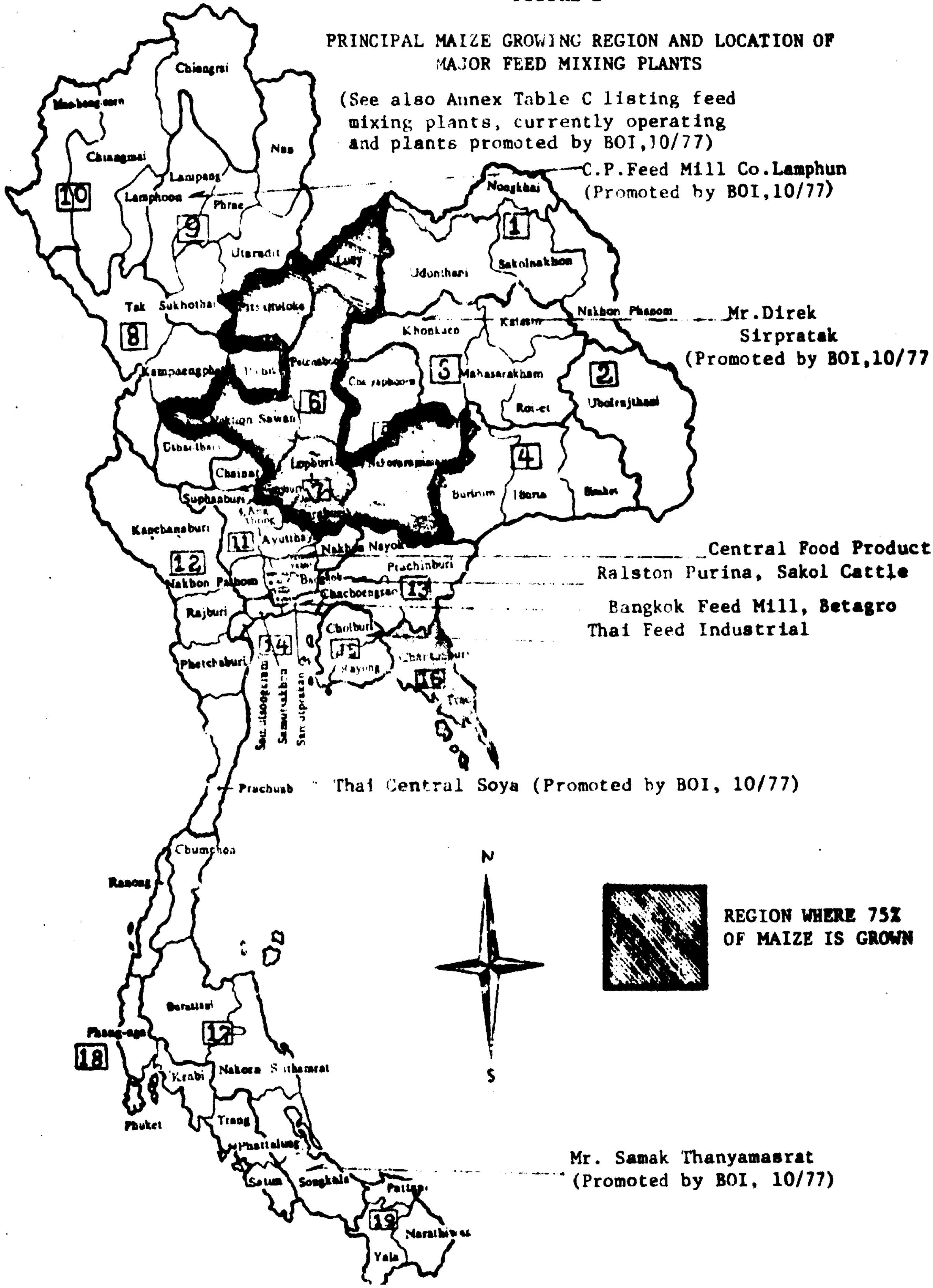
Carbohydrates:	67.9%
Fat:	7.93%
Protein:	9.04%
Amynolysene acid:	2.4 to 3%
Crude fiber:	2.39%
Ash:	2.32%
Other:	7.42 to 8.02%
Total	100%

The carotene content is higher than dent corns and the resistance to plant diseases and insects is considered medium.

FIGURE 1

PRINCIPAL MAIZE GROWING REGION AND LOCATION OF MAJOR FEED MIXING PLANTS

(See also Annex Table C listing feed mixing plants, currently operating and plants promoted by BOI,10/77)



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