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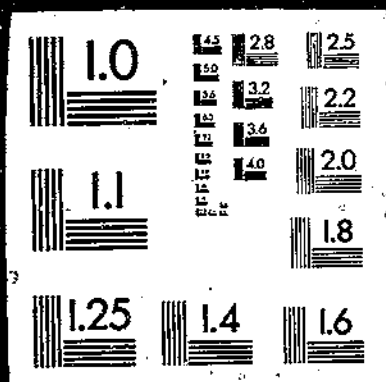
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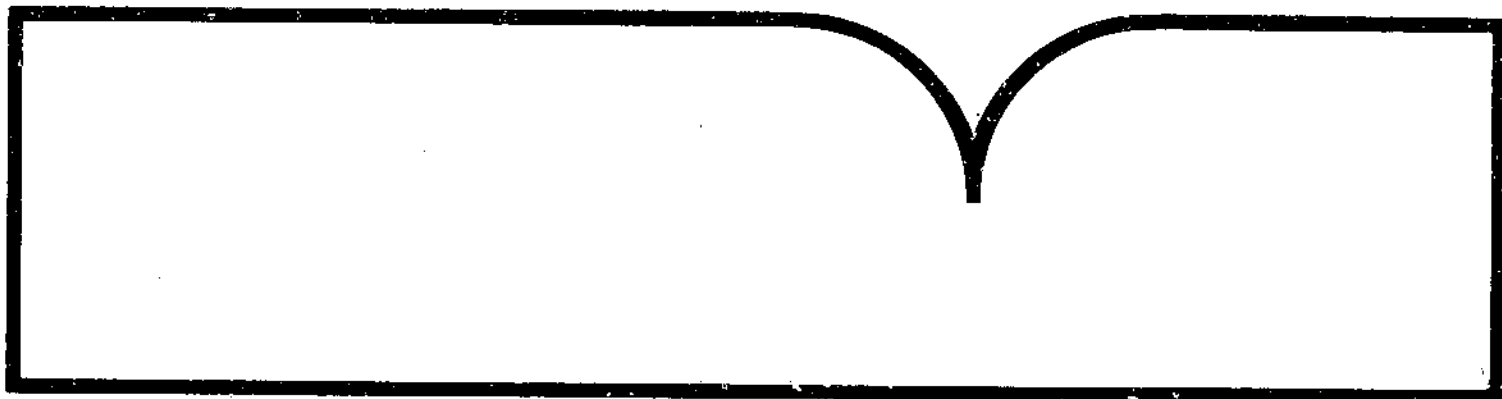


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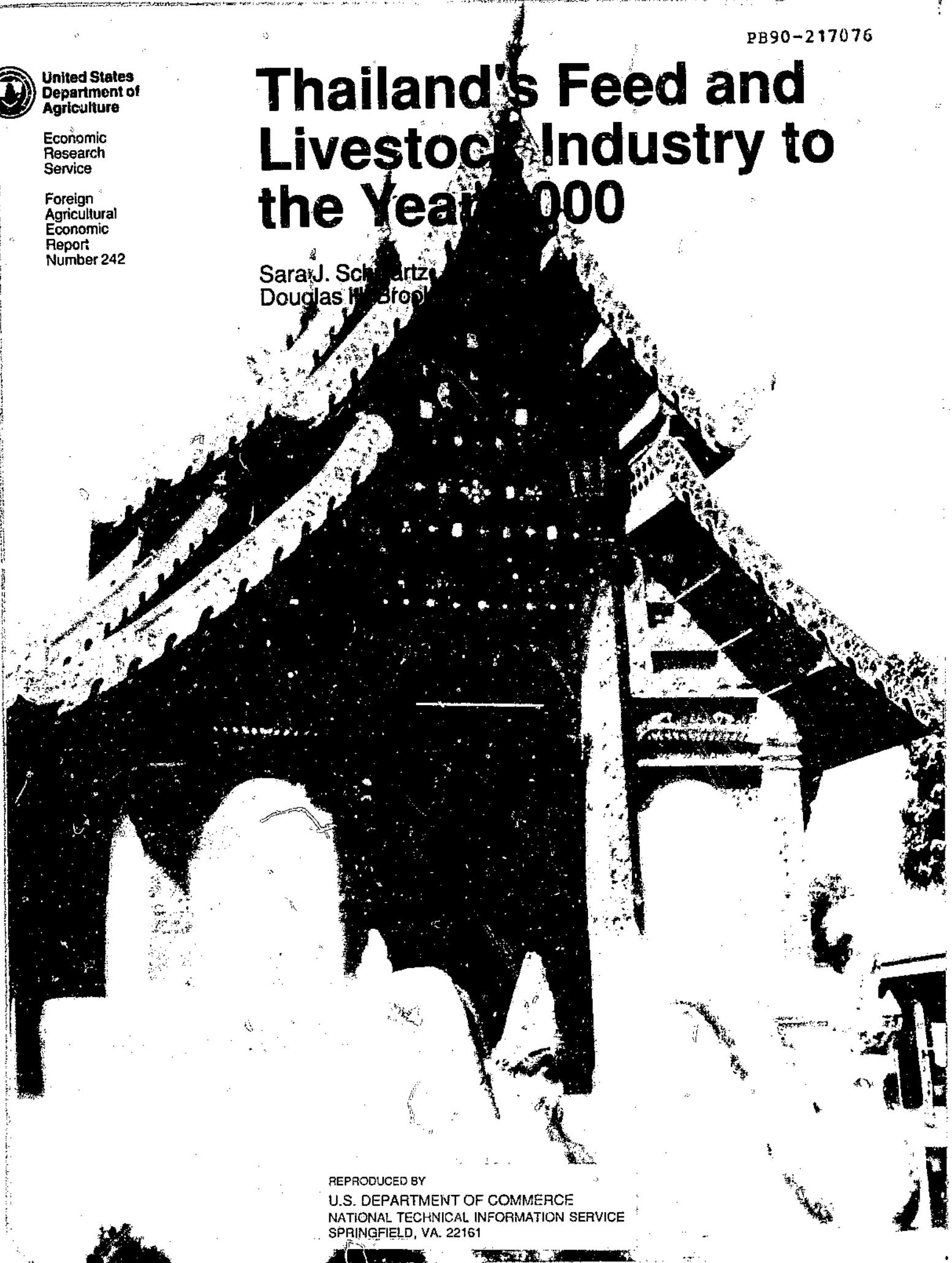
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Sara J. Schwartz
Douglas H. Brod



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Abstract

If Thailand's income keeps growing moderately, its rice and poultry meat exports could rise substantially. But income growth is generally accompanied by increased demand for livestock products. If that happens, much of Thailand's production of coarse grains (particularly corn), which is now exported, will go into domestic use, and imports of oilseeds or oilseed meal will expand, creating opportunities for U.S. exporters of these commodities. Projections to the year 2000 are made based on three scenarios of per capita income growth, 1.5 percent, 4 percent, and 6.5 percent per year.

Keywords: Thailand, feed, livestock, agriculture, trade.

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Contents

	Page
Summary	
Expanding Domestic Demand for Livestock Products Could Curtail Thailand's Corn Exports and Expand Oilseed or Oilseed Meal Imports	6
Background of Thai Agriculture	
Trends in Thailand's Income and Animal Product Sector Lead to Changes in Consumption Patterns	8
Importance of Export Demand for Thailand's Poultry and Livestock Industry	10
Recent Trends in Thailand's Livestock Sector	
Livestock Production Trends	12
Poultry Production Trends and Performance Comparison with the United States	13
Pork Production Trends and Performance Comparison with the United States	14
Government Regulations Slow Livestock Development	16
Beef Production Stagnates but Dairy Industry Expanding	18
Aquaculture Production Growing Rapidly	20
Feed Sector Meets Growing Demand	
Livestock Feed Production and Composition	22
Rice Area, Yield, Production, and Use	24
Rice Used for Both Food and Feed	26
Corn Production and Use	28
Sorghum Area, Yield, Production, and Use	30
Growth in Thailand's Grain Exports	32
Cassava Production and Use	34
Protein Meal Use	36
Soybean Production and Use	38
Development Of Scenarios For Year 2000	
Implications of Livestock Growth for Future Grain Exports	40
Model Outline	42
Results of Scenarios	
Growth To Continue in Livestock and Feed Demand	46
Poultry and Egg Production Will Grow To Meet Demand	48
Hog Sector To Modernize; Other Livestock Sectors Small but Growing	50
Rice—Growth in Feed and Export Use	52
Coarse Grains—Domestic Feed Use To Expand, Cutting Exports	54
Corn Exports Will Depend on Domestic Demand, But Appear Headed Down	56
Soybeans and Meal—More Imports To Be Needed Despite Rapid Production Growth	60

Continued—

Conclusions

Thailand's Coarse Grain Export Market Share To Contract, and
Oilseed or Meal Imports To Expand, Creating Opportunities for
U.S. Exports62

References64

Appendix: Data Issues67

Appendix Tables68

List of Tables

Table	Page
1. Proportion of household food expenditures spent on cereals, fish, and livestock products	9
2. Meat and dairy products in Thailand, 1987	11
3. Livestock production in Thailand	12
4. Broiler industry performance measures, Thailand and United States, 1988	13
5. Hog industry performance measures, Thailand and United States, 1981	15
6. Supply and distribution of dairy products	19
7. Thai exports of prawns and frozen fowl, 1978-87	21
8. Distribution of feed production by use, 1988	23
9. Nutritional values of major feeds used in Thailand	27
10. Growth in and destination of Thailand's exports	33
11. Meat consumption projections for year 2000	41
12. Average annual growth rates, 1975-85, and projections to 2000	41
13. Average annual growth rates for grains and soybean production 1960-85, and projections to 2000	41
14. Estimates of income elasticities of demand in Thailand	45
15. Livestock and feed use projections for the year 2000	47
16. Projected feed export availability in the year 2000	57
17. Livestock and feed use projections for the year 2000, with no change in hog marketing policies	58
18. Projected feed export availability in the year 2000, with no change in hog marketing policies	59
Appendix table 1. Supply and distribution of rice in Thailand, 1960/61-1989/90	68
Appendix table 2. Supply and distribution of corn in Thailand, 1960/61-1989/90	69
Appendix table 3. Supply and distribution of sorghum in Thailand, 1963/64-1989/90	70

Appendix table 4. Supply and distribution of soybeans in Thailand, 1964-89	71
Appendix table 5. Supply and distribution of cassava in Thailand, 1960-88	72
Appendix table 6. Supply and distribution of soybean meal in Thailand, 1961/62-1989/90	73
Appendix table 7. Supply and distribution of fishmeal in Thailand, 1964-89	74
Appendix table 8. Supply and distribution of total protein meals in Thailand, 1961/62-1989/90	75
Appendix table 9. Thailand's rice exports by destination	76
Appendix table 10. Thailand's corn exports by destination	77
Appendix table 11. Thailand's sorghum exports by destination	78
Appendix table 12. Average retail prices of livestock products and fish, Thailand	79
Appendix table 13. Per capita meat and egg consumption in Thailand . . .	79
Appendix table 14. Total meat and egg consumption in Thailand	80
Appendix table 15. Thailand's estimated feed use	80

Summary

Expanding Domestic Demand for Livestock Products Could Curtail Thailand's Corn Exports and Expand Oilseed or Oilseed Meal Imports

If Thailand continues to experience moderate per capita income growth (4 percent per year) through the year 2000, domestic demand for feed could outpace production growth. Corn exports could drop and oilseed or oilseed meal imports could rise. Poultry meat and rice exports would continue to increase.

Thailand, a Southeast Asian kingdom of 56 million people, is rapidly developing and one of the few developing countries with a substantial agricultural surplus. It is a major U.S. competitor in the rice, coarse grain, and nongrain feed markets and has recently become an important poultry meat exporter. Rapid growth of the Thai economy in general, and the livestock sector in particular, will have important implications for Thailand's grain export availabilities and protein meal requirements.

During the last 20 years, Thailand has established itself as a strong competitor in world feed markets. In recent years, it has been the world's largest rice and cassava exporter, fifth largest corn exporter, and an important sorghum exporter. More recently, Thailand has challenged the United States in Asian poultry markets, particularly in Japan where, in 1987, Thailand held 38 percent of the poultry meat import market. In addition, Thailand is modernizing its hog sector to meet both domestic demand and export goals, and importing breeding stock to increase dairy production.

Rising income is fueling increased consumption of livestock products in Thailand. Poultry production has expanded and modernized in response to increased domestic and foreign (especially Japanese) demand. Continued growth in the poultry sector, accompanied by expansion and modernization of pork production and marketing, is likely to increase domestic demand for feed. Domestic production of feed is unlikely to grow as rapidly. Egg, beef, dairy, and aquaculture production are also forecast to grow, but beginning from much lower levels and adding less demand for feed supplies. Consequently, poultry and pork production can be expected to account for most of the growth in livestock production and feed use through the year 2000.

Rice is the leading feed grain in Thailand. It is also the leading source of calories in the typical Thai diet, the leading source of employment, and the leading agricultural export. Yields are low, and there is potential to substantially increase rice production. Per capita rice

consumption and rice's share of Thai feed rations have been declining over time, but population growth and an expanding livestock sector could still adversely affect the amount of rice available for export.

Thailand is an important corn exporter, particularly to some southeast Asian markets. Corn also accounts for roughly half of the total raw material used by the commercial feed sector in Thailand. As commercial feed operations expand, domestic feed use could reduce corn export availability to the point that Thailand withdraws from world corn markets. Growth in production of sorghum and cassava, which serve as alternative feeds, may make total cessation of Thai corn exports unlikely. However, the rapid growth of Thailand's livestock production could significantly reduce corn exports.

To sort out these trends and what they mean for the future, projections are made to the year 2000 under alternative income growth scenarios. We forecast domestic livestock demand and livestock exports, and their implications for grain exports and protein meal imports. In the base growth scenario (4-percent annual growth in per capita income), we forecast that per capita meat consumption would rise at an annual average rate of 4 percent from its 1985 level to 39 kilograms by 2000, with more than half of the gain coming from pork consumption.

The base growth scenario forecasts that production of rice could continue growing to 14.9 million tons by 2000, leaving 6 million tons available for export after subtracting domestic food and feed use. Corn production is also forecast to expand, but not as rapidly as domestic feed use, reducing exports roughly 45 percent from the 1984-86 average to 1.8 million tons. Sorghum production and exports are projected to reach 459,000 tons. Even with 5-percent annual growth in soybean area and 2-percent growth in yield, growth of protein meal demand is projected to outstrip supply. This implies that imports of 1.7 million tons may be necessary to meet the projected demand.

Depending on domestic and international developments, growth in per capita income may be higher or lower than the 4-percent rate used in the base scenario. A lower rate (1.5 percent) would slow the demand-driven expansion of the livestock industry and consequently leave more grains available for export. In the slow-growth scenario, 7.4 million tons of rice and over 3 million tons of corn would be available for export, and the protein meal deficit would be less than 900,000 tons. With higher growth (6.5 percent per year) in per capita income and stronger expansion of livestock production and feed demand, rice exports could drop below 4 million tons, corn exports could cease entirely, and soybean imports could rise sharply, possibly to 2.8 million tons.

Thailand is an important participant in international agricultural trade. Rising income is changing domestic demand patterns. Production is responding to technological improvements, government policies, and local and world price signals. The speed and course of domestic development in Thailand will affect world markets where Thailand is competitive. The moderate-growth scenario shows that Thailand's rice and poultry meat exports may increase substantially by 2000. Expectations of Thailand's falling corn exports and rapidly rising imports of oilseed meal can create important market opportunities for U.S. corn and soybean meal exporters. However, the United States may face increasing competition in world rice and poultry meat markets.

The livestock projections indicate that strong domestic and export demand may cause poultry meat production to more than double by 2000. Pork production could also more than double if incomes continue to rise and marketing constraints are relaxed. Beef consumption will likely remain low due to the high price of imports and production problems common to tropical environments.

The projections show that the continuing growth of Thailand's livestock industry could exert a strong influence on the country's coarse grain export availability. Unless farmers adopt technological improvements, corn exports in the year 2000 may be 1.8 million tons, 45 percent less than the 1984/85-1986/87 average. Rice exports may also be affected since rice is an important feed ingredient in Thailand. However, rice production is forecast to grow faster than domestic consumption. Population growth, together with increased feed demand, will likely increase domestic rice utilization, but with a moderate rate of growth in production, 6 million tons of milled rice will be available for export.

The projections indicate that protein meal consumption could increase as the poultry, aquaculture, and dairy industries expand, and as the hog sector modernizes. Domestic meal production could more than double but Thailand may still need to supplement annual domestic crush by over a million tons of protein meal.

Main Questions, Approach, and Findings

Situation. Thailand is a major agricultural exporter, competing with the United States in the following areas:

- Rice
- Coarse grains (especially corn)
- Poultry meat

Question. Will Thailand's rapid per capita income growth result in greater meat consumption and increased domestic use of feed grains and protein meal, and thus reduce corn exports and increase oilseed or protein meal imports?

Approach. Develop three scenarios of domestic meat demand based on different rates of per capita income growth between the base period (1984-86) and the year 2000. Assume domestic production will meet demand. Estimate feed demand for different scenarios and grains and oilseed production response.

Scenario	Annual per capita income growth	Annual growth in per capita meat consumption
	Percent	
I	1.5	2
II	4.0	4
III	6.5	7

Findings. Thailand's domestic production of feed grains and oilseeds will not keep pace with expanded domestic demand. Corn exports will decline and oilseed or protein meal imports will increase.

Scenario	Corn exports	Oilseed meal imports
	Million tons	
I	3.2	0.9
II	1.8	1.7
III	0	2.8

Trends in Thailand's Income and Animal Product Sector Lead to Changes in Consumption Patterns

For the past 25 years, Thailand's economy, including its agricultural sector, has grown rapidly. Rising incomes have allowed Thais to diversify their diets, increasing domestic demand for animal products.

The Thai economy has been growing rapidly and modernizing dramatically over the past 25 years. Population and per capita income have increased at average annual rates of 2.7 and 4.2 percent, respectively, increasing the demand for livestock products.

Thailand experienced rapid growth in the 1970's, when its gross national product increased by an average nominal rate of 7.2 percent per year. While growth slowed in the early and mid-1980's, it has now returned to rates of 7-11 percent per year. Urban centers expanded as the country's industrial base grew. Cities now hold a fifth of the Thai population. In addition, rural incomes have risen as domestic and export demand for agricultural products increased.

As per capita incomes rose, the proportion of household expenditures allocated to food declined from 52 percent in the early 1960's to 41 percent by the mid-1980's (37).¹

The proportion of food expenditures spent on rice and other cereals declined from 32 to 18 percent while the share spent on protein sources (meat, fish, eggs, and dairy products) remained at a relatively constant 30-34 percent over the same time period (table 1). Animal protein consumption in Thailand is still very low in comparison with more developed countries, such as Japan and the United States, and it is also lower than in some other southeast Asian countries, such as Malaysia, Indonesia, and the Philippines, indicating room for large increases.

Rice is still the central component of the Thai diet, comprising over 50 percent of calories consumed. However, per capita rice consumption is declining by about 1 percent per year. Higher per capita incomes have allowed people to diversify their diets toward higher proportions of protein, fruits, and vegetables than in the

past (12), despite increases in the prices of these commodities relative to rice.

Like many East Asian people, the Thais eat more fish than meat (12). Until the early 1980's, average fish prices were lower than those of meat (20) and the ready availability of both freshwater and marine fish made it an ideal source of protein. Since 1981, the relative price of meat to fish has declined (fig. 1), which, with rising incomes, has led to increased meat consumption. Fish, nevertheless, remains a very popular source of protein and continues to absorb an increasing proportion of household food expenditures.

Meat prices declined because of dramatic technological changes in poultry and hog production during the last 10 years (see livestock section below). Pork is the most important protein source after fish. Real pork prices fell at an average annual rate of 4 percent between 1975 and 1985 while per capita consumption rose an average 4 percent per year to 8.9 kg (dressed weight). Pork consumption increased sharply in the late 1970's but stagnated in the 1980's despite falling real retail prices, rising incomes, and a taste preference for fresh pork. Per capita consumption seems to have been higher between 1978 and 1982, averaging 11.1 kilograms per year, although the 1980's decline is more likely a result of poor data than an actual reduction in consumption.²

Poultry consumption has risen rapidly in response to increased commercial broiler production and reduced prices. The real retail price of chicken fell at an average annual rate of 5 percent between 1975 and 1985 while annual per capita poultry consumption rose 7 percent per year to 7.6 kg (dressed weight). Per capita consumption has since leveled off, fluctuating between 7 and 8 kg per year, while consumer preference has been shifting from whole birds to parts.

¹ Italicized numbers in parentheses refer to literature cited in the References section.

² See appendix for discussion of data issues.

Background of Thai Agriculture

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¹ Italicized numbers in parentheses refer to literature cited in the References section.

² See appendix for discussion of data issues.

Per capita beef consumption, mainly from water buffalo and beef cattle (which are mainly draft animals), is low (about 4.8 kg per year) in comparison with chicken, pork, and fish. Beef consumption does not appear to have risen significantly since the mid-1970's, although, as with pork consumption, the data are weak. One reason for restrained beef consumption is that while real prices of chicken and pork have fallen in the last 10 years, beef prices have remained relatively constant. The quality of local beef is very low and the price of imported beef is too high for the average consumer. Import duties and taxes double the landed cost of the meat. Sales of imported high-quality cuts (193 tons in 1987) have been limited to hotels, fast-food chains, western supermarkets, and airlines.

Thailand's dairy sector stands in sharp contrast to the buffalo and beef situation. Consumption of milk products has recently been growing 25-40 percent per year. Still, dairy products make up only a small source of pro-

tein in Thailand. Consumption of milk and dairy products was only 486,000 tons (liquid milk equivalent) in 1986 (37), or 9.3 kg per capita intake per year. This compares with annual per capita consumption of 67.8 kg in Japan (31) and 266 kg in the United States.

Powdered milk, including infant formula, makes up 26 percent of the market. UHT milk³ was introduced in 1976 and is becoming increasingly popular, particularly in rural areas. UHT milk now represents 7 percent of the dairy market, and a new Chokchai Dairy Farm factory is expected to produce an additional 100,000 liters of UHT milk each day. Pasteurized fresh milk represents only 3 percent of the dairy products consumed, with per capita annual intake under 2 liters.

³ Ultra-high-temperature milk (UHT) is milk heated to 138 degrees Centigrade to destroy bacteria and heat-resistant spores and can be stored at room temperatures for up to 6 months (1).

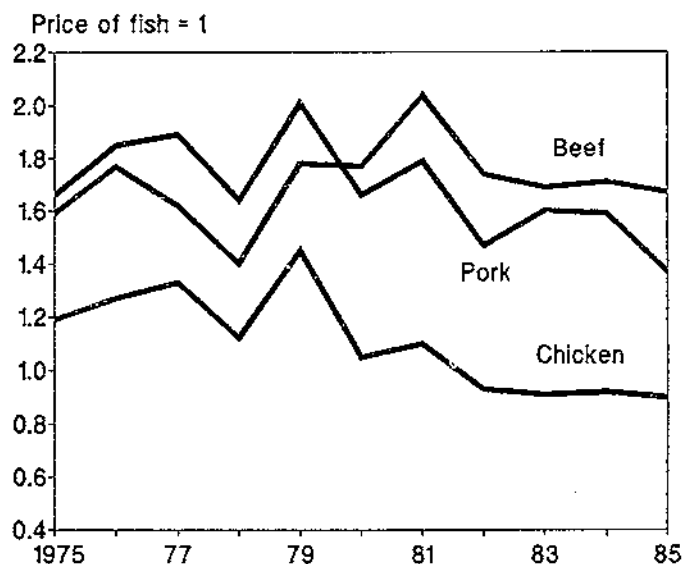
Table 1—Proportion of household food expenditures¹ spent on cereals, fish, and livestock products

Item	1960-64	1965-69	Percent			
			1970-74	1975-79	1980-84	1985-86
Rice and cereal	32	32	27	26	22	18
Meat	17	17	15	14	11	12
Fish	7	9	11	13	15	18
Milk, cheese, and eggs	6	5	6	6	4	4
Total protein	30	31	32	33	31	34
Food expenditure as percentage of total consumption expenditure	52	52	51	49	46	41

¹Includes beverages.

Source: National Income of Thailand, Office of the National Economic and Social Development Board, Office of the Prime Minister, Bangkok, Thailand, various years.

Figure 1
Retail meat prices relative to fish, Thailand 1/



1/ Average price of chub, mackerel, and catfish.
Source: Statistical Yearbook of Thailand, various issues.

Background of Thai Agriculture

Importance of Export Demand for Thailand's Poultry and Livestock Industry

Poultry meat exports, chiefly to Japan, account for a fifth of total Thai poultry meat production, but disease problems inhibit significant exports of pork or beef products.

Exports have also provided a boost to the Thai livestock sector, particularly to poultry production and, to a lesser extent, the pork sector. At the same time as rapid economic growth spurred domestic consumption of meat in the 1970's, vertically integrated feed companies recognized that Thailand could compete effectively for the broiler meat import market in Japan. During the last decade, Thailand established a strong and growing market there for boneless chicken. In 1975, Thailand exported 135 tons of frozen boneless chicken to Japan; by 1987 Thailand held 38 percent of the Japanese market, exporting over 75,000 tons of poultry meat there and another 5,000 tons to other countries in Asia, Europe, and the Middle East. The export market takes 20 percent of production and exerts a strong influence over Thailand's poultry production and prices.

Poultry meat was Thailand's fifth most valuable agricultural export item in 1987, earning \$156 million in foreign exchange. Thailand maintains its competitive edge because of poultry production costs that are 26 percent lower per kilogram than those in the United States (private industry sources). Thai labor costs to debone the meat are significantly lower (deboned meat accounts for 85 percent of total sales) and proximity to Japan brings down transportation costs. Singapore and Hong Kong are currently the only markets for whole Thai chickens.

Recent sales indicate that poultry exports to European and Middle Eastern markets may expand as Thailand continues to tailor its exports to the specific sanitary and slaughter requirements of those markets. Thailand's frozen broiler exports have been able to meet the sanitary requirements of West Germany, Belgium, and the Netherlands, and are under consideration in other EC countries. However, until market access in those areas is wider, Thailand's poultry meat exports will continue to hinge on the needs of the Japanese market.

Exports also account for a small share of live hog and pork production. Thai exporters hope to expand

exports to major Asian markets as the quality of Thailand's pork improves. Asian countries, particularly Japan, Hong Kong, and Singapore, could potentially provide a ready market. However, Japan, which annually imports over 200,000 tons of fresh pork, will continue to ban Thailand's pork as long as foot-and-mouth disease remains a problem in Thailand.

Hong Kong, Singapore, and other Southeast Asian countries may be the best prospects for Thailand's pork exports. Hong Kong imports live hogs from Thailand and could be a strong market for fresh and processed pork products. Hong Kong currently imports about 58,000 tons of fresh pork and 6,000 tons of processed pork each year, primarily from China and the European Community. In addition, Singapore has ended its own hog operations and imports live hogs and fresh and processed pork. Expansion of Thai exports to Singapore depends largely on Malaysia's willingness to allow the transport of pigs from Thailand to Singapore through peninsular Malaysia. Vietnam has also imported hogs and small quantities of fresh pork from Thailand.

Thailand does not export significant quantities of beef or dairy products. In fact, a large share of Thailand's milk consumption is supplied by imports. Despite official support for expanded dairy production through the Department of Livestock Development, Thailand is able to supply only about 13 percent of the milk consumed in the country. The rest is imported, primarily in the form of nonfat dry milk and whole milk powder, mostly from the European Community, Australia, and New Zealand.

Disease problems preclude significant Thai exports of cattle and beef. The problems are likely to continue as long as animals are smuggled into Thailand from neighboring countries and illegally slaughtered. Although the slaughter regulations are expected to change to encourage the legal slaughter of healthy animals, it is doubtful that Thailand could effectively compete with lower cost and higher quality producers such as the United States and Australia for Asia's beef markets.

Thailand formerly exported live buffalo and cattle to Malaysia, Hong Kong, and Singapore. However, legal trade has virtually disappeared (only 149 cattle to Malaysia in 1987, and no cattle were exported in 1986, versus over 60,000 head in 1962) due to disease problems and increased competition from China for the Hong Kong market.⁴

⁴ One study (38) estimated that the official trade statistics underestimate cattle and buffalo exports to Malaysia by one-third due to the illegal exports.

The livestock sector is becoming an increasingly important part of Thailand's agriculture and economy. There has been a recent trend toward further processing of livestock products for export. In addition to frozen, deboned chicken parts, Thailand now exports pork sausages, and frozen deshelled shrimp are entering export channels at an increasing rate. In calendar year 1988, Thailand earned \$192 million in foreign exchange from frozen poultry meat exports. Processing creates employment opportunities, raises value added, and takes advantage of Thailand's low labor costs.

Table 2—Meat and dairy products in Thailand, 1987¹

Type of meat	Production	Domestic consumption	Exports	Imports
<i>1,000 metric tons</i>				
Broiler meat	464	382	82	0
Pork ²	502	502	NA	NA
Beef ³	248	248	NA	NA
Dairy ⁴	75	619	259	603

NA = less than 500 tons.

¹ See appendix for discussion of data.

² Excludes live hog imports and exports.

³ 1986 data, includes buffalo meat, excludes live cattle and buffalo imports.

⁴ Liquid milk equivalents.

Recent Trends in Thailand's Livestock Sector

Livestock Production Trends

Thailand's livestock sector has expanded and modernized in the last 20 years; poultry and pork operations have especially progressed away from small backyard sidelines to large, automated, commercial enterprises.

The last 20 years have brought dramatic changes to the structure and performance of Thailand's livestock industry, but the modernization of the industry has been uneven. Adoption of modern technology and increasing scale have cut costs and almost totally transformed poultry raising. Commercial hog raising began more recently and is still in transition, shifting from traditional backyard operations to large, modern

enterprises. The cattle industry has changed much less, while the dairy industry is small but growing rapidly and receiving strong Government support. The modernization and commercialization of the livestock sector, together with growth of commercial aquaculture operations, have been accompanied by rapid growth in domestic use of grains and protein meal.

Table 3—Livestock production in Thailand

Year	Cattle ¹	Buffalo ¹	Dairy cattle ¹	Hogs ²	Broilers ²	Hens ²	Ducks ²
	----- 1,000 head -----			----- Million -----			
1975	4,142	5,597	NA	3,866	41.6	NA	7.5
1976	4,322	5,895	NA	5,185	58.2	NA	7.6
1977	4,341	5,827	NA	5,420	78.0	11.6	6.3
1978	4,437	5,959	18.9	6,713	104.0	10.9	5.5
1979	4,276	6,028	20.7	7,342	130.0	13.9	7.0
1980	39,38	5,651	23.3	6,589	200.0	14.1	7.3
1981	4,469	6,124	25.7	6,448	234.0	15.0	7.7
1982	4,579	6,417	30.0	6,504	261.0	15.9	8.9
1983	4,833	6,354	37.8	6,290	225.0	17.1	10.3
1984	4,789	6,301	47.5	6,361	247.0	18.9	11.1
1985	4,829	6,250	53.3	6,941	273.0	17.1	12.9
1986	4,879	6,257	65.4	6,665	299.0	17.2	13.2
1987	4,969	5,998	NA	6,520	322.0	NA	NA

NA = Not available.

¹In stock, Agricultural Statistics of Thailand.

²Slaughter estimates; Source: Chesley, USDA, and private industry estimates for poultry; derived from Thai Government statistics for hogs.

Poultry Production Trends and Performance Comparison with the United States

In shifting to a commercial poultry sector, Thailand's broiler production rose more than ninefold between 1975 and 1988. Thailand's broiler production compares favorably with that of the United States on most measures and, in 1988, Thailand's cost of production was 26 percent lower.

The first large-scale poultry operation was established in 1970. Before then, the commercial poultry sector was characterized by small, independent growers. Less than 2 percent of the commercial growers, concentrated in the Central Plain, raised more than 5,000 birds. By 1979, 92 percent of commercial growers raised 5,000 birds or more, mostly on a contract or wage basis (23). Production rose from 36.4 million birds in 1975 to an estimated 338 million in 1988. Most poultry production now takes place under contract to vertically integrated firms. The firms provide all inputs and repurchase the chickens at slaughter weight.

Production costs fell as producers became more efficient. In 1988, the cost of broiler production (liveweight) was \$0.81 per bird, compared with \$1.10 per bird in the United States (table 4). Feed comprises 63-70 percent of the total cost of broiler production in Thailand (23). In 1988, feed accounted for 68 percent of the cost of production in the United States (36). Higher labor costs in the United States may account for the difference in the total cost of production. The feed

conversion ratio, mortality rate (in most years), weight, and market age are the same as for broilers raised in the United States. The usual feed ration includes corn, soymeal, and fishmeal (75:15:10 by weight), with sorghum, alternate protein meals, and cassava added when warranted by relative prices.

Ducks are also an important part of the Thai poultry sector, being raised for both meat and eggs. According to Government data, there were nearly 16 million ducks on Thailand's poultry farms as of April 1, 1987, an increase of two-thirds since 1978 (8). Commercially raised ducks are typically fed for up to 52 days (after which growth stops) but may be sold as early as 39 days. The feed-conversion ratio for ducks (2.8-3:1) is higher than that for chickens, and the preference for wet feed has led to the inclusion of mimosoy (a mung bean byproduct) in duck feed. Typical duck feed also includes (depending on relative prices) rice bran, corn, tapioca, and sorghum, although ducks are particularly sensitive to aflatoxin, a problem in Thailand's corn.

Table 4—Broiler Industry performance measures, Thailand and United States, 1988

Item	Thailand	United States
Market age	7 weeks	7 weeks
Average market weight (dressed)	1.4 kg	1.4 kg
Feed conversion ratio	2.1	2.0
Mortality ¹	7 percent	3-5 percent
Average cost of production/bird	\$0.81	\$1.10

¹Most years, the mortality rate in Thailand is 2.0 percent. Mortality was higher in 1988 due to unusually hot temperatures early in the year.

Recent Trends in Thailand's Livestock Sector

Pork Production Trends and Performance Comparison with the United States

Recent price swings have abetted modernization of Thailand's pork sector. More than 80 percent of hogs are now raised by commercial growers (compared with less than 20 percent in 1977), who achieve performance measures comparable with U.S. producers.

According to the available data, hog slaughter nearly doubled in the late 1970's (table 3). While the trend in pork production has remained relatively constant since then, increasing scale of production and more efficient management have lowered costs.

Before 1979, most hogs were raised on small-scale rice farms to supplement income. These backyard operations consisted of two or three hogs fed on farm wastes for 10 months until they reached a market weight of 120-130 kg (9). In 1978, only 10-15 percent of hogs were raised commercially (9). The situation is radically different today. By 1988, over 80 percent of the hogs were raised by commercial growers centered around urban centers, which are the primary markets for meat. According to industry sources, less than 20 percent of the hogs are now raised by noncommercial producers, mostly in the more remote provinces.

Much of this change is the result of recent price swings, which coincided with a rapid increase in management expertise and improved ability of feed and pharmaceutical companies to respond. In 1980, hog prices were low, and many small and medium producers cut back herds and looked for ways to improve efficiency. In 1983, prices rose and hog producers expanded their operations, employing new technology, commercial feed ingredients, and efficient management tools.

Pharmaceutical companies accelerated the process by aggressively marketing premixes (additives, including vitamins, trace elements, and drugs) together with explicit instructions on how to mix feed rations using available grains. Feed companies quickly responded by marketing the necessary concentrates (feed containing high-protein components) that could not be produced on farms. As a result, farmers were able to raise hogs to market weight (110 kg) and close to Western and Japanese standards within 5-6 months, compared with 9-10 months using traditional methods (table 5). When, in the mid-1980's, prices fell to less than half the 1983 level due to overproduction, some growers (especially those raising fewer than 100 pigs) could not compete with the more efficient producers and were forced to shut down. The market began to stabilize in 1986, leaving the most efficient producers to benefit from higher prices and establishing a broad foundation of a modern pork sector.

Efforts to improve the quality of Thailand's pork continue. In 1987, Thailand imported 2,000 pigs (up from 550 in 1986) to improve performance and carcass traits (37). Commercial breeders introduce new imports every 2 years to change the bloodline. Most commercial hogs are three-way crosses with duroc boars and white mother lines. As production expands, commercial farms are becoming increasingly interested in export markets and processing pork products.

Table 5—Hog industry performance measures. Thailand and United States, 1981

Item	Unit	Thailand		United States ³
		Traditional ¹	Commercial ²	
Litters per sow per year	No.	2.0	2.2	1.65
Pigs per litter, live	No.	9-12	9-10	9-10
Pigs weaned per litter	No.	7.5	8.5	7.2-7.6
Death loss, birth to weaning	Percent	21-55	10	20-25
Average weight per pig at weaning	Kg	8-12 (8 weeks)	6-8 (4 weeks)	10-11 (5.5 weeks)
Pigs weaned per sow per year	No.	12-19	18-19	12
Age of gilt at first farrowing	Months	18-24	11.8-12.8	11.8-12.8
Sow/boar ratio	Sows	65-85	20	13-14
Average weight of barrows and gilts at slaughter	Kg	120-130	90-110	100-104
Average age at slaughter	Days	270-300	180	175-177
Net gain, weaning to slaughterweight	Kg	110-120	82-104	87-92
Average daily post-weaning gain	Kg	0.36-0.44	0.55-0.69	0.64-0.67
Average age at first breeding	Months	14-20	8-9	8-9
Dressing	Percent	55-60	60-65	71

¹Source: Village level estimates from various sources by Charan Chantakhana.

²Commercial estimates from Anupong Cheochernviljit (swine producer in Nakhon Pathom), as cited by Winrock International.

³Source: USDA/ERS estimate.

Government Regulations Slow Livestock Development

Government regulations, which had hindered growth of the pork sector in the past, were relaxed in the last few years to give private firms more incentive to invest in the sector. However, the Government's emphasis is on providing incentives to produce export-quality pork. Foreign buyers' concerns about foot-and-mouth disease may limit Thailand's export potential.

Government intervention in the transport, slaughter, and marketing of hogs has hampered growth of the pork market. Until recently, the transport of carcasses between provinces had been illegal. Since 50 percent of the marketable hogs are consumed in Bangkok, this meant that live hogs had to be shipped long distances to the city, arriving bruised and stressed, and producing low-quality meat. In 1979, the law was changed to allow wholesalers to slaughter hogs in provinces close to Bangkok and transport the carcasses to the city. This change provided an incentive for large, modern breeding and fattening operations to develop in those provinces.

The 1959 Animal Slaughtering and Meat Sale Control Act restricted slaughterhouse ownership to local governments. Facilities were leased to private firms by special permission, but the Government retained the property rights. Animals have to be inspected, a permit issued, and taxes (equivalent to 2 percent of the selling price) levied before the animals can be slaughtered. Slaughterhouse inspections are often carried out by unqualified officials. To avoid inspection and taxes, up to 60 percent of the hogs are illegally slaughtered, usually under unhygienic conditions. Deregulation may improve quality controls, thereby opening export markets for live hogs and pork products.

Prior to 1984, investors had no property rights, so there were no incentives to modernize or maintain the slaughter facilities. In 1984, the Government allowed private firms to own slaughter facilities if 50 to 70 percent of the products were exported. However, the presence of foot-and-mouth disease in the country limits exports. In addition, since the Asian export

market is for lean meat and few byproducts, the high rate of exports required by the Government deterred most investors. One firm, in conjunction with Swift, did apply for a license. In 1985, another firm signed a joint venture agreement with an American firm, Oscar Mayer, to produce processed pork products for domestic and export markets. However, disease and market constraints have led the firms to concentrate on processed poultry products instead.

In September 1986, the Government announced steps to liberalize slaughter restrictions. The Prime Minister ordered the revision of all regulations and laws hindering legal animal slaughter and processing. The Prime Minister has supported the privatization of slaughter operations in response to pressure from livestock raisers and the feed industry.

By 1988, few private firms had responded to Government incentives to invest in slaughter operations. As a result, the Government relaxed some of its restrictions. New slaughter plant income is now tax exempt, on the condition that 30 percent of its pork be exported after the fourth year of operation. This requirement can be waived, however, if export markets remain closed. The slaughter fee will be waived for exported pork. Investors can retain ownership of the slaughter facility rather than transferring it to local governments and leasing it back. Firms must invest at least 10 million baht rather than the previously required 50 million baht. These changes should make it more attractive for firms to invest in new slaughter operations, but the emphasis on export promotion may prove premature due to foreign buyers' ongoing concerns about foot-and-mouth disease.

Changes In Government regulation of hog slaughter

- 1959**—Establishment of state ownership and inspection of abattoirs and imposition of taxes on animals slaughtered. Illegal slaughter under unhygienic conditions becomes prevalent.
- 1984**—Some deregulation allowing private leasing (but not ownership) if export goals were met. But lack of property rights, poor product quality, and disease constrained exports and thus private investment.
- 1986**—Further liberalization by Government, but still not enough incentives to attract private investment in slaughter facilities.
- 1988**—Slaughter plants can be privately held, with plant income tax exempt, if 30 percent of pork exported and investment minimums met. Emphasis on exports may still be premature and serve as disincentive to investment.
-

Beef Production Stagnates but Dairy Industry Expanding

Extensive cattle raising in Thailand is hindered by regulations, disease, small landholdings, and inadequate forage. Dairy production is growing rapidly, with Government help, but dairy cattle too are affected by the heat and disease. Production per cow is about half the U.S. level.

Slaughter regulations also hamper local beef production and processing. Many of the restrictions that apply to hog slaughter also apply to cattle and buffalo slaughter. Abattoirs cannot be privately owned, only live animals can be moved between provinces, and each animal is taxed at a high rate before slaughter. To prevent depletion of the buffalo herds, the Government regulates the age of slaughter. Fertile females cannot be slaughtered before they are 15 years old and males must be at least 8 years old.

The regulations are routinely ignored and up to 75 percent of cattle and buffalo are slaughtered illegally to avoid the laws and taxes. This encourages the slaughter of smuggled, sick, and generally poor quality animals. There are no incentives to produce high-quality beef because no premiums are paid for tenderness, freshness, or special cuts.

Thailand's cattle and buffalo population is currently estimated at 11 million head (37). There are 6.3 million water buffalo and about 4.8 million cattle, of which about 1 percent are for dairy. The animals are generally used for draft and as a form of savings for rural households. Meat is simply a byproduct of the animals slaughtered when they are too old to work.

Extensive cattle raising in Thailand is currently not possible due to the small size of individual landholdings among the rural population. Cattle and buffalo are fed on crop residues, especially rice straw, and are left to forage along roadsides, on wasteland, and in scrub forest. Seasonal variation in cropping intensity and a declining base of forage land cause large swings in animal feed availability from season to season and from year to year. With the exception of dairy cows, cattle and buffalo are not fed concentrates or mineral supplements.

Bovine diseases, including foot-and-mouth disease, hemorrhagic septicemia, anthrax, and internal parasites, are commonly found in Thailand. While not generally fatal, the diseases affect the efficiency of the animals both for draft purposes and for meat and milk

production. Production and distribution of vaccines remain inadequate. In addition, cattle are routinely smuggled into Thailand from Burma, Laos, and Kampuchea where bovine diseases spread unchecked.

Dairy Production Expanding

Thailand's dairy herd is small but growing rapidly. The herd has been growing at an average annual rate of 19 percent since 1982, when Thailand's dairy herd was only 30,000 head. In 1988, it totaled about 77,000 head. Less than half that number are cows in milk, and only 2,000-2,500 head are purebred. In 1988, annual production was estimated to be 100,000 tons of liquid milk equivalent or slightly more than 2,000 kg per cow. Productivity is low because of the hot, humid climate, poor nutrition, disease problems, and inferior genetic quality.

The Thai Government is working to improve the genetic stock of Thailand's dairy herd. Artificial insemination programs have started, but there is need for better quality semen. A few embryo transplants have been successful since 1985, but the process is still at an experimental stage.

The main effort to improve dairy production concentrates on importing breeding stock, with nearly 5,000 head imported in 1988. Most dairy cattle are now crossbreeds of native (Bangala, Zebu, Sahiwal, or Brahman) and Friesian, Brown Swiss, or other European breeds. The Government has recently stepped up its efforts to encourage imports of heifers to improve domestic herds. Several private firms have imported U.S. Holstein heifers and other purebreds from Israel, Australia, and New Zealand.

There is some debate about whether purebred dairy cattle can thrive under Thai conditions. The Holstein stock in the Government breeding project produces as much as 25 liters of milk per day, but averages only about 12 liters in Thailand. Imported Holsteins from the United States have also suffered from laminitis. Meanwhile, the Northeast Agriculture Dairy Co. has

plans to import 3,000 purebred milk cows from Australia and New Zealand to produce hybrids for export to ASEAN (Association of Southeast Asian Nations) countries, although it is unclear how they will avoid problems of foot-and-mouth disease.

Small farmers feel that the pure breeds do well in the cool season (November to February) but not in the heat and humidity of summer. Despite innovative plans to introduce climate control and feed the cattle at night when it is cooler, most small farmers are wary of investing the large purchase price in purebred stock. Holstein-Friesian is the most popular purebred, although others include Red Dane, Brown Swiss, Jersey, Australian Illawara Skorthorn, Red Sindhi, and Sahiwal.

A state enterprise, the Dairy Farming Promotion Organization (DFPO), operates 19 dairy centers, including one that accounts for 40 percent of all dairy cattle in Thailand. Three dairy cooperatives, large-scale operations located near Bangkok, account for about 25 percent of Thailand's dairy cattle. There are a few large, independent, commercial operations, the largest of which maintains a herd of about 3,000 milk cows (39). These commercial operations use rice bran, corn, and cassava (when the price is low) in feed rations.

In contrast to these large herds, the average herd size of small-scale producers is 10-12 cows, raised on 3-5 hectares. Dairying is usually a part-time activity and the farms are not intensively managed. Herds are fed

on farm wastes and roughage. Onfarm feed is not enough to support the herds, so the cattle feed on wasteland and secondary forestland. Farmers supplement this low-quality feed with concentrates to improve productivity at a rate of 1 kg of concentrate for every 2 kg of milk produced.

Milk imports are considerable and, despite low productivity, there is a growing surplus of raw milk supplies. In 1986, Thailand exported over 1,000 tons of fresh milk for the first time, and 1987 fresh milk exports were 3,000 tons, mostly to the Philippines. Raw milk prices are supported by the Government. The guaranteed minimum price which milk processors must pay is \$0.25 per liter, double the c.i.f. import price of powdered milk (in liquid milk equivalents, not including infant formula). Processors have, in the past, refused to pay the price for local supplies when cheaper imports were readily available.

As a result, in 1983 the Government instituted import controls on dairy products which continue to the present time. Sterilized and pasteurized milk imports are banned. A quota system has been imposed on powdered milk imports, requiring processors to buy 20 liters of Thai raw milk for every kilogram of imported powder. It seems likely that the Government will continue to promote self-sufficiency by conducting public campaigns to increase fresh milk consumption (including a campaign backed by the King to promote consumption by school children), by limiting imports and encouraging domestic herd improvement.

Table 6—Supply and distribution of dairy products¹

Year	Production	Imports	Exports	Domestic consumption	Per capita consumption
	----- 1,000 metric tons -----				Kgs
1975	7.8	268.6	7.5	268.9	6.4
1976	8.1	375.7	5.9	327.9	7.6
1977	10.1	395.4	24.2	381.4	8.7
1978	12.7	415.6	13.6	414.7	9.2
1979	14.7	414.4	17.9	411.2	8.9
1980	17.5	358.5	19.7	356.3	7.6
1981	21.3	445.1	14.1	452.3	9.5
1982	27.0	303.1	22.8	307.3	6.3
1983	34.1	458.5	16.8	475.8	9.6
1984	46.2	472.3	11.4	504.4	10.0
1985	54.6	444.4	12.0	485.4	9.5
1986	64.2	425.0	33.8	486.0	9.3
1987	70.0	456.0	59.2	520.0	9.6

¹ Fluid basis, includes milk powder, infant formula, butter, cheese, and curd.

Sources: USDA, Agricultural Statistics of Thailand, and Foreign Trade Statistics of Thailand.

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¹Fluid basis, includes milk powder, infant formula, butter, cheese, and curd.

Sources: USDA, Agricultural Statistics of Thailand, and Foreign Trade Statistics of Thailand.

Recent Trends in Thailand's Livestock Sector

Aquaculture Production Growing Rapidly

With Government support, aquaculture, mainly saltwater shrimp, has grown rapidly in Thailand, with farm-raised shrimp already accounting for almost 15 percent of the shrimp market, and export earnings exceeding those of poultry meat.

The fledgling commercial aquaculture industry is growing rapidly and is strongly promoted by the Government. While Thai farmers commonly maintain freshwater fishponds in conjunction with cropping activities for domestic consumption and sale in local markets, one of the newest and most lucrative commercial aquaculture developments is in marine shrimp farming. Shrimp, produced mostly for export, now constitutes the main aquaculture product.

Shrimp production is concentrated along the coast to take advantage of the feed mills near Bangkok (and because freshwater shrimp have lower prices and yields). Although farm-raised shrimp account for less than 15 percent of the market (the rest being acquired through ocean and freshwater fishing), the share raised and fed on farms is growing rapidly.

The current 5-year National Economic and Social Development Plan includes a marine shrimp-farming development project. The Thai Government has been increasing the budget allocation for planning and applying technological improvements to shrimp aquaculture from \$151,000 in 1987 to \$8 million for 1990, rising to \$21 million by 1994. Shrimp farming also qualifies for Board of Investment promotional privileges, consisting of a number of Government incentives offered to many export industries. One new shrimp feedmill is taking advantage of the promotional privileges. The feedmill, with a planned annual productive capacity of 180,000 tons of feed, opened in 1989.

Aquaculture is receiving increasing attention from feed manufacturers. Corn makes up 50-60 percent of the high-protein feed ration for this industry. Feed accounts for 50-60 percent of the cost of shrimp pro-

duction, and most of the the feed cost is for fishmeal. High-quality shrimp feed includes fishmeal with about 60-percent protein content. Since most of the domestic fishmeal is of lower quality, the growing shrimp industry has led to increased fishmeal imports.

Shrimp production capacity has experienced a fourfold expansion since 1987, rising to 100,000 tons in 1989. Further expansion may be limited because much of the production takes place in ecologically fragile mangrove swamps. In addition, high feed prices and electricity rates and limited cold storage capacity are posing temporary obstacles to expansion. However, there is considerable room for increasing yields as more intensive production methods are adopted. Yields could rise from the current 2 tons per hectare to 5 tons once advanced techniques in temperature control, feed inputs, and other production methods are adopted.

The shrimp industry has recently consolidated after a period of rapid expansion, but it is expected to continue to grow, particularly since exports are increasing to Asia, Europe, and North America. In 1987, the leading export markets for Thailand's shrimp were Japan, the United States, and Singapore. The United Nations Food and Agriculture Organization has predicted that Thailand will become the world's largest producer of black tiger shrimp within the next 3 years (3).

Shrimp exports earn more foreign exchange than frozen poultry (table 7). Private firms, often in joint ventures with foreign investors, have been able to take advantage of Thailand's low labor costs to process deshelled and frozen shrimp. Exports are priced competitively and market expansion is expected to continue.

Table 7—Thai exports of prawns and frozen fowl, 1978-87

Export	1978	1979	1980	1981	1982
Prawns:					
Metric tons	15,378	18,626	17,915	18,761	20,138
Million baht	1,500	3,372	1,961	2,136	2,764
Frozen fowl:					
Metric tons	9,287	14,158	18,503	26,905	33,217
Million baht	334	517	659	1,187	1,310
	1983	1984	1985	1986	1987
Prawns:					
Metric tons	20,150	19,428	24,041	28,063	33,909
Million baht	3,164	2,799	3,489	4,391	5,745
Frozen fowl:					
Metric tons	22,926	34,217	37,839	64,796	81,905
Million baht	946	1,420	1,467	3,121	4,020

Source: Bank of Thailand, *Quarterly Bulletin*, various issues.

Livestock Feed Production and Composition

Buoyed by the livestock industry, Thailand's feed sector continues to expand, with domestic use now accounting for more than 50 percent of Thai corn production. Grain and soybean production has expanded to accommodate the growth in domestic feed demand.

Over the last 10 years, the commercial feed sector has experienced about 10-percent annual growth, partly at the expense of home-mixed feeds. The primary carbohydrates used in the industry are corn, rice bran, and broken rice. Sorghum and cassava are rarely used domestically since the export prices are usually higher than domestic prices for the nutritional equivalent of corn and rice products. Protein meals are mostly derived from fish, soybeans, peanuts, tamarind leaf, and yeast. Imported peanut meal, sunflowerseed meal, and rapeseed meal have recently begun to appear in feed mixes. Salt, powdered bone, and powdered shell are the main mineral ingredients (5).

While the commercial feed industry supplies only half of the total feed consumed in Thailand, it provides 96 percent of the feed requirements for the broiler sector, 40-50 percent for layers, and 60 percent for ducks. However, it supplies only 20 percent of the feed requirement for hogs (37). In 1987, commercially produced compound feed use reached nearly 2 million tons, of which 60 percent was for broilers and layers, 25 percent for swine, and the remainder for ducks, prawns, and cattle (37). Estimates of 1988 commercial and noncommercial distribution of feed use are presented in table 8.

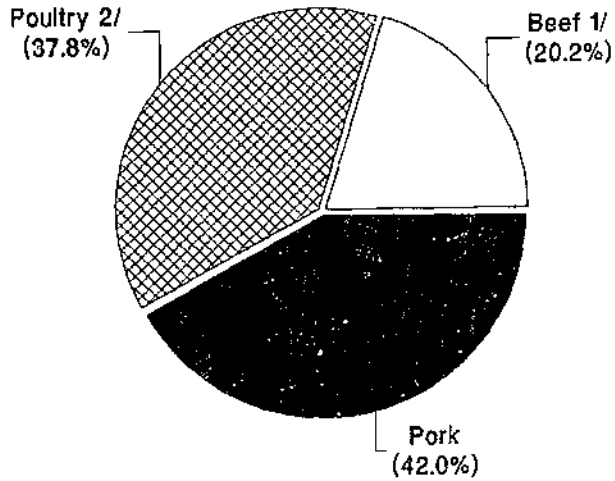
In 1987, due to drought and the potential for severe price hikes, animal feed became a controlled product, requiring permission from the Internal Trade Department before prices could be raised. Although permission was granted when grain prices rose in 1988, the regulation slows the responsiveness of the industry to market forces. While livestock producers may benefit in the short run, the long-term consequence of such intervention may be slower growth of the feed sector at a time when demand is increasing rapidly.

Corn makes up about 40 percent of total raw material used for commercial feed (37). Broken rice and rice bran can be substituted for corn if they are priced competitively, and they are often preferred in the noncommercial sector because of their local availability from nearby rice mills. However, the yellow color that corn imparts to broilers makes it the feed of preference in that sector. Hog producers often prefer rice and rice bran to corn in hog rations because of their nutritional characteristics and local availability.

Even in drought years, grain production has been adequate at existing prices to supply domestic food and feed needs while permitting exports. Through the 1970's, area expansion enabled coarse grain producers to keep up with demand. Yields of grains and oilseeds in Thailand are low but rising gradually. Fertilizer use is low, and high-yielding varieties have not been widely adopted in nonirrigated areas. Unless prices change significantly, this scenario is not expected to change.

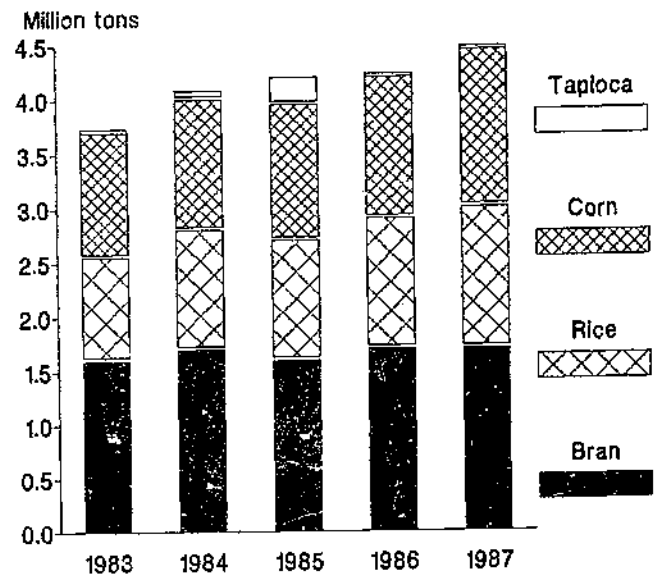
The domestic demand for corn, rice, and protein meal for feed grew in the 1970's with expanded poultry and livestock production. In the case of corn, domestic feed use increased from 5 percent of production in 1970 to over 50 percent in recent years. Over 15 percent of rice paddy is converted into animal feed in the form of bran and milled broken rice. Figure 3 presents estimates of the energy composition of feed for recent years. The rice/corn price ratio influences the proportion of each of these grains in domestic rations. Corn, rice, sorghum, and cassava production generally respond to price signals driven by export markets, but the domestic livestock industry significantly buoys the market. Oilseed production has also increased rapidly as Thailand attempts to reduce its dependence on imports. Also see appendix tables 1-8.

Figure 2
Thailand's meat production, 1986



1/ Includes buffalo meat.
2/ Includes duck meat.

Figure 3
Thailand estimated feed use



See appendix table 15.
Source: USDA, FAS, Annual Agricultural Situation Reports, various issues.

Table 8—Distribution of feed production by use, 1988¹

Use	Quantity	Distribution
	1,000 metric tons	Percent
Broiler feed	1,300 ²	28.0
Layer feed	800	17.2
Duck feed	800	17.2
Hog feed	1,500	32.3
Shrimp feed	100	2.2
Cattle feed	90	1.9
Fish feed	60	1.3
Total	4,650	100.0

¹Estimates provided by Charuphot Neesanant, President, Thai Feed Mills Association.

²Estimate including feed for parent stock would be 1.5 million metric tons.

Feed Sector Meets Growing Demand

Rice Area, Yield, Production, and Use

Rice production rose 3 percent per year from 1975/76 to 1984/85, with exports rising 9 percent per year over the same period, despite efforts by the Thai Government to encourage farmers to diversify their production and reduce the acreage planted to rice.

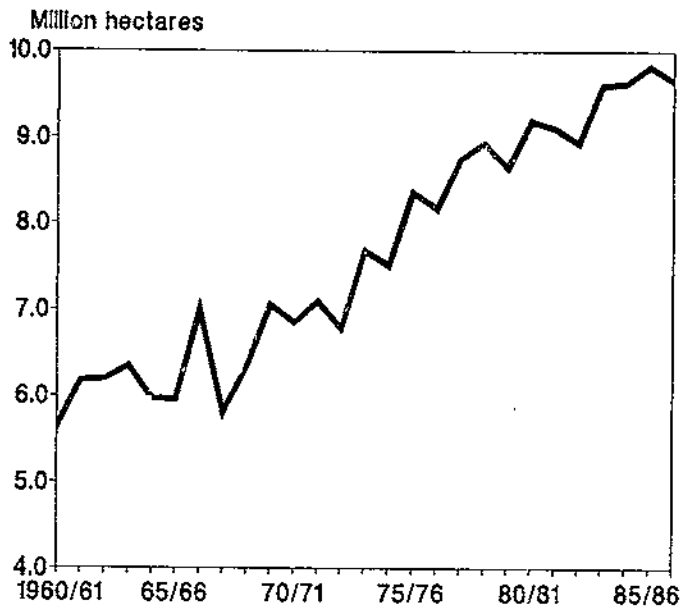
Rice is the basic staple in the Thai diet and a major export commodity, earning 8.6 percent of the country's total foreign exchange earnings in 1988 and 15 percent as recently as 1984 (4). Production surged in the late 1970's when irrigation systems were expanded and rehabilitated, leading to increased dry season production and more stable yields in the wet season (figs. 4 and 5). The wet season crop is rainfed and usually accounts for 90 percent of production, while the dry season crop is almost totally irrigated. Thailand does not employ high-yielding variety seeds or significant quantities of fertilizer on its main season crop due to the high price of inputs and the risks inherent in inadequate water control during the monsoon season. However, expansion in the use of tube wells during the 1987 drought indicates the potential for increasing yields.

Expanded irrigation facilities have allowed rice production to rise to meet domestic needs and to increase exports over the last 10 years (fig. 6). Area planted to rice increased in the dry season. Yields of dry season, irrigated rice tend to be higher than those of the main crop. Rice production expanded at an average annual rate of 4 percent between 1975/76 and 1984/85, reaching 13.1 million tons (milled) by 1984/85, allowing exports to increase at

an average annual rate of 9 percent during the same period. Production and export growth then slowed, partially due to low prices in the mid-1980's and drought in 1986/87 and 1987/88, but rebounded sharply in late 1988.

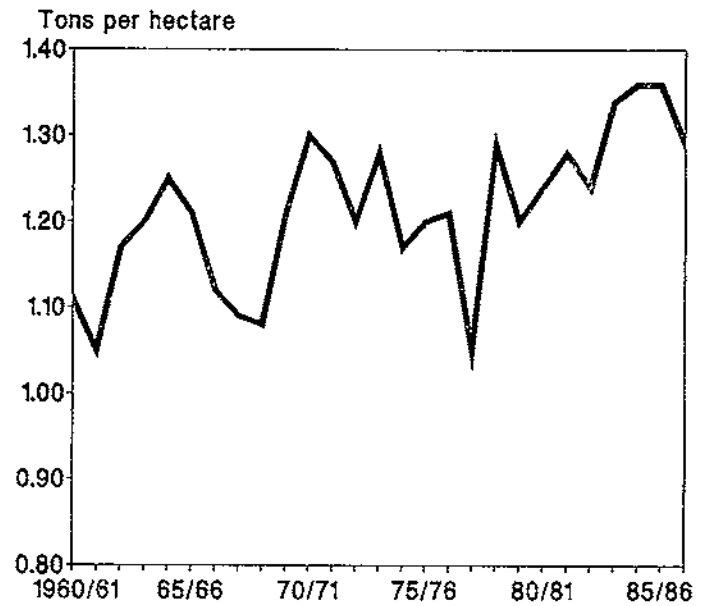
Given the current Thai budget deficit and austerity measures imposed to reduce the deficit, the Government will probably not invest in infrastructure to support increased rice production as it did in the 1970's. However, Thai farmers are highly responsive to price signals, and if prices remain high, they may undertake more capital investment themselves. The Government has consistently encouraged farmers, particularly those in marginal areas, to diversify agricultural production and reduce acreage planted to rice. While Thai farmers may be willing to exercise some flexibility regarding dry season production, many may be prevented by soil, water, and climate conditions from switching to alternative crops during the wet season, when the bulk of the rice is planted. Rice production is therefore not expected to decline significantly. There is potential for area and yield increases. But, without continued high world prices and additional investment in irrigation facilities, area planted to rice is expected to level off and yield growth will most likely slow.

Figure 4
Rice area, Thailand



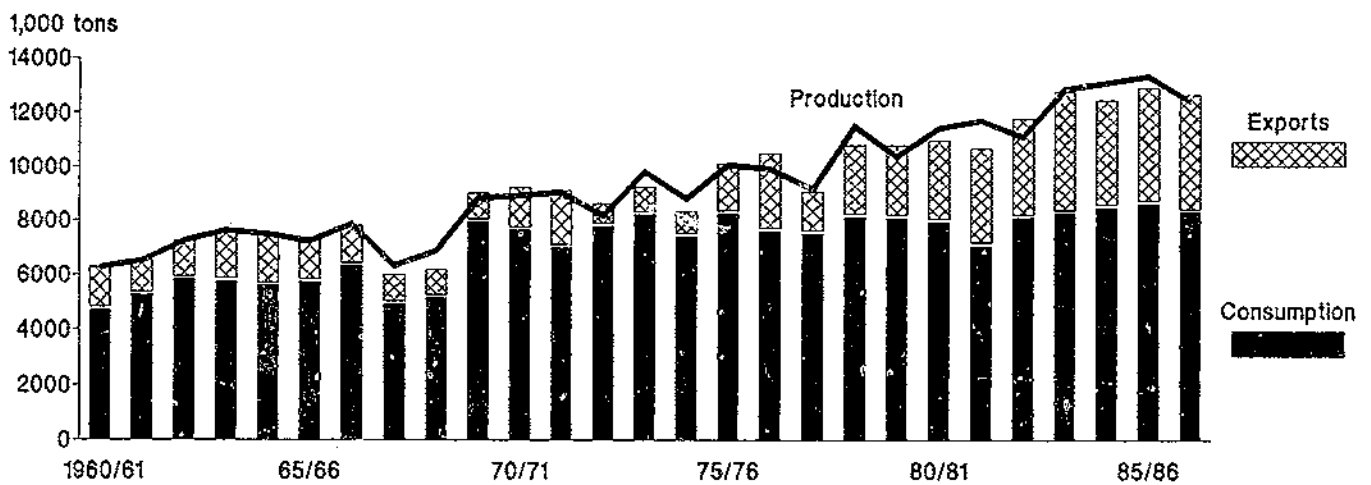
See appendix table 1.

Figure 5
Rice yield, Thailand



See appendix table 1.

Figure 6
Rice production and use, Thailand



See appendix table 1.

Rice Used for Both Food and Feed

Their low cost and ready availability make broken rice and rice bran good feeds for commercial and noncommercial livestock producers. Recent shifts in domestic rice consumption can be attributed to the feed use of rice and to changes in rice's price relative to corn.

Domestic rice consumption has been increasing about 1 percent each year. This rate of growth reflects the influences of a growing population and increased use of rice for feed in Thailand's expanding livestock industry. Rising income has led to a shift to alternative sources of calories in the human diet, so that the growth rate in human consumption is now less than the population growth rate. Rice is used extensively in the livestock industry, and recent sharp movements in total domestic rice use can be traced to changes in the poultry and hog sectors and the shifting price of rice relative to corn in the late 1980's. When the price of rice relative to corn was low, domestic rice consumption increased. When the price of rice relative to corn was high, domestic consumption declined, reflecting shifts in local feed use rather than changes in food use patterns.

While rice is an important livestock feed, it is produced primarily for human consumption. The rice and rice products used for feed (broken rice, rice bran, and rice bran cake) are byproducts of the milling process. Availability and price of rice products for feed are therefore subject to conditions influencing the supply of and demand for rice for food in both domestic and international markets.

Rice products comprise at least 60 percent of the feed ingredients used in the livestock sector (37), though estimates of the quantity of broken rice and bran fed to livestock vary. An estimated average of 2.7 million tons of rice products are annually consumed as feed (1983-85), of which 1.1 million (41 percent) is broken rice and 1.6 million (59 percent) is bran. Some studies (5, 9) estimate even greater volumes consumed. The low cost and ready availability throughout the country have made broken rice an ideal source of energy, and bran a reasonable source of protein and fiber for both commercial and noncommercial livestock producers.

Broken rice, used in poultry and hog rations, is milled, polished rice that has been broken in the milling process. Broken rice has a lower protein content than corn, but is not susceptible to aflatoxin. Bran is the seed coat and germ removed from the grain after hulling. There are two kinds of bran, fine and coarse. Coarse bran is the outer layer, which is lower in nutritional value, and is fed primarily to ducks and cattle (5). Fine bran is the inner layer, containing 14-19 percent oil, and is used to fatten pigs. A small quantity of fine bran is used to produce vegetable oil and the resulting bran cake is also used as a feed ingredient (9).

Rice bran is an important feed in Thailand, but estimating the quantity available for feed in any given year poses some problems due to changes in milling technology and bran's importance in the noncommercial livestock sector. Approximately 11 percent of the weight of paddy rice consists of bran. A 1979 study (5) found that almost all bran (over 90 percent) was fed to animals, and estimated that 8.6 percent of paddy production was broken rice used for feed. More recent analyses found lower rates of feed utilization. USDA estimates of Thailand's feed use (1984-86) show that an average of 77 percent of available bran was fed to livestock and only 5.6 percent of total paddy production was broken rice fed to animals (37). The difference may be due to the increase in total rice production (a 20-percent rise between 1979 and 1986), increased availability of corn (a 62-percent increase between 1979 and 1985), and changing price relationships among corn, rice, and protein meal supplements required for each grain.

Rice and corn are close nutritional substitutes, although broken rice contains slightly less protein than corn and needs to be supplemented with more protein meal. Rice bran and cake complement both corn and rice, adding higher protein content (about 13 percent) but lower levels of digestible carbohydrates (9).

Table 9—Nutritional values of major feeds used in Thailand

Feed	Protein		Metabolizable energy	
	Hogs	Broilers	Hogs	Poultry
	Percent		kcal/kg	
Corn dent yellow grain ¹	8.8	8.8	3,325	3,350
Rice, broken ¹	8.7	8.7	2,360	2,990
Rice bran, solvent ¹	12.9	12.9	2,200	2,100
Sorghum, grain ¹	8.9	8.8	3,229	3,288
Cassava ²	1.25 ³	1.8 ⁴	3,640	3,720
Soybean meal, solvent ¹	44	44	3,090	2,230
Fish meal, menhaden ¹	60.5	60.5	2,734	2,820

¹Arthur E. Cullison, *Feeds and Feeding*. Reston Publishing Co., Inc., Reston, Virginia, 1979. National Research Council, Subcommittee on Poultry Nutrition, Board on Agriculture, National Research Council, Nutrient Requirements of Poultry, National Academy Press, Washington, DC, 1984.

²W. G. Pond and J. H. Maner, *Swine Production in Temperate and Tropical Environment*. W. H. Freeman and Co., San Francisco, 1974. M.L. Scott, M.C. Nesheim, and R.J. Young, *Nutrition of the Chicken*. M.L. Scott and Associates, Ithaca, NY, 1982.

³Dried root.

⁴Meal.

Corn Production and Use

Coarse grains production has increased tenfold since 1960 in response to growth in exports and the livestock sector. About half of Thailand's coarse grain production is consumed domestically now compared with less than 10 percent in the early 1960's. Thailand's corn area increased about 7 percent per year but has slowed in recent years. In addition, yields remain low due to farmers' reluctance to invest in hybrid seeds and inputs.

Thailand's coarse grains production has increased dramatically, if somewhat erratically over the last 25 years. Domestic consumption has grown more steadily, so fluctuations in export levels are caused primarily by year-to-year production variations. The principal coarse grains are corn and sorghum, although small quantities of barley are also grown for the brewing industry.

Thailand produces hard, flint corn with a deep yellow color, high protein content, and a high corn gluten meal yield that are well suited for Asia's livestock industry. In response to growing export markets and domestic livestock demand, corn production has expanded over the last three decades.

Production gains were achieved primarily by increasing the area planted to corn (fig. 7). In 1960, Thailand harvested only 285,000 hectares of corn. Between 1960 and 1975, planted area increased an average 11 percent per year, slowing down to 7 percent per year between 1976 and 1985. In 1985, Thailand harvested a record crop of 5.4 million tons on 2.3 million hectares. Since then, production has fluctuated due to low world prices and drought in 1986 and 1987 and the resulting strong demand and higher prices in 1988.

Corn yields are low, at 1.6 to 2.7 tons per hectare (fig. 8), compared with a U.S. average of 7.5 tons/ha in 1987. Yields have remained low in the traditional corn-growing areas of the central plain and lower northern part of the country where 50 percent of the corn is grown. Newly developed areas farther north and east have achieved higher yields (3.5 tons/ha) in the first 3 years of production, but yields drop to levels as low as 1.6 tons/ha afterwards. Farmers often shift to alternative crops such as sorghum or cassava after corn yields drop off.

Yields depend heavily on weather factors, particularly the timing and strength of the monsoon. Usually, one crop of corn is planted in April/May and harvested in August/September. A smaller second crop is planted in August/September and harvested in November/

December. A weak monsoon in June and July can delay tasseling and silking, lead to poor pollination, and hamper plant growth. Pest outbreaks are associated with drought. Heavy rains in September can cause flood damage to the small second crop planted in August, particularly in areas of poorly drained lowland soils, and enhance the risk of downy mildew (26). Sorghum and mung beans are often planted instead of a second corn crop to avoid the risk of disease.

Since most of the corn is grown during the rainy season, the harvested grain often retains a high moisture content. Thai feed mills will accept corn with a moisture content of up to 15.5 percent. High moisture levels increase the chance of contamination by aflatoxin, a naturally occurring fungus that some scientists say is a carcinogen. Dryers are rarely used, so aflatoxin contamination affects up to a fourth of the corn crop. Aflatoxin reduces corn's export potential as well as the quality of domestic feed. The Government has been encouraging farmers to plant the crop later so that they will be able to harvest the corn in the dry season. However, farmers are more concerned with early-season drought than with postharvest aflatoxin problems. The construction of large numbers of up-country dryers in recent years may help to reduce the incidence of aflatoxin.

Farmers use few inputs in an effort to reduce the financial risks of drought. Less than 10 percent of the variable cost of corn production is spent on seed, fertilizer, and pesticides, although input use rises when corn prices are high.

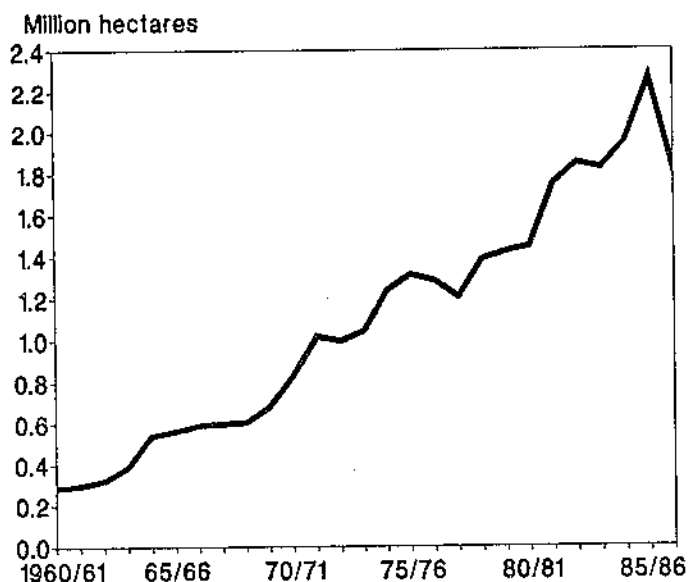
Commercial seed use is low (about 25,000 tons in 1987) and open-pollinated seed is preferred to hybrids. While the yield of open-pollinated seed is lower than that of hybrid seed, it is cheaper and has a higher germination rate. As a result, hybrid seed use is limited to less than 15 percent of corn area.

Hybrid seeds have been available for sale in Thailand only since 1984. They have yielded up to 6.25 tons per hectare under research conditions. However, a high

level of fertilizer use, appropriate cultivation practices, and adequate moisture levels are needed to reach the maximum yield. Hybrid seeds cultivated with low fertilizer inputs still yield 3.1 tons per hectare compared with 2.3 tons obtained from other varieties. However, hybrid seeds cost nearly three times as much as the

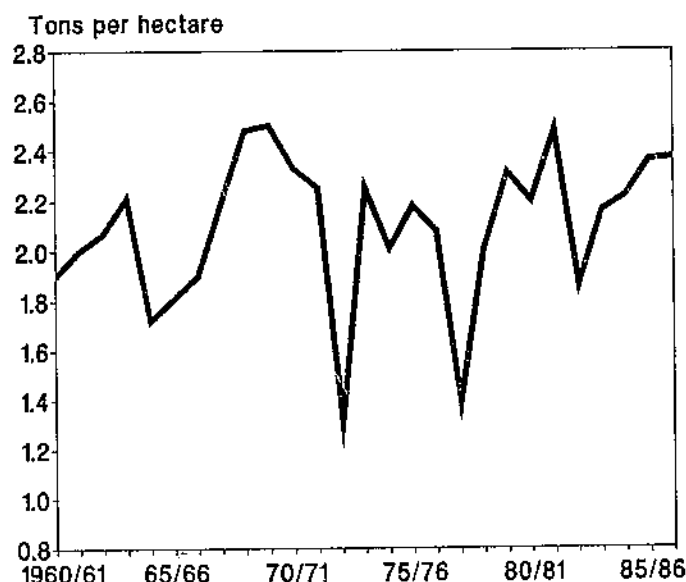
other. The need to use fertilizer boosts the cost of producing hybrid corn. While the potential yield increases could produce a rate of return to fertilizer use of nearly 100 percent (11), farmers have been unwilling to invest in inputs, given generally low corn prices and the risk of drought.

Figure 7
Corn area, Thailand



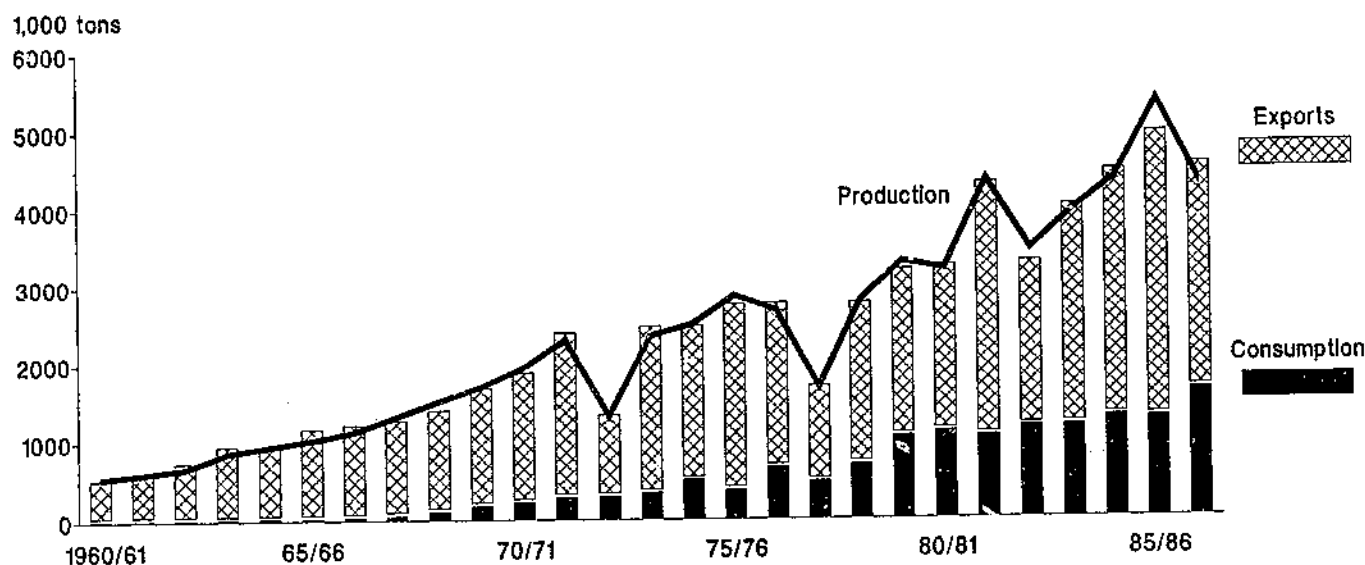
See appendix tab's 2.

Figure 8
Corn yield, Thailand



See appendix table 2.

Figure 9
Corn production and use, Thailand



Feed Sector Meets Growing Demand

Sorghum Area, Yield, Production, and Use

Thailand's sorghum crop, stabilized at about 285,000 metric tons, is produced mostly for export. Hybrid red sorghum, first introduced in 1984, now accounts for 60 percent of total production.

Sorghum, a relatively minor crop in Thailand, is more drought-resistant than rice or corn and is produced primarily for export. Thai farmers first planted white sorghum (Heggari variety) in 1963 and produced 8,000 tons on 4,000 hectares. Area increased at an annual average rate of 29 percent so that by 1975, 202,000 hectares were planted and production increased to 300,000 tons. Sorghum production fluctuated throughout the 1970's as it expanded onto less productive land (fig. 10) and yields subsequently dropped (fig. 11). Between 1976 and 1985, area expanded by an annual average rate of only 2.5 percent per year while production rose about 1 percent per year.

In dry years, more sorghum is planted as a substitute for corn. Small crops of sorghum are also planted after corn is harvested in October/November. Production in the late 1980's stabilized at about 285,000 tons.

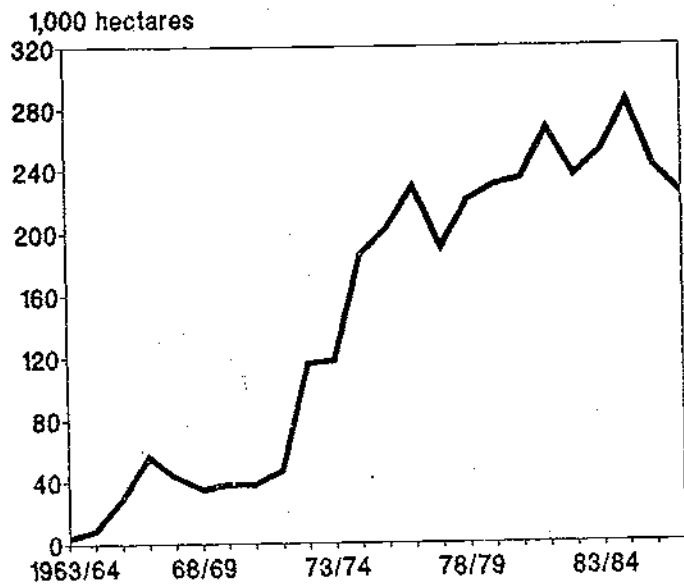
Two varieties of sorghum are produced in Thailand, red and white. Until 1984, white sorghum was the dominant variety. Now, red sorghum accounts for about 60 percent of production. White sorghum is produced for export to the Middle East, particularly Saudi Arabia, as feed for goats and camels. Sorghum is also used as a "binding agent" in tapioca pellets.

Red sorghum is more suitable than white for livestock feed because of its lower tannic acid content. High levels of tannin make white sorghum unsuitable for cattle, hog, and poultry consumption unless mixed with other sorghum varieties.

Hybrid red sorghum seed was first introduced for sale in Thailand in 1980. It gained acceptance slowly because production costs were higher and market opportunities limited. The hybrid seeds require fertilizer, and local traders were initially reluctant to buy red sorghum because they had no market experience with the new variety. Farmers were reluctant to invest in the new variety until the market was more established, even though the hybrid red sorghum yielded 2.0-2.5 tons per hectare, double that of the Heggari variety, and commanded a higher price due to lower tannin content.

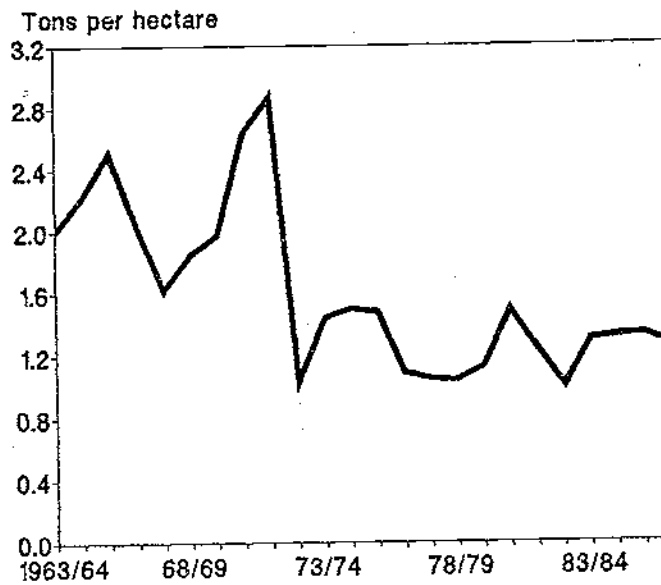
By 1984, farmers had become more receptive to the red hybrids. Seed firms successfully marketed the new variety and the Government promoted its production as an alternative to cassava. Even though overall production is stable, producers continue to shift from white to red sorghum because the red variety is more suitable for Asia's livestock industry, including the domestic market, and fetches a higher price than white sorghum. However, sorghum is used for local feed only when the price is 10-15 percent less than that of corn.

Figure 10
Sorghum area, Thailand



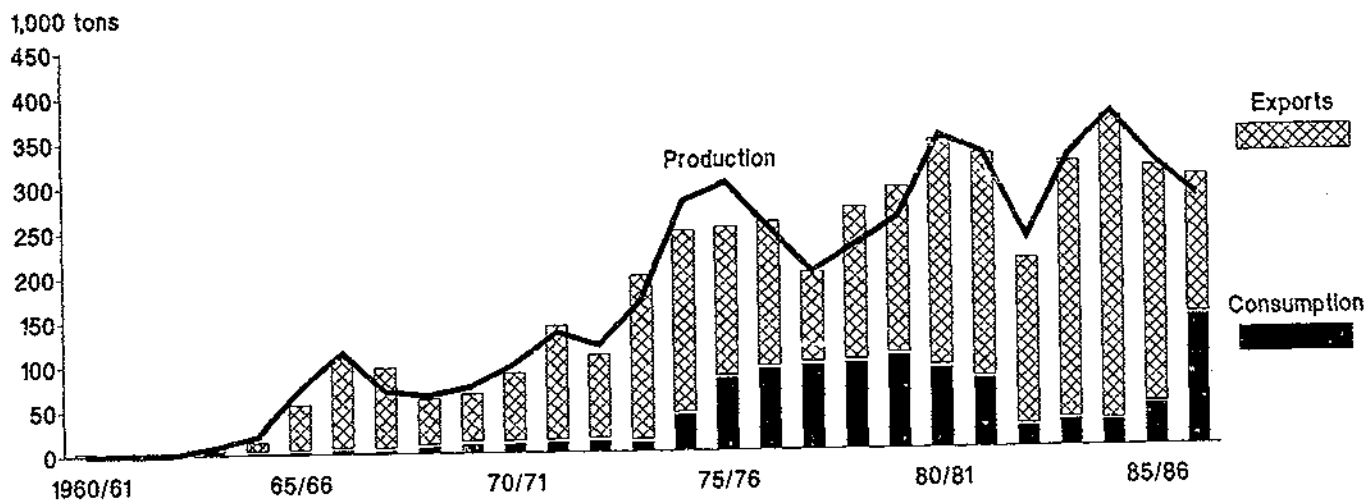
See appendix table 3.

Figure 11
Sorghum yield, Thailand



See appendix table 3.

Figure 12
Sorghum production and use, Thailand



See appendix table 3.

Growth in Thailand's Grain Exports

Thailand has emerged as a major grain exporter over the last 25 years. Thailand has expanded its share of the world rice market to 40 percent and is an important coarse grains competitor, particularly in the Middle East and Southeast Asian markets.

Thailand has always been a major rice exporter. Until 1981, Thailand and the United States each held about 25 percent of the world market. After 1981, Thailand expanded its market share to over 30 percent, mostly at the expense of the United States. Thailand currently exports an average of 4.4 million tons of rice per year (1984-88).

Thailand's corn exports have risen dramatically since 1960 when exports amounted to only 519,000 tons. Between 1960 and 1975, exports grew at an annual average rate of 9 percent, slowing to a 7-percent rate between 1975 and 1985. Before 1980, Thailand shipped up to 70 percent of its corn exports to Japan and Taiwan. However, price and quality (particularly aflatoxin) concerns caused corn trade with Japan and Taiwan to come to a halt after 1981. By that time, Thailand had diversified its corn export market so that 34 percent of its sales were to Southeast Asia, 34 percent to the Middle East, and 3 percent to Africa. Diversification efforts were so successful that even though exports to Japan and Taiwan virtually ceased after 1981 and resumed only in 1988, there was little effect on total export quantities.

Thailand is a minor corn exporter compared with the United States, which exports an annual average of 43 million tons (1984/85 to 1988/89). However, Thailand is still a significant competitor, particularly in some Asian markets. Thailand holds most of the Southeast Asian market. Thailand's geographical location, ability to ship small, bagged quantities (1,000 to 10,000 tons) with quick (3-5 day) turnaround, and Asian consumer preference for very yellow corn in poultry feed give Thailand a comparative advantage over other exporters. The hardness of the corn and low levels of foreign matter resulting from greater manual handling are additional advantages over U.S. corn. Thailand has also proved to be an effective competitor in South Korea and China, capturing 12 percent (515,000 tons) of South Korea's corn market and 25 percent (246,000 tons) of China's import market (1985-87).

However, the price and concern about aflatoxin by Taiwan and Japan, the region's largest corn importers,

have yet to be fully resolved. In addition, Thailand's transportation advantage in Asia is declining. One reason: its ports, small and shallow, cannot easily handle bulk shipments of corn. This increases shipping costs, and with lower international shipping rates in recent years it can be cheaper for East Asian countries to import corn from the United States than from Thailand. In addition, some of Thailand's traditional Asian customers, particularly Singapore and Hong Kong, are cutting back on livestock production and reducing their overall demand for feed grains.

Sorghum Exports Also Significant

Sorghum exports became significant in the mid-1960's when Thailand exported an annual average of 84,000 tons (1965/66 to 1967/68). Thailand's sorghum went primarily to the Middle East (especially Saudi Arabia), to be used mainly as goat and camel feed. Exports increased an average 8 percent per year between 1975 and 1985, reaching a high of 342,000 tons in 1984/85.

Thailand's ability to ship small, bagged quantities of sorghum had been particularly well suited to Saudi Arabia. Until 1984, ports in Saudi Arabia did not have bulk handling facilities. Once those facilities were in place, Saudi Arabia began to reduce sorghum imports from Thailand and to take advantage of lower priced bulk shipments from the United States and Argentina. As a result, Thailand's sorghum exports to Saudi Arabia fell off from a high of about 207,000 tons in 1984 to nothing in 1988.

In 1984, exports to the Middle East accounted for over 90 percent of Thailand's total sorghum sales. By 1987, almost 90 percent of Thailand's sorghum exports went to Asian countries. The shift in trading pattern occurred because of increased competition in the Middle East and the ability of Thai traders to make inroads into the Taiwanese and Japanese markets. In 1988, Taiwan imported 83 percent of Thailand's total sorghum exports. Japan buys red sorghum from Thailand when the quality and price are particularly favorable.

Table 10—Growth in and destination of Thailand's exports¹

Export	Destination					Percent of crop ² exported
	EC	Middle East	Africa	Asia	World	
1,000 metric tons						Percent
Rice						
1978	20	267	628	645	1,569	14
1988	151	828	1,546	1,957	4,781	27
Corn						
1978	0	297	67	1,588	1,955	74
1988	0	81	6	1,118	1,206	37

¹ Calendar year.

² Coarse grains production estimated on a July/June crop year.

Cassava Production and Use

Cassava is produced almost exclusively for export, mostly to the European Community. It is an effective feed substitute if complemented by oilseed meal and when its price is about half the corn price.

Cassava, also referred to as manioc and, in processed form, tapioca, is a major nongrain feed ingredient used primarily in the European Community (EC) and an important food crop in Latin America, Africa, and Asia. One ton of cassava root produces 0.4 ton of tapioca pellets, the most common form for feed. Unlike many developing countries, Thailand produces cassava almost exclusively for export. It is not a food staple nor is it used extensively in the domestic livestock industry. The tapioca export industry expanded as a result of EC agricultural policies that permit nongrain feed imports and protein meal supplements to enter with no or minimal tariffs while domestic grain prices are kept high and grain imports are heavily taxed. Tapioca is generally Thailand's second most important agricultural export crop after rice, averaging \$797 million a year (1986-88).

Cassava production in Thailand expanded entirely in response to export demand. Cassava, with its high drought tolerance, low yield risk, and low labor requirement, is grown in 36 out of 72 provinces on 1.4 million hectares (7 percent of Thailand's arable land). Production is centered in the northeastern region, which is characterized by poor soil, drought, and low farm incomes. Cassava production reached 20 million tons in 1984, declined slightly in response to lower prices and weakened export demand, then rebounded in 1988.

Prior to 1984, cassava was not used for feed in Thailand because the competitive price of corn made it uneconomical. One study showed that the cassava price has to be half that of corn (although it has 70 percent of the feed value) before it is used by the industry (17). Cassava prices were so low in 1984, that feed companies began experimenting with cassava-based feed rations. Domestic feed use increased from 75,000 tons in 1984 to 250,000 tons in 1985, but dropped off again when cassava prices rose relative to corn in 1986.

While Thailand has been exporting small quantities of cassava starch, flour, and meal since the mid-1950's, cassava became a major nongrain feed export in the

mid-1960's. Cassava is shipped to Europe in the form of tapioca pellets and, less frequently, as dried chips. Sales to the EC expanded rapidly (at an average annual rate of 29 percent) from 337,307 tons in 1967 to 5.7 million tons in 1978 (2), competing both with EC coarse grains producers and U.S. nongrain feed exports. In 1981, EC coarse grains producers began to lobby for import restrictions. Thailand signed a voluntary agreement with the EC that year limiting annual tapioca exports to the EC to 5 million tons in 1983 and 1984 and to 4.5 million tons in 1985 and 1986.

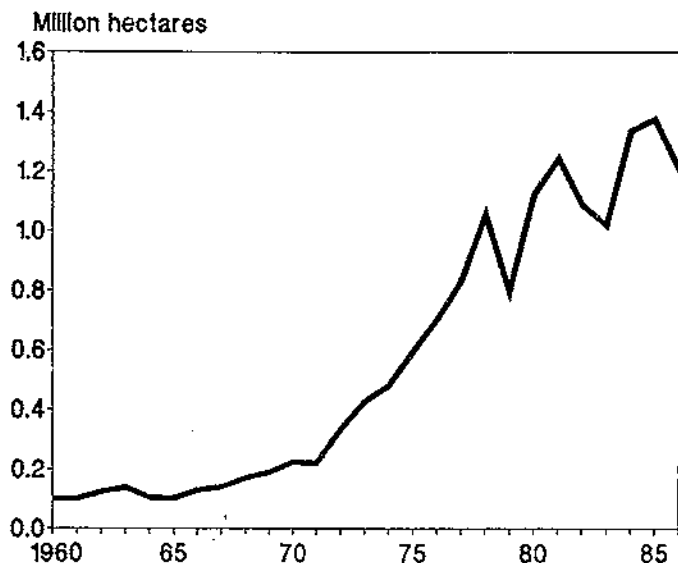
Thailand renewed its voluntary export agreement with the EC in 1986, agreeing to limit its exports to the EC to 21 million tons of tapioca products between 1987 and 1990. The agreement raises the annual average to 5.25 million tons from the 4.73 million tons required by the former agreement. However, in 1985, Portugal was not then part of the EC and not subject to its quotas. That year, Portugal was a major importer of Thai cassava. When Portugal joined the EC in 1986, it became subject to EC restrictions on cassava imports. The EC increased its quota by 10 percent in 1986, but this increase was not enough to cover what Portugal might have bought if it had not been part of the EC. As a result, Thailand's cassava exports to the 12 countries of the European Community fell 12 percent in 1986, despite the 10-percent increase in the Community quota.

While nearly all of Thailand's tapioca exports usually go to the EC, other countries have shown a willingness to substitute imported tapioca for imported coarse grains when tapioca's price is relatively low. To encourage tapioca exports to non-EC markets, the Government has tied part of each exporter's EC quota to its exports to other markets. In 1985, export prices plummeted. That year, 28 percent of the sales were to non-EC markets. Low prices and aggressive marketing allowed tapioca to make inroads into a number of non-EC feed markets. Japan imported 419,000 tons of tapioca products, Portugal, 392,000 tons, the Soviet Union, 288,000 tons, Taiwan, 281,000 tons, and South

Korea, 243,000 tons. Even the United States imported 14,000 tons into Hawaii. Sales to these markets dropped off in 1986 as a result of higher tapioca prices and lower coarse grain prices, but were back to high levels in 1988 (over 2 million tons), with

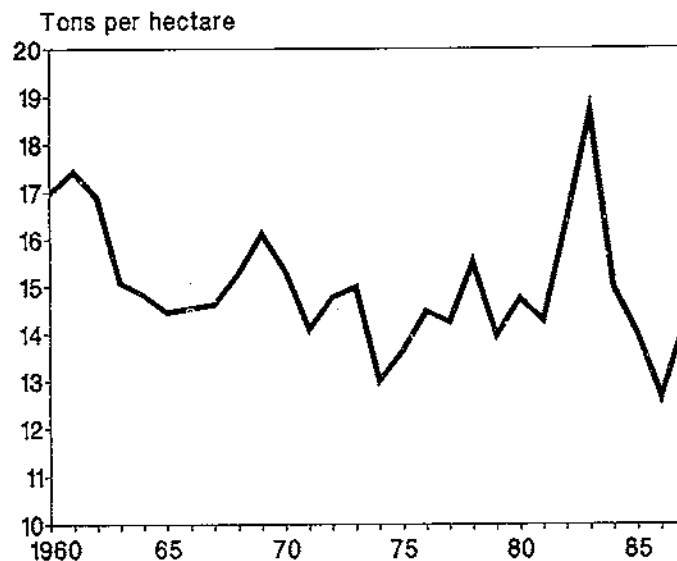
the Soviet Union alone purchasing 900,000 tons of tapioca products, the United States taking 100,000 tons, and South Korea and Eastern Europe importing large quantities. Thus, the prospect of tapioca as an intermittent competitor in coarse grain markets remains.

Figure 13
Cassava area, Thailand



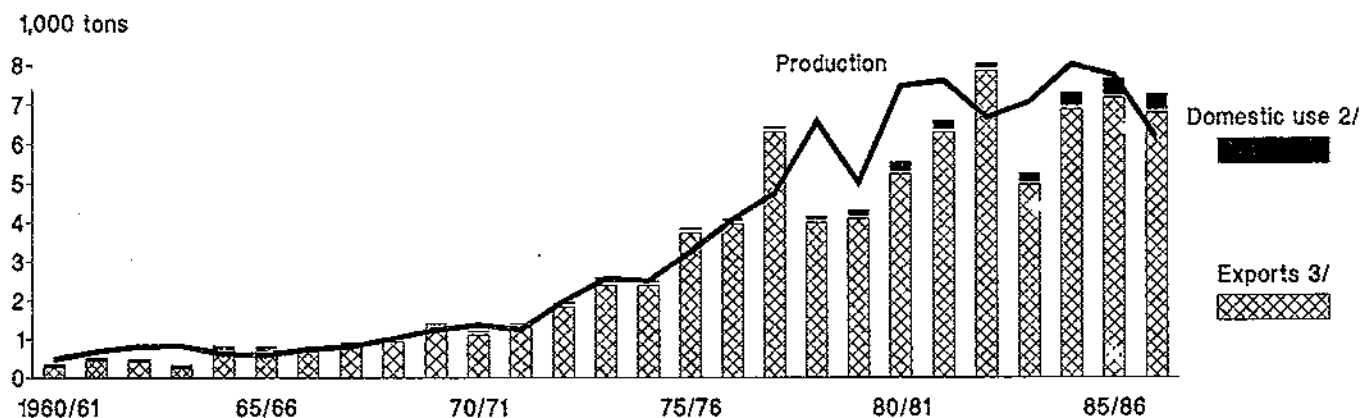
Sources: Agricultural Statistics of Thailand, USDA, and Titapiwatanakun.

Figure 14
Cassava yield, Thailand 1/



1/ Roots.
Sources: Agricultural Statistics of Thailand, USDA, and Titapiwatanakun.

Figure 15
Tapioca products, production and use, Thailand 1/



1/ Pellet equivalent. Includes flour, chips, and pellets.
2/ Product basis. Includes animal feed and starch.
3/ Includes roots, flour, chips, and pellets.
Source: Agricultural Statistics of Thailand, USDA, and Titapiwatanakun.

Feed Sector Meets Growing Demand

Protein Meal Use

Unlike grains, the protein meal sector has not kept pace with Thailand's livestock growth. Fishmeal quality is generally not high enough for the domestic markets and soybean meal supply is inadequate.

While domestic grain supplies have kept pace with Thailand's livestock sector, protein meal production has not and imports must supplement domestic resources. Soybean meal and fishmeal are the primary protein sources, with their shares in feed rations depending on the relative prices. Soybean meal dominates the livestock industry because production of fishmeal is lagging as the supply of trash fish (those not usually eaten by humans) in the Gulf of Thailand is dwindling. Although fishmeal generally has a higher protein content than soybean meal (60 percent vs. 44 percent), the fishmeal industry is currently running only at an estimated 60 percent of its 300,000-ton capacity (37). The only support the Government has offered this declining industry came in 1984 when it lifted export taxes.

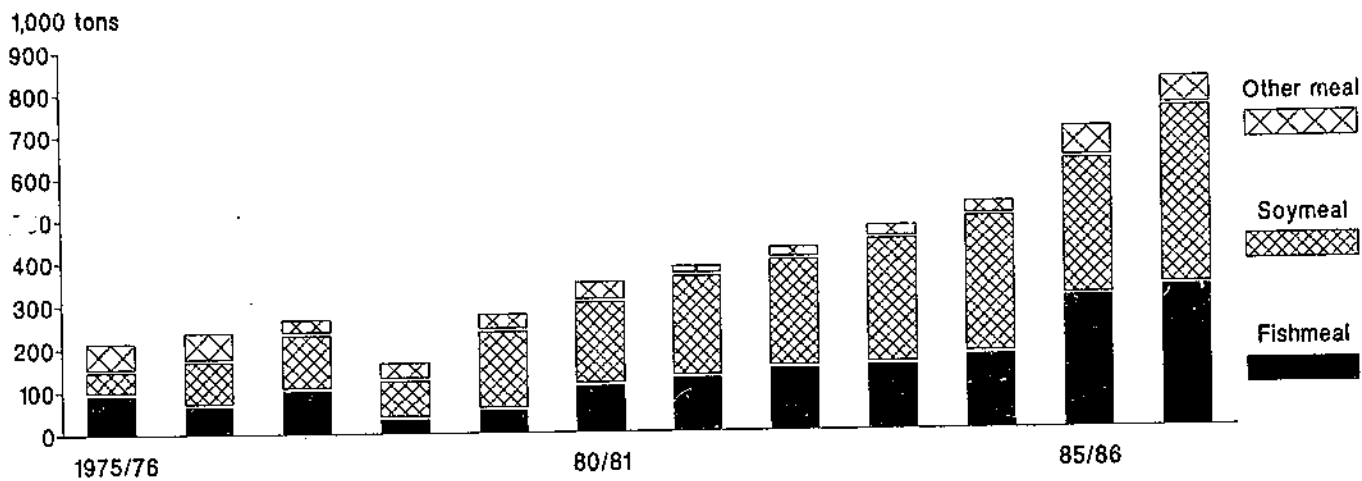
In the 1960's, the commercial feed industry took advantage of the abundance of fishmeal to produce concentrates and compound feed, mostly for the hog sector. However, the industry turned increasingly to soybean meal when fishmeal prices began to rise. Fishmeal production rose, but much of it was exported and domestic use stayed between 50,000 and 90,000 tons throughout the 1970's and early 1980's. In 1970

the livestock industry absorbed 80 percent of fishmeal production. By 1985, the livestock industry accounted for only 41 percent.

Fishmeal has been increasingly produced for export, mostly to Malaysia, Singapore, Indonesia, and Taiwan. Over the past 5 years, Thailand annually exported between 68,000 and 93,200 metric tons of fishmeal, most of which was of low quality (less than 55-percent protein). Rapid growth of shrimp production, which uses high-protein feed from fish protein sources (primarily fishmeal and squidmeal), may increase domestic demand for high-quality fishmeal, competing with the demand from duck farms and export markets.

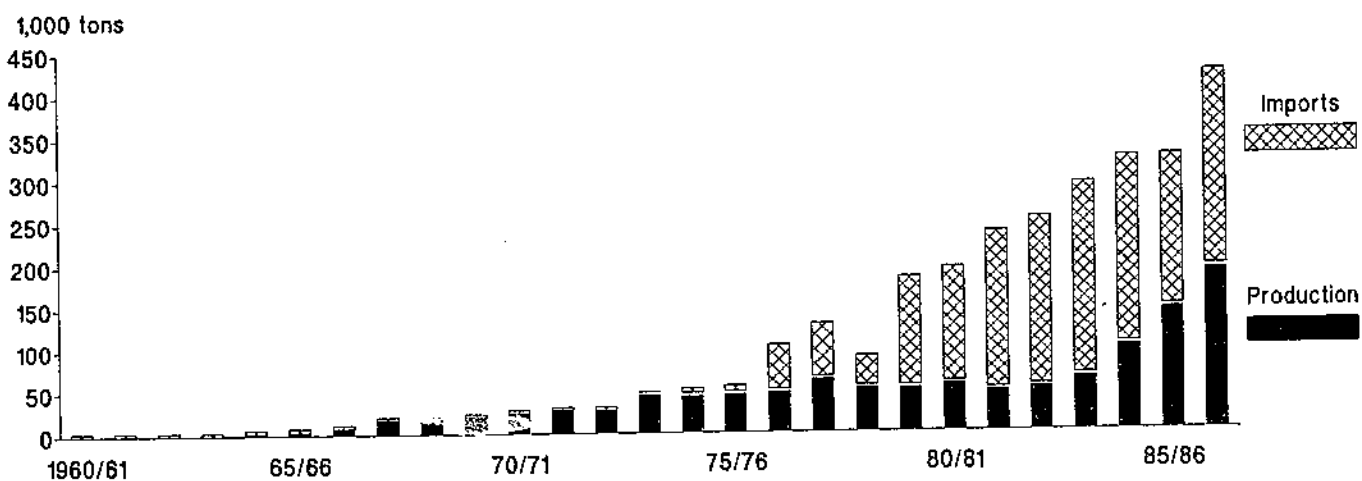
Most fishmeal produced in Thailand is low quality, with large amounts of mud, sand, and broken shells. Production of higher quality meal is constrained by competition for fresh fish from the canned fish industry. The imbalance between the surplus of low-quality fishmeal and shortage of high-quality meal has led to increasing calls from animal feed producers to liberalize imports of both fishmeal and soybean meal, and to improving fishmeal quality as prices for higher quality meal are bid up.

Figure 16
Protein meal consumption, Thailand



Source: USDA.

Figure 17
Soymeal supply, Thailand



See appendix table 6.

Soybean Production and Use

Thailand's soybean and soybean meal production has more than doubled since 1982, despite soybean yields that are only about half the U.S. level. The driving force behind the expansion has been Government support for producers and protection from imports.

Soybean meal use has increased at an average annual rate of 19 percent, soaring from only 17,800 tons in 1970 to over 400,000 tons in 1988. Imports expanded rapidly at the same time. Between 1970 and 1983, soybean meal imports rose from 1,000 to 230,000 tons, an average growth rate of 62 percent per year. In 1984, the Government imposed import restrictions to encourage domestic production and, since then, imports have leveled off, averaging 210,000 tons per year.

The Government has successfully stimulated domestic soybean and soybean meal production by restricting imports, supporting farm prices, and providing subsidized inputs to improve yields. As a result, farm returns are high, and planted area and soybean production have more than doubled since 1982, growing an average of 23 percent per year to 450,000 tons in 1988/89, as farmers substituted soybeans for dry season rice, corn, mung beans, and tobacco.

Yields, however, are low (about 1.3 tons per hectare versus 2.2 in the United States) and variable costs of production are high (about \$160 per ton compared with \$52 in the United States). The primary production constraints are the low germination rate of local varieties, limited availability of high-yielding seed and rhizobium inoculate (a nitrogen-fixating bacteria), the high cost of phosphate fertilizer, poor weed control, and large harvest losses due to repeated handling during and after harvest. The Government has sought to reduce these problems by instituting a barter system whereby farmers exchange local varieties of seed for high-yielding seed. Small quantities of rhizobium are sold at subsidized rates for every 10 kg of seeds bartered. Some high-yielding seeds are also available for sale, but to date the Government has been able to supply only 15 percent of the high-yielding seed necessary to plant current acreage (assuming 37.5 kg of seed per hectare on 230,000 hectares) (42).

Since 1984, an increasing proportion of Thailand's soybean crop has been crushed, expanding from 49 percent of production to 70 percent in 1983/89. During the same time, food use fell from 37 percent to about

24 percent of production. Negligible quantities (less than 1,000 tons) were exported, mostly to Malaysia. Nestle Thailand Co. has introduced "soya-milk" drinks in Thailand, increasing domestic demand for soybeans.

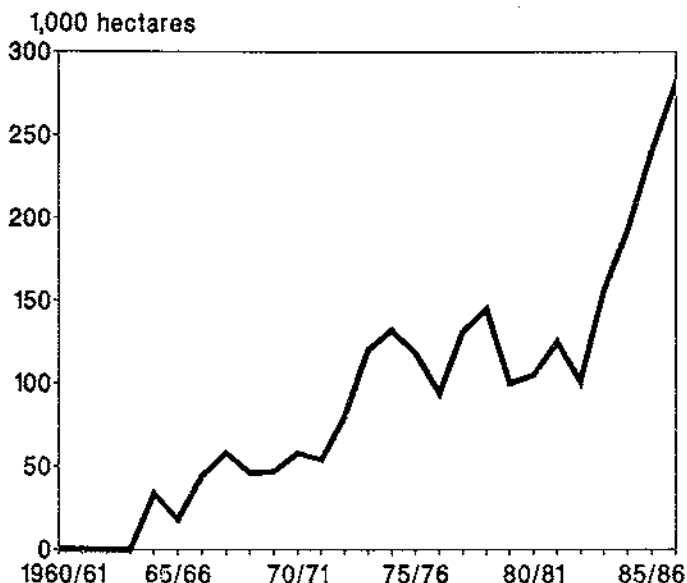
Oilseed crushers are protected from international competition. Since a ban on soybean imports was in effect from 1982 until 1988, when it was eased slightly, crushers must pay high domestic prices for soybeans and charge high prices for their soybean meal. To prevent a flood of cheap imported meal, the Government imposed a quota system in 1984 which requires feed manufacturers to buy a given quantity of domestic meal for every ton imported, with the ratio varying from period to period and depending on local soybean production. For 1988/89, the ratio was 2 to 1. The system has become quite complex because importers must present proof of purchase of domestic meal before import licenses are granted. Therefore, local sales and deliveries must be carefully timed to precede import supplies. Local shortages, high prices, and high storage and administrative costs have hampered the feed and livestock industry.

Annual imports of soybean meal averaged 209,000 tons between 1985/86 and 1988/89. Imports of peanut meal, sunflowerseed meal, rapeseed meal, and other protein sources not subject to quota or licensing arrangements have grown rapidly in the last few years and now represent close to 40 percent of total meal imports.

Thailand produces small quantities of other oilseeds but only negligible quantities of the meal are used in feed rations. These include peanut, coconut, cottonseed, and kapok. According to a 1979 study (5), these meals are used only to feed cattle and sometimes dairy herds. Only 7-10 percent of domestic peanut production is used as meal in animal feed. Small quantities of sesame meal were once used in feed rations, but an increased demand for sesame for human consumption has pushed the price above that of alternative oil meals used for feed.

Figure 18

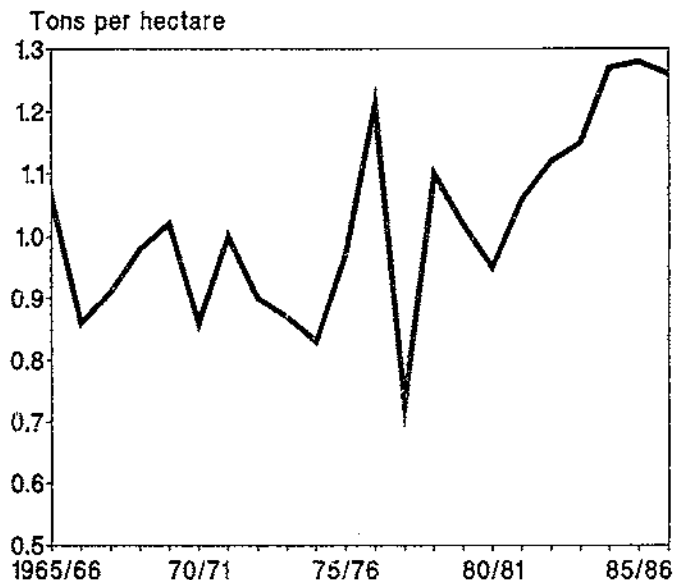
Soybean area, Thailand



See appendix table 4.

Figure 19

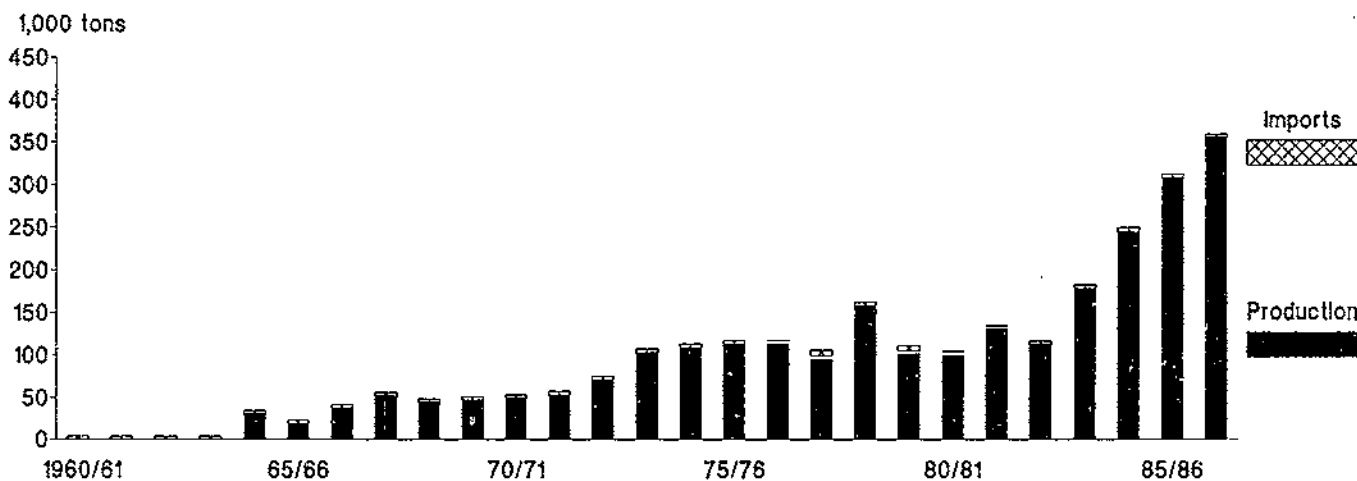
Soybean yield, Thailand



See appendix table 4.

Figure 20

Soybean supply, Thailand



See appendix table 4.

Implications of Livestock Growth for Future Grain Exports

Thailand's future grain exports depend on the development of the domestic livestock industry. Per capita income growth will determine the rate of growth of domestic demand. Three scenarios were examined: (1) low growth, per capita income rising 1.5 percent per year; (2) moderate growth, 4 percent per year; (3) high growth, 6.5 percent per year.

Thailand's ability to export competitively priced grain depends, to some extent, on the development of its livestock sector. This section looks at the implications of livestock development for grain export prospects by developing a set of projections to the year 2000 for grain production and domestic demand. A similar set of projections is developed for oilmeals. Export availabilities or import requirements are then calculated as residuals.

The rate of economic growth in Thailand is likely to be the most important variable determining the rate of growth of domestic demand and export availability. We consequently developed three sets of projections based on alternative assumptions about rates of growth of real per capita income. The projections indicate that corn exports may decline over the next decade, perhaps sharply, and demand for imports of oilseed meal may increase substantially. Rice export availabilities could increase or fall, depending on how rapidly incomes and the livestock sector develop.

Prices of agricultural products are not explicitly considered in the analysis. Our implicit assumption is that the recent surge in world grain export prices is temporary, and that real prices will resume their long-term downward trend over the next decade. Moreover, we assume no major change in relative prices from those the Thai economy has experienced in recent years, and no major shocks to the international or domestic economic environment. Factors such as political upheavals, oil price shocks, interest rate changes, or trade liberalization could result in significantly different outcomes. In several critical places, we have tried to indicate how different price assumptions would alter the outcome for domestic consumption and exports.

Macroeconomic and Population Growth Assumptions

Expansion of the livestock sector depends on Thailand's income and population growth, relative price

shifts, export demand, and changes in Government policy. The country's economy is expected to grow at a slower rate during the next decade than in the 1980's. The growth will be attributable partly to agriculture, but more to manufacturing and services. The Thai Government is expected to remain fiscally conservative and to continue promoting exports in its efforts to reduce budget deficits, foreign debt, and trade imbalances.

The Sixth Five Year Plan (1987-91) annual growth target of 5 percent is likely to be achieved easily, given the strong growth of the country's manufacturing sector, continued low oil prices, and the Government's conservative fiscal policy. Thailand's population growth rate is currently 1.7 percent but may fall to 1.5 percent by 2000. If the plan's target is met, then per capita income can be expected to rise by at least 3.3 percent per year.

Demand for livestock products and feeds is forecast to expand substantially by the year 2000. Meat consumption in Thailand is projected to the year 2000 under three different growth scenarios (table 11). The base scenario (scenario II) assumes an annual per capita income growth rate of 4 percent, a constant annual population growth rate of 1.6 percent (as forecast by the World Bank), and the authors' estimates of elasticities of demand with respect to per capita income. The other two scenarios present estimates based on lower and higher growth rates. The low-growth scenario (scenario I) assumes per capita income rises 1.5 percent per year, and the third scenario depicts rapid economic growth, with annual per capita income rising 6.5 percent, less than the recent growth rates but a high level to sustain for more than a decade. Tables 12 and 13 present the average annual growth rates for key variables during the 1975-85 period and as projected for 1985-2000.

Table 11—Meat consumption projections for year 2000¹

Per capita income growth rate	Unit	1985	2000		
			Scenario I (1.5%)	Scenario II (4%)	Scenario III (6.5%)
Total meat	1,000 tons	1,091	1,753	2,566	3,756
Beef	1,000 tons	248	355	427	513
Pork	1,000 tons	457	782	1,252	1,976
Poultry	1,000 tons	386	616	887	1,267
Eggs	Mil. doz.	350	486	585	703
Per capita meat	kgs	21.2	26.7	39.1	57.2
Beef	kgs	4.8	5.4	6.5	7.8
Pork	kgs	8.9	11.9	19.1	30.1
Poultry	kgs	7.5	9.4	13.5	19.9
Eggs	Dozen	6.6	7.4	8.9	10.7

¹Assumes annual population growth rate of 1.6 percent. Income elasticities are estimated to be 0.5 for beef, 1.3 for pork, 1.0 for poultry, and 0.5 for eggs.

Table 13—Average annual growth rates for grains and soybean production, 1960-85, and projections to 2000

Crop	1960-75	1976-85	1986-2000
	<i>Percent</i>		
Rice:			
Area	2.0	1.6	0
Yield	.6	2.0	1.0
Production	2.7	3.7	1.0
Corn:			
Area	10.8	6.8	1.0
Yield	.4	2.6	1.0
Production	11.2	9.6	2.0
Sorghum:			
Area	29.3	2.5	0
Yield	-4.6	2.4	2.0
Production	24.7	5.0	2.0
Soybeans:			
Area	15.4	7.4	5.0
Yield	-1.6	3.2	2.0
Production	14.7	10.7	7.0

Table 12—Average annual growth rates, 1975-85, and projections to 2000

Item	1975-85 actual	1986-2000 scenarios		
		I	II	III
		<i>Percent</i>		
Per capita consumption:				
Total meat	4	2	4	7
Beef	2	1	2	3
Pork	4	2	5	8
Poultry	7	2	4	7
Eggs	5	1	2	3
Total consumption:				
Total meat	6	3	6	9
Beef	5	2	4	5
Pork	4	4	7	10
Poultry	9	3	6	8
Eggs	7	2	3	5
Production:				
Broilers	21	4	6	9
Layers	5	1	3	4
Hogs	6	3	6	9
Eggs	7	1	3	4
Feed use:				
Total feed	8	3	6	9
Rice	5	0	3	6
Corn	15	5	8	10
Sorghum	-3	0	0	0
Protein meal	12	7	10	12
Exports:				
Rice	9	4	2	-1
Corn	4	0	-4	-57
Sorghum	5	4	4	-1
Poultry	36	6	6	6
Imports:				
Oilseed meal	16	9	14	18
Per capita GNP	4	15	4	6.5

Model Outline

The projections model assumes that growth in population and national income leads to growth in domestic consumption of livestock products. In the case of poultry, export demand also plays an important role. Livestock production is assumed to increase to meet the demand, in turn creating increased demand for feed grains and protein meals. Export availabilities are assumed to be the residuals after domestic food and feed demands are satisfied. Relative prices are assumed to remain constant.

Consumption trends are influenced by income, population, prices, and preferences. Increases in consumption of individual products depend on how consumers allocate increases in their real income. Several studies have reached varied results regarding income elasticities of demand for livestock products with respect to per capita income.

Income elasticities change over time and as income rises, and their reliability depends on the data and methods used to estimate them. This study draws on the research of the Thailand Development Research Institute (TDRI) and others (32, 35, 18, 13). TDRI estimated the elasticities of chicken, pork, and duckmeat for both urban and rural areas. The income elasticity for pork was slightly more than one in urban areas and higher in rural areas (table 14), indicating that as incomes rise, a larger proportion of income will be allocated to pork. The income elasticity for chicken was nearly one in urban areas but only 0.5 in rural areas, implying a likely slower growth in chicken consumption in rural areas than in urban centers.

Incomes tend to be higher in urban areas. While there is some potential for continued growth in meat consumption in the cities, the greatest potential for meat consumption expansion lies in the countryside where approximately 80 percent of the population live. However, without substantially higher commodity prices, it is unlikely that rural incomes will rise as rapidly as urban incomes over the next dozen years.

Income elasticities of demand are assumed to be 0.5 for eggs, 1.0 for poultry, 1.3 for pork, and 0.5 for beef. These income elasticities, together with the 1.6 percent annual population growth and the national income growth rate assumed in each scenario, are used to determine total and per capita egg and meat consumption levels in the year 2000, based on their 1985 levels. It is possible that an increased fish contribution could affect demand for other protein supplies. However, the decline in the volume of fish in Thailand's territorial

waters and disease problems in inland fisheries in the face of expanding commercial livestock operations make relative price changes favoring fish unlikely.

It is difficult to find accurate and consistent data series for Thailand. Where possible, we have relied on official figures from the Royal Thai Government. The appendix provides a discussion of the difficulties in obtaining consumption information. For production, export, animal weight, and feed-conversion information, we have used materials from Thailand, the U.S. Department of Agriculture, and other research studies. Caution should be used in interpreting the results of this analysis of the potential outcomes of the income-consumption-production interactions in Thailand.

Population

Thailand's population is assumed to grow at 1.6 percent per year.

$$P_t = P_{t-1} \cdot 1.016,$$

where P is the national population and t is a time (year) index.

Livestock Consumption

Domestic consumption of meat and eggs is projected to grow with population and income from 1985 levels according to

$$C_t = C_{t-1} \cdot (1 + e \cdot g)$$

$$C_t = c_t \cdot p_t,$$

where c is the level of per capita consumption, C is the aggregate domestic consumption (demand) level, g is the growth rate of per capita income (4 percent in the base scenario), and e is the income elasticity of demand, assumed constant over time at 1.0 for poultry, 1.3 for pork, 0.5 for beef, and 0.5 for eggs.

Livestock Production

Animal production is assumed to be adequate to meet domestic (and, in the case of poultry, export) demand.

Demand for poultry meat (PM) is met partly from culled layers and partly from broilers. The number of layers (L) required to meet the egg demand is calculated as

$$L = \text{Eggs demanded} / 275$$

assuming a commercial laying rate of 275 eggs per year. Meat from culled layers (LM) assumes a 2-year lifespan, 2 kg carcass weight, and 0.6 ratio of meat to carcass weight.

$$LM = (L/2) \cdot 2.0 \cdot 0.6.$$

Domestic broiler meat demand (DBM) accounts for the domestic poultry meat demand not met by culled layers $DBM = PM - LM$. The export broiler meat demand (XBM) is assumed to come 90 percent from the Japanese market, where Thailand is assumed to have 40 percent of the market for 300,000 tons (carcass weight) of poultry imported in the year 2000 (consistent with internal USDA projections),

$$XBM = (300,000 \cdot 0.4) / 0.9.$$

The number of (million) broilers required to satisfy domestic and export demand, assuming an average weight of 1.8 kg/broiler, is then

$$B = (DBM + XBM) / 1.8.$$

For other livestock (hogs and cattle), production is assumed to meet domestic demand, and the number of animals (A) is calculated from the animal meat (AM) requirement, average carcass weight (CW), and ratio of meat to carcass (MCR), according to:

$$A = AM / (CW \cdot MCR),$$

assuming carcass weights of 110 and 330 kg, and meat-to-carcass ratios of 0.7 and 0.45 for hogs and cattle, respectively.

Feed Demand

Demand for layer feed is assumed to amount to 120 g/day/bird, of which 81 percent is energy (carbohy-

drate) feed and the remaining 19 percent is protein meal. Total demand for layer feed (LF), the layer feed energy component (LFE), and the layer feed protein component (LFP) are then

$$LF = L \cdot 120 \text{ g/day/bird} \cdot 365 \text{ days/yr} = L \cdot 43.8 \text{ kg/bird},$$

$$LFE = LF \cdot 0.81, \text{ and}$$

$$LFP = LF \cdot 0.19.$$

For broilers and hogs, the feed requirement is calculated by multiplying the number of animals times average carcass weight times the feed conversion ratio, using a feed conversion ratio of 2.0 for broilers and 3.5 for hogs. The ratio of energy grain to protein meal feed is taken to be 0.7:0.3 for broilers and 0.8:0.2 for hogs.

Feed for miscellaneous purposes, including dairy, pets, and aquaculture, is assumed to use 10 percent of the amounts designated for poultry and hogs.

Grain Production

Crop area harvested is assumed to remain constant for rice and sorghum, grow 1 percent per year for corn, and 5 percent per year for soybeans. Yields are expected to increase 1 percent per year for rice and corn, and 2 percent per year for sorghum and soybeans. The milling rate for rice is assumed to be 0.66.

$$\text{Area}_t = \text{Area}_{t-1} \cdot \text{area annual growth rate},$$

$$\text{Yield}_t = \text{Yield}_{t-1} \cdot \text{yield annual growth rate},$$

$$\text{Production} = \text{Area} \cdot \text{Yield}.$$

Food Grain Consumption

Human per capita rice consumption (rc) is forecast to decline 1 percent per year,

$$rc_t = rc_{t-1} \cdot 0.99,$$

following the trend of recent years. Total human rice consumption is determined by declining per capita consumption and increasing population,

$$RC_t = rc_t \cdot P_t.$$

Nonfeed use of corn is assumed to take 2.5 percent of production, in line with recent years.

Feed Consumption

Feed grain use is assumed to be met half by corn and half by rice products. Feed use of rice includes rice bran and broken rice (both milling byproducts). Rice bran constitutes 11 percent of paddy production, and 75 percent of bran is assumed to be used for feed. Sufficient broken rice is added to the rice bran to make up rice's 50-percent share of energy feed rations. Food use of soybeans is calculated by a linear projection of the last 10 years, with the remainder of production crushed (crushing rate of 79.5 percent) and added to

an assumed constant (at 230,000 tons) supply of fish-meal to get total protein meal supplies. Additional oilseed meal is imported to fill the deficit.

Export Availability

Grain export availability and oilseed meal import requirements are calculated by subtracting food and feed needs from production totals. Since stocks do not otherwise explicitly enter the model, figures for export availability include amounts available for net stock changes.

Table 14—Estimates of income elasticities of demand in Thailand

Item	Current study	TDRI (1985)		Mann (1982)	Garnjana-Goonchorn (1971)	Trairatvorakul (1981)
		Urban	Rural			
Rice				-0.024 ¹		0.125 ²
Meat				.498	0.825	.437
Poultry	1.0		0.512			
Chicken		0.994	.431			.584
Duck		.609	1.341		.332	.408
Pork	1.3	1.101			.270	
Beef	.5			2.413	.142	.422
Fish						.303
Freshwater						
Marine				.720 ³		
Dairy products					.258	
Eggs	.5					.480
Hen						.450
Duck					1.907	
Milk				.313		
Oils and fats				.718	.618	
Fruits and vegetables				1.238 ⁴		
Sugar				.424		
Coffee, tea, cocoa, etc.				.370	.519	
Other food				.101		
Beverages					.390	
All food				1.605		
Nonfood						

¹Rice and cereals.

²White rice.

³Milk, cheese, and eggs.

⁴Sugar, preserves, and confectionery.

Growth To Continue in Livestock and Feed Demand

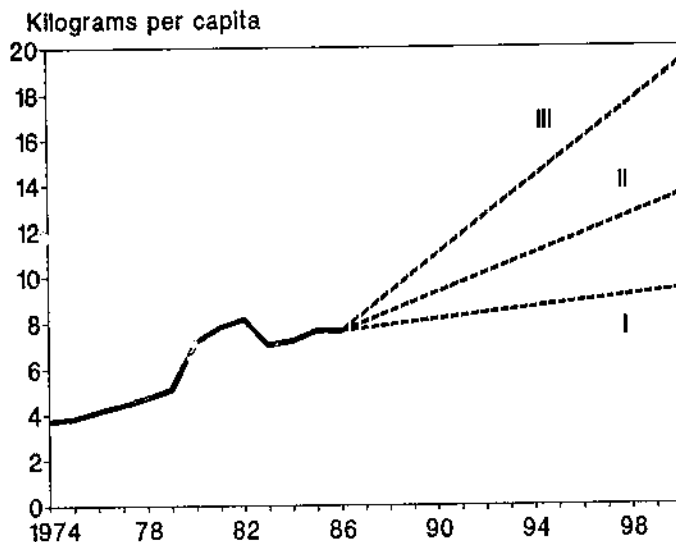
Demand for meat in Thailand is projected under the base scenario to continue growing at 6 percent per year, doubling to 2.5 million tons by 2000. Total feed demand could reach 11 million tons.

The base scenario, scenario II, estimates show per capita meat consumption rising 4 percent per year from the 1985 base to 39 kg by the year 2000, with the greatest increase resulting from higher levels of pork consumption. Total domestic meat consumption increases 6 percent per year, more than doubling to over 2.5 million tons. Increased meat demand could be met by increased domestic livestock production (table 15). The projections assume that barriers to hog slaughter and marketing are removed, although the case of a stagnant hog sector is discussed later.

Total feed demand could reach 11 million tons by the year 2000 under the base scenario assumptions. The

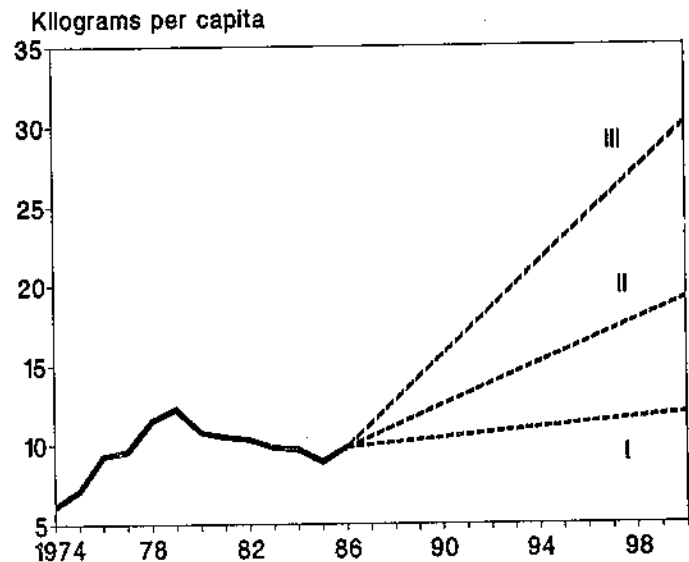
demand for energy (carbohydrate) grain will continue to be met by domestic supplies. However, some of the expansion in protein meal will have to come from oil-seed imports, even if the Government continues to protect soybean producers with import restrictions and subsidized inputs. Projections for production of feedstuffs are made by applying annual growth rates to yield and area harvested, beginning with a 1984/85-1986/87 average base period. More recent data were not used in the projections since the 1987/88 crop year in Thailand was affected by severe drought conditions, and the high 1988/89 prices and increased production in Thailand were heavily influenced by the North American drought.

Figure 21
Poultry consumption projections, Thailand



See appendix table 13.
Sources: 1974-86 derived from Chesley, USDA, and private industry estimates.

Figure 22
Pork consumption projections, Thailand



See appendix table 13.
Source: 1974-86 derived from Agricultural Statistics of Thailand.

Table 15—Livestock and feed use projections for the year 2000¹

Item	1985	2000	Energy feed	Protein meal ²	Total feed requirement
	----- Million head-----		----- 1,000 tons-----		
Scenario I (1.5% growth)					
Broilers	273	493	1,242	532	1,775
Layers	17	21	753	177	930
Hogs	7	10	3,128	782	3,910
Miscellaneous ³	—	—	512	149	662
Total	—	—	5,635	1,640	7,277
Scenario II (4% growth)					
Broilers	273	680	1,713	734	2,447
Layers	17	26	906	213	1,119
Hogs	7	16	5,008	1,252	6,260
Miscellaneous	—	—	763	220	983
Total	—	—	8,390	2,419	10,809
Scenario III (6.5% growth)					
Broilers	273	941	2,372	1,017	3,388
Layers	17	31	1,088	255	1,343
Hogs	7	26	7,905	1,976	9,881
Miscellaneous	—	—	1,137	325	1,461
Total	—	—	12,502	3,573	16,073

— = Not applicable.

¹Feed requirements are calculated as follows:

Broilers - 2.0 (feed conversion ratio) * 1.8 kg (body weight)

Layers - 120 g/day/bird

Hogs - 3.5 (feed conversion ratio) * 110 kg (body weight).

²Industry and USDA estimates of balanced feed ration proportions.

³Miscellaneous includes feed use by dairy cattle, pets, and aquaculture, and is assumed equal to 10 percent of poultry and hog feed demand.

Poultry and Egg Production Will Grow To Meet Demand

Broiler production, already highly commercialized, is projected to double by the turn of the century under the base scenario, with exports, mostly to Japan, taking nearly 20 percent of the total.

The base scenario, scenario II, indicates that poultry production may have to rise 6 percent per year from the base to 505 million broilers and culled layers just to meet domestic demand. This assumes an average broiler carcass weight of 1.8 kg and a ratio of bone-in to carcass weight of 0.8. It also assumes the average layer lives 2 years, weighs 2 kilograms, and is 60-percent meat.

Broiler meat exports are also expected to increase. More than 90 percent of Thailand's poultry meat exports go to Japan. Japan may increase poultry meat imports from all sources to 300,000 tons (carcass weight) by 2000, up from 195,000 in 1987. Assuming that nearly all (90 percent) poultry meat exports continue to go to Japan and that Thailand increases its market share slightly to 40 percent, broiler meat exports may reach 133,000 tons, carcass weight. This implies that 74 million broilers would be produced for export, which may be a conservative estimate. Some analysts have suggested that the Thai market share in Japan could grow to 70 percent.

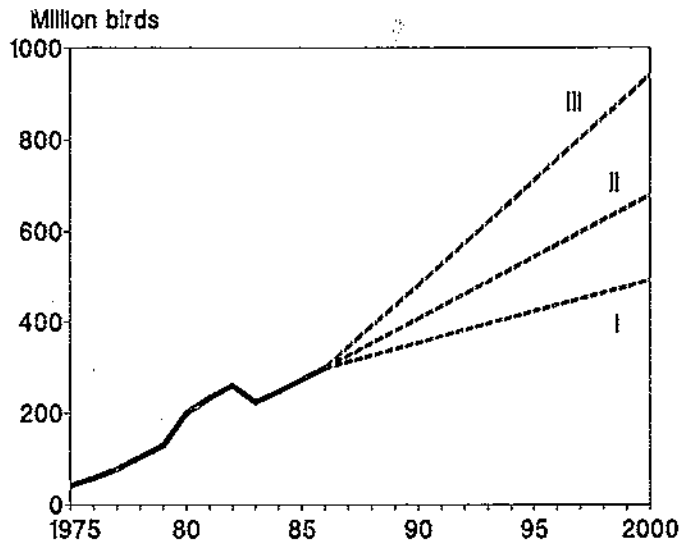
In 1985, Thailand's broiler industry was producing less than capacity. According to private industry sources, production could have been increased 20 percent to 6 million chickens per week within 2 months if prices had increased. Over the next 11 years, Thai growers should be able to expand their operations to meet the

growing demand of domestic and export markets. Thailand has been trying to penetrate export markets outside Japan, particularly in other ASEAN countries, the Middle East, and Western Europe. While there has been some success, given increasing self-sufficiency in most of these markets, the vast majority of Thailand's broiler exports will probably continue to be limited to Japan.

Since Thailand's broiler operations have already reached Western standards, it is assumed here that no technological change will create variations in feed mix, although new technology or Government policy changes regarding soybean meal imports and crushing may lead to lower cost production.

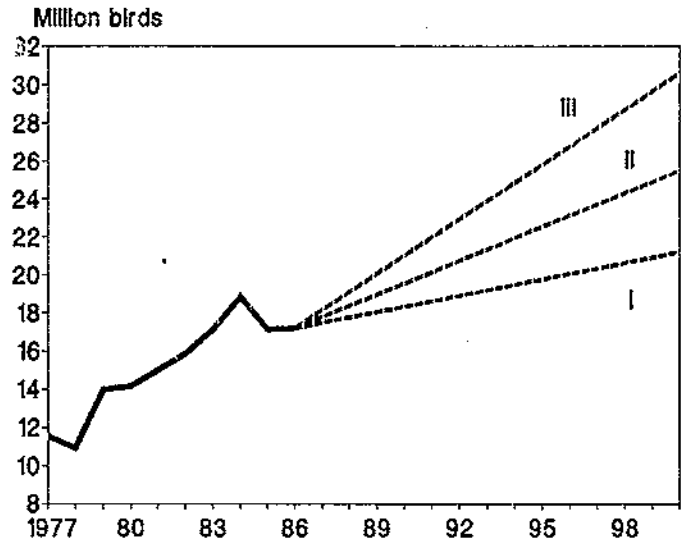
Egg production would have to increase 3 percent per year to 585 million dozen to meet projected demand, assuming 4-percent annual per capita income growth. It is likely that egg production will become almost completely commercialized by 2000, creating increased demand for both protein and energy feed for layers. Sales of both duck and chicken layer feed have been increasing since the early 1980's. The supply of layers necessary to fill the egg demand is derived by assuming that all layers will be fed commercially produced mixed feed by 2000 and will produce eggs at the commercial rate of 275 eggs per bird.

Figure 23
Broiler slaughter projections, Thailand



Sources: 1975-86 derived from Chesley, USDA, and private industry estimates.

Figure 24
Layer inventory projections, Thailand



Sources: 1977-86 derived from Chesley, USDA, and private industry estimates.

Hog Sector To Modernize; Other Livestock Sectors Small but Growing

Demand for pork by the year 2000 could be nearly triple the 1985 level and could be supplied by a modernized domestic industry, provided that the Government's restrictive policies are relaxed. Total demand for beef is projected to grow at 4 percent per year and can probably be met from traditional production methods. Demand for dairy products is growing rapidly and will probably continue to require large imports.

Pork production is expected to be completely modernized by 2000. Demand for protein meal from this sector is expected to increase significantly from 1985 as traditional production is replaced by modern breeding and fattening operations. Modernization implies increased use of programming methods to determine the optimal feed mix based on the relative prices of rice, rice bran, corn, sorghum, and tapioca. It is impossible to predict the mix of energy feed ingredients. But, with the assumption of constant relative feed prices, it is likely that hog producers will continue to prefer broken rice and rice bran over corn in their rations.

Based on an annual per capita income growth rate of 4 percent, total consumption of pork could grow at an annual average rate of 7 percent to 1.3 million tons by 2000, almost triple the 1985 base. While we assume that policy changes do take place to allow this growth, these changes may not occur as rapidly as we expect. If, in fact, slaughter operations and the marketing system are not modernized to meet consumer and producer needs, annual hog production may be unable to expand much beyond the current 6-7 million head.

Per capita beef consumption is projected to rise 2 percent per year to 6.5 kg, totaling 427,000 tons. Most of the increase is expected to come from domestic cattle, buffalo, and culled dairy herds fed in the traditional way as described above. Little protein meal would be demanded by this sector, except for the small, but growing, dairy herds. Beef import growth has averaged 10.8 percent per year since 1979. However, even if we assume imports continue to grow at this rate, only 450 tons, less than 1 percent of total beef consumption, would be imported into Thailand by the year 2000.

Cattle and buffalo production is expected to be influenced more by the rate of farm mechanization than by the demand for beef. The Thai Government is continuing to improve dairy herds by importing thousands of dairy cows from the United States, New Zealand, and Australia. However, it is unlikely that the dairy industry will be able to reach domestic self-sufficiency.

There is a possibility that the Government could impose further dairy import restrictions. However, it would be very expensive for the Government to continue to subsidize a dairy industry large enough to meet the growing Thai demand for milk products. While dairy and aquaculture are growing fast, their shares of Thailand's total feed consumption are forecast to remain small (10 percent of poultry and hog demand) until the next century.

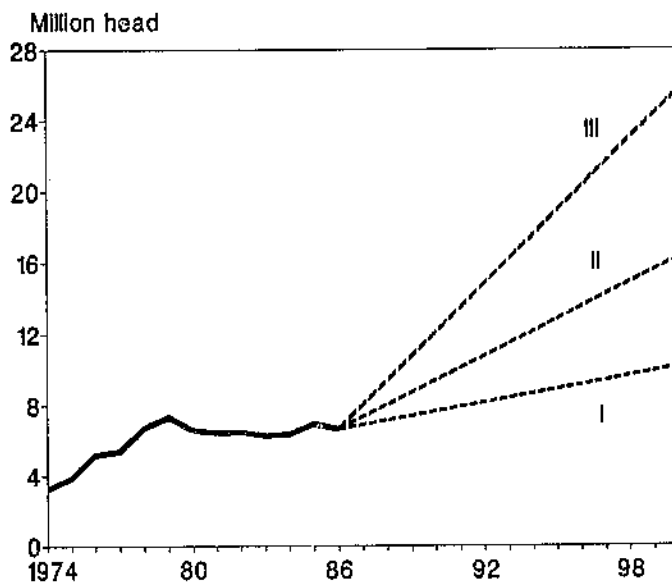
Livestock Consumption Projections Are Sensitive to Income Growth

Scenarios I and III provide an indication as to how sensitive the expansion of meat consumption may be to higher and lower income growth rates. The low-growth scenario (scenario I) still reveals strong total domestic meat consumption growth of 3 percent per year to 1.8 million tons and a per capita meat consumption increase of 2 percent per year to 27 kg. Scenario III projects stronger growth in per capita income. In this case, total domestic meat consumption rises 9 percent per year from 1.1 million tons to over 3.7 million tons and per capita meat consumption rises 7 percent per year to 57 kg, of which more than half is pork.

The rapid-growth scenario may not be sustainable, but the estimates serve as a possible upper range for Thailand, which hopes to enter the ranks of the newly industrialized countries, which include (in Asia) Hong Kong, Taiwan, South Korea, and Singapore. Per capita meat consumption was 94 kg (carcass weight) in Hong Kong and 57 kg in Taiwan in 1986. Taiwan's per capita income grew from nearly \$1,000 (in current dollars) per year in 1975 (close to Thailand's 1988 per capita GNP) to \$3,144 per year in 1985, an annual average growth of 13 percent. During that time, per capita meat consumption in Taiwan increased about 7 percent per year. It is reasonable to assume that per capita meat consumption would rise rapidly and that, therefore, Thais would be able to consume 57 kg of meat per capita once incomes begin to approach those of the newly industrialized countries.

Total poultry and pork production would have to increase by at least annual average rates of 3 percent and 4 percent respectively from the 1985 base just to meet the low-growth demand projected in scenario I. They would need to increase 10 and 8 percent respectively per year to meet the higher demand presented in scenario III. Domestic food demand is forecast to respond to variations in the livestock growth rate, and export availabilities will be conversely affected.

Figure 25
Hog slaughter projections, Thailand



Source: 1974-86 derived from Agricultural Statistics of Thailand.

Rice—Growth in Feed and Export Use

Thailand's grain production will continue to meet the demand of the domestic market, although oilseed or oilseed meal will need to be imported. Total production of rice is projected to grow at 1 percent per year through the year 2000, with a slight decline in per capita food use and increasing volume going to feed and export markets.

Rice's share of total feed has been declining. In the early 1970's, 90 percent of domestic feed grain consisted of rice (9). By 1985, rice products made up just over 60 percent of total feed grain use. This downward trend is expected to continue as demand for food and exports rises. However, we assume that rice and rice bran, because of their widespread availability, will still make up half of the domestic energy feed supply through 2000.

A rice baseline projection through 2000 has been developed using the following assumptions. Area is forecast to remain stable at the average harvested between 1984/85 and 1986/87. While rice area has been growing steadily in recent years, continued expansion is unlikely without substantial new investment in irrigation facilities. Yields are forecast to increase by 1 percent per year, in contrast to the 2-percent annual average growth in yields achieved between 1980 and 1985. Rice production is expected to increase 1 percent per year to nearly 14.9 million tons milled by 2000, 13 percent above the average produced between 1984/85 and 1986/87. Per capita human rice consumption is assumed to decline by 1 percent per year, in line with recent trends. With population increasing 1.6 percent per year through 2000, domestic food use would rise 8.5 percent to 6.6 million tons.

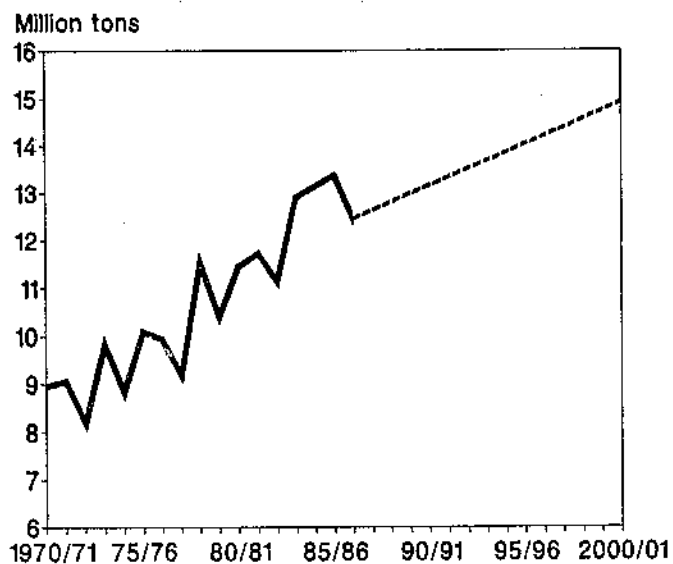
Rice for feed consists of rice bran and broken rice, products of the milling process. We assumed that 11 percent of the rough rice is converted to bran and 75 percent of the bran available is used for feed. We also assumed that some of the paddy will be converted into feed-quality broken rice in the milling process. With rough rice production forecast at 22.6 million tons by 2000, the implied bran production would reach 2.49

million tons, of which 1.86 million tons would be available for feed. Feed-quality broken rice is assumed to also contribute to 50 percent of the energy demanded in 2000, and with a 4-percent per capita income growth rate, the implied feed demand for rice products could grow 3 percent per year, reaching 4.2 million tons.

With 1.86 million tons of rice bran used for feed, the implied demand for 2.33 million tons of broken rice would require a higher than traditional level of paddy converted to broken rice for feed. Greater use of broken rice for feed purposes could change the composition of Thailand's rice exports to more of the higher quality shipments, possibly raising world prices for lower quality (such as 25-percent broken) sales. Thailand's feed industry might alternatively use an even greater amount of corn than forecast here, or increase use of alternative feeds, such as sorghum and cassava as has been done when the rice to corn price ratio has been unfavorable.

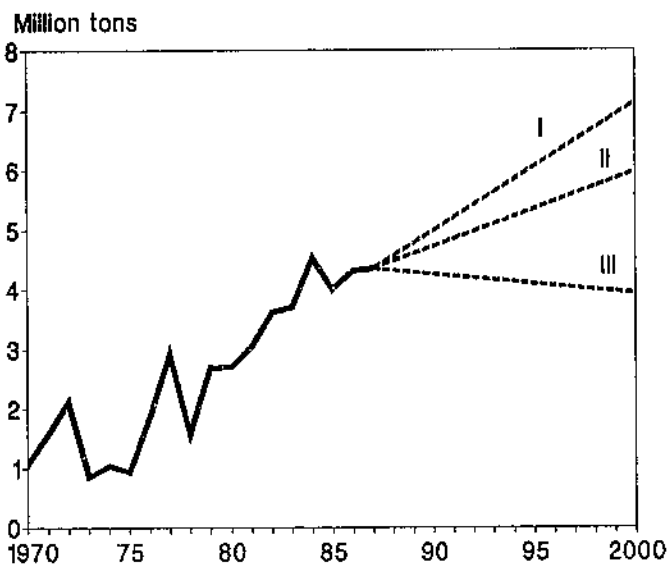
Thailand remains a major rice exporter under all scenarios considered. With domestic food use forecast at 6.6 million tons (milled) under all scenarios, exports are still forecast to increase 2 percent per year, reaching 6 million tons by 2000 in scenario II. Export supply estimates range from 4 million tons (high feed demand growth scenario) to 7.4 million tons (low feed demand growth scenario). In the low demand growth and large export supply scenario, insufficient world demand for rice could depress rice prices, slowing growth in production. Increased demand for rice products for feed may alternatively cause rice feed prices to rise. Livestock producers would then be likely to switch to alternative feeds such as corn, placing even more pressure on corn prices. This could result in further increases in corn production or reduced corn export availability.

Figure 26
Rice production projections, Thailand



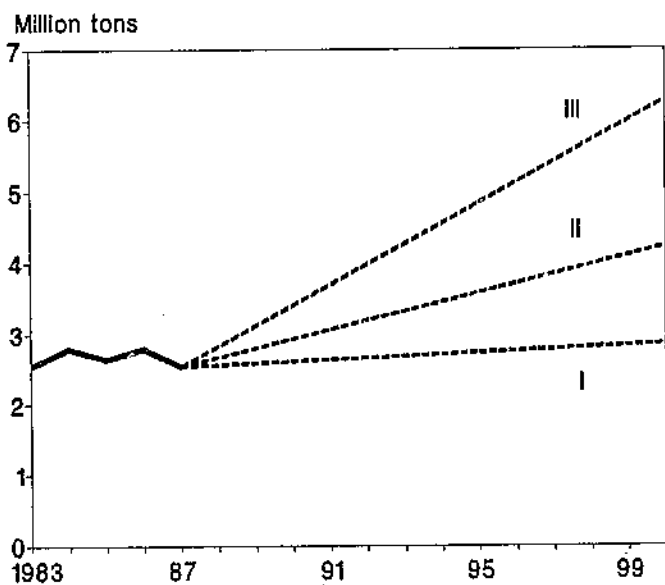
Source: 1970/71-86/87, USDA.

Figure 27
Rice export projections, Thailand



Source: 1970-87, USDA.

Figure 28
Rice feed projections, Thailand



Source: 1983-87, ERS.

Coarse Grains—Domestic Feed Use To Expand, Cutting Exports

Corn production is projected to grow 2 percent per year, but domestic use will expand more rapidly, so exports may decline. Sorghum production, most of which is exported, may increase by 2 percent per year. Prospects for cassava are more uncertain: with very low prices, cassava could become an important feed component, but low prices may also induce producers to switch to other crops.

Increased pork and poultry production will place strong demand on domestic coarse grain supplies. Thailand's capacity to supply its export markets will depend to a large extent on coarse grain producers' ability to increase yields. The technology to increase yields (such as seeds of high-yielding varieties and fertilizer) is available, but price incentives to encourage adoption generally are not. With the assumption of a declining world export price for corn and ample world supplies, there is little to suggest that, given normal weather, the farm price for corn will rise to a high enough level in the long run to overcome farmers' reluctance to invest significantly in the inputs needed to improve yields. Yields are therefore forecast to increase by only 1 percent per year.

Corn area expansion would be largely at the expense of cotton or other field crops. Unless the relative price of corn to other field crops improves, significant expansion in corn area cannot be expected, in contrast to the late 1970's and early 1980's when area expanded at an average annual rate of 6 percent. However, since domestic feed demand is increasing and can be expected to be met from domestic supplies, we assume here that the corn area harvested will increase slightly. Corn area is expected to expand by 1 percent per year to the year 2000 as increased demand lifts domestic prices slightly upward. Corn production projections consequently reflect a slow-growth pattern, reaching 6.2 million tons.

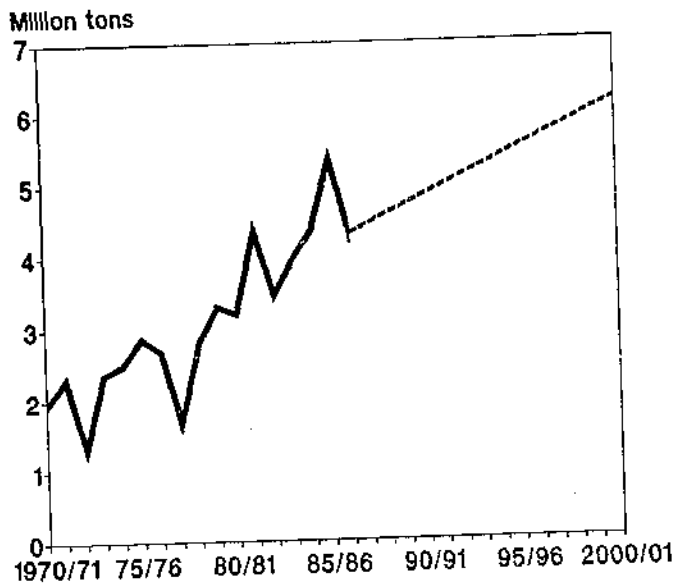
Corn is expected to comprise half of the domestic energy feed demand by 2000. Assuming livestock production derived from the 4-percent growth in per capita income and domestic food use of corn accounts for 2.5

percent of production, export availability would be reduced to only 1.8 million tons in the base scenario. This would represent an average annual decline of 4 percent in exports from the base period average of 3.3 million tons.

Sorghum area is expected to remain stable at 250,000 hectares, the average area harvested between 1984/85 and 1986/87, with yields increasing 2 percent per year as farmers gradually shift to high-yielding varieties. Sorghum will likely continue to be produced primarily for export with little input into domestic feed rations. Exports (assumed to take total production) may expand 4 percent per year, reaching 459,000 tons by 2000. Red sorghum is assumed to comprise the bulk of Thai production by 2000 with east Asia as the primary export market. Thailand is already beginning to make inroads into the Taiwanese, Japanese, and South Korean markets and will probably gain a solid foothold once sufficient quantities of red sorghum are produced and the quality becomes more dependable.

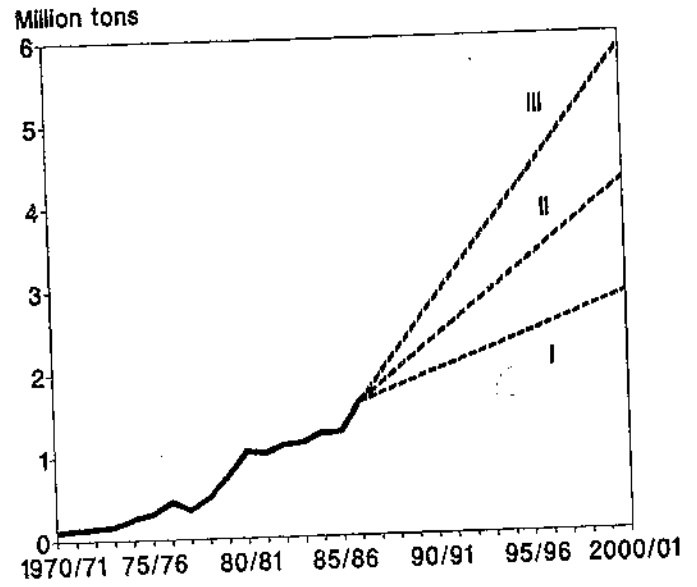
As mentioned earlier, cassava production has grown rapidly in response to EC demand. Removal of the EC policy granting preferential treatment to nongrain feeds could create a large surplus of cassava in Thailand. If cassava prices fall, tapioca pellets may become an important element in domestic feed rations, freeing additional corn and rice for export. In addition, corn could be planted on some of the land currently planted to cassava, thereby increasing corn supplies. Although low in protein, tapioca has entered domestic feed when its price is less than half that of corn. However, long-term prospects of low prices would encourage cassava growers to switch to alternative crops, where possible.

Figure 29
Corn production projections, Thailand



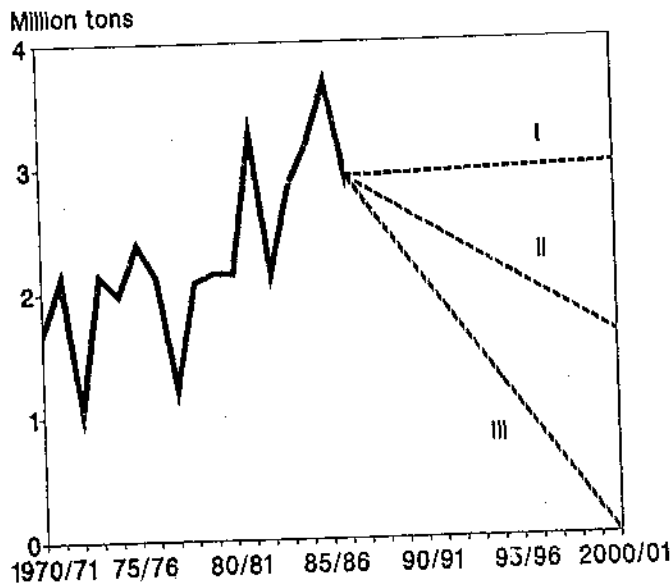
Source: 1970/71-86/87, USDA.

Figure 30
Corn consumption projections, Thailand



Source: 1970/71-86/87, USDA.

Figure 31
Corn export projections, Thailand



Source: 1970/71-86/87, USDA.

Corn Exports Will Depend on Domestic Demand, but Appear Headed Down

The projections show wide variation in levels of feed demand and export, depending on domestic income growth, domestic demand for livestock products, and hence, feed. The projections assume a loosening of restrictive policies in the livestock sector.

Scenarios I and III present a range of estimates for Thai feed use and export availability. The higher and lower estimates of grain export availability can be determined by applying the livestock production projections based on the slow and rapid per capita income growth rates portrayed in scenarios I and III. Total feed demand could range from 7.3 to 16.1 million metric tons per year. The rice feed demanded, based on the slow and rapid growth scenarios, ranges from 2.8 to 6.3 million tons. However, it is unlikely that so much rice will be diverted to feed use unless world rice prices fall dramatically.

Over 3 million tons of corn would be available for export under the slow-growth scenario, which inhibits the expansion of meat consumption and feed demand. The rapid-growth scenario indicates that Thailand could be short 243,000 tons of corn to meet domestic feed demand, but the shortfall could be met from sorghum or cassava production. This scenario is somewhat unlikely since such strong domestic demand would push up the farm price for corn enough to cause producers to expand area and increase yields through the use of high-yielding varieties and fertilizer. However, rapid income growth and a resulting sharp rise in consumer demand for meat does imply a sharp cut-back in corn export availabilities.

What Happens If Policy Changes Do Not Occur?

The estimates must be qualified by the assumption that barriers to hog slaughter and marketing are removed.

This assumption has important effects on the results. If the barriers are not removed, pork production could stagnate and total feed demand could be limited to 6.4 million tons even under the 4-percent per capita annual income growth scenario (table 17), an annual increase of only 2 percent. Similarly, a lower actual income elasticity of demand for pork would also result in slow growth in meat demand, pork production, and the derived demand for feed.

If pork production does not expand as forecast due to constraining slaughter and marketing regulations, demand for coarse grain would be weaker and 3.4 million tons of corn could be made available for export (table 18). Without the expansion in pork production, rice feed demanded might decline 2 percent per year, limiting use to 2.2 million tons, well within forecast rice feed availability. However, reduced domestic demand combined with projected production increases result in a glut of rice if export markets do not expand rapidly.

It should be emphasized that these projections are based on income growth and do not account for cross-price effects. If constraints to pork production remain, the domestic demand for poultry may increase more than predicted, and the growth in feed will be determined primarily by the growth in demand for poultry and for miscellaneous uses alone.

Table 16—Projected feed export availability in the year 2000

Feed	1984/85-86/87 average production	Projected production	Domestic food consumption	For feed use	Export availability ¹
<i>1,000 metric tons</i>					
Scenario I (1.5% growth)					
Rice ²	12,988	14,914	6,560	953	7,401
Rice bran	2,165	2,486	—	1,864	—
Corn	4,670	6,162	154	2,818	3,191
Sorghum	325	459	0	0	459
Protein meal ³	410	752	—	1,640	(888)
Scenario II (4% growth)					
Rice	12,988	14,914	6,560	2,331	6,023
Rice bran	2,165	2,486	—	1,864	—
Corn	4,670	6,162	154	4,195	1,813
Sorghum	325	459	0	0	459
Protein meal	410	752	—	2,419	(1,667)
Scenario III (6.5% growth)					
Rice	12,988	14,914	6,560	4,387	3,967
Rice bran	2,165	2,486	—	1,864	—
Corn	4,670	6,162	154	6,008	0
Sorghum	325	459	0	243	216
Protein meal	410	752	—	3,573	(2,821)

— = Not applicable.

¹Includes net change in domestic stocks.

²Milled rice.

³Includes soymeal and fishmeal.

Table 17—Livestock and feed use projections for the year 2000,¹ with no change in hog marketing policies

Item	1985	2000	Energy feed	Protein meal ²	Total feed requirement
	----- Million head-----		----- 1,000 tons-----		
Scenario I (1.5% growth)					
Broilers	273	493	1,242	532	1,775
Layers	17	21	753	177	930
Hogs	6	6	1,828	457	2,285
Miscellaneous ³	—	—	512	149	662
Total	—	—	4,335	1,315	5,652
Scenario II (4% growth)					
Broilers	273	680	1,713	734	2,447
Layers	17	26	906	213	1,119
Hogs	6	6	1,828	457	2,285
Miscellaneous	—	—	763	220	983
Total	—	—	5,210	1,624	6,834
Scenario III (6.5% growth)					
Broilers	273	941	2,372	1,017	3,388
Layers	17	31	1,088	255	1,343
Hogs	6	6	1,828	457	2,285
Miscellaneous	—	—	1,137	325	1,461
Total	—	—	6,425	2,054	8,477

— = Not applicable.

¹Feed requirements are calculated as follows:

Broilers - 2.0 (feed conversion ratio) * 1.8 kg (body weight)

Layers - 120 g/day/bird

Hogs - 3.5 (feed conversion ratio) * 110 kg (body weight).

²Industry and USDA estimates of balanced feed ration proportions.

³Miscellaneous includes feed use by dairy cattle, pets, and aquaculture, and is assumed equal to 10 percent of poultry and hog feed demand in liberalized marketing scenarios.

Table 18—Projected feed export availability in the year 2000, with no change in hog marketing policies

Feed	1984/85-86/87 average production	Projected production	Domestic food consumption	For feed use	Export availability
<i>1,000 metric tons</i>					
Scenario I (1.5% growth)					
Rice ²	12,988	14,914	6,560	303	8,051
Rice bran	2,165	2,486	—	1,864	—
Corn	4,670	6,162	154	2,168	3,841
Sorghum	325	459	0	0	459
Protein meal ³	410	752	—	1,315	(563)
Scenario II (4% growth)					
Rice	12,988	14,914	6,560	741	7,613
Rice bran	2,165	2,486	—	1,864	—
Corn	4,670	6,162	154	2,605	3,403
Sorghum	325	459	0	0	459
Protein meal	410	752	—	1,624	(872)
Scenario III (6.5% growth)					
Rice	12,988	14,914	6,560	1,348	7,006
Rice bran	2,165	2,486	—	1,864	—
Corn	4,670	6,162	154	3,213	2,796
Sorghum	325	459	0	0	459
Protein meal	410	752	—	2,054	(1,302)

— = Not applicable.

¹Includes net change in domestic stocks.

²Milled rice.

³Includes soymeal and fishmeal.

Soybeans and Meal—More Imports To Be Needed Despite Rapid Production Growth

Even with a projected growth in soybean production of 7 percent per year, demand for protein meal is expected to grow even faster: by 10 percent per year. The difference will have to be made up by imports of either soybeans or meal, which may mean that the Government will have to relax its import restrictions.

Although the Government is in the process of revising soybean and soybean meal import regulations, domestic producers will probably remain protected from low-priced imports. This study assumes that the Government will maintain a tariff system on soybeans and soybean meal high enough to support soybean farmers at the current level, and that the Government will continue to expand its distribution of seed, rhizobium, and fertilizer to farmers. Given low projected prices of rice and corn and strong Government encouragement, farmers in the northern provinces can be expected to substitute soybeans for some corn or dry-season rice.

We assumed that total soybean area will expand 5 percent per year and yields will increase 2 percent per year, a modest rise compared with the 7-percent average annual increase in yields achieved between 1984 and 1987 on a smaller beginning base. Production would then rise 7 percent per year, reaching 792,000 tons by 2000. A linear projection of domestic food use of soybeans indicates that 136,000 tons will be used for human consumption. The remaining production, when crushed, would produce 522,000 tons of meal (assuming a crushing rate of 79.5 percent).

Potential demand for protein meal is projected to increase 10 percent per year in the base scenario, reaching 2.4 million tons by 2000, or 1.9 million tons above forecast domestic soybean meal production. The forecast production is only for soybean meal and the feed demand is for total protein meals, because it is unlikely that production of fishmeal or other protein meals will expand significantly. Given that fishmeal production is assumed to remain at its 1987 level of 230,000 tons, more than a million tons of protein meal would need to be imported. Soybean meal is expected to be the meal import of choice for feed producers, although imports of peanut meal, sunflowerseed meal, rapeseed meal, and other protein sources may increase as well.

All growth scenarios require additional protein meal to meet the demand of a growing, commercialized live-

stock sector. Even the slow-growth scenario implies a need for 888,000 tons of additional meal, an annual increase of 9 percent in protein meal imports and over three times the level of current imports. Rapid growth could require over 2.8 million tons by 2000, an 18-percent annual increase in protein meal imports.

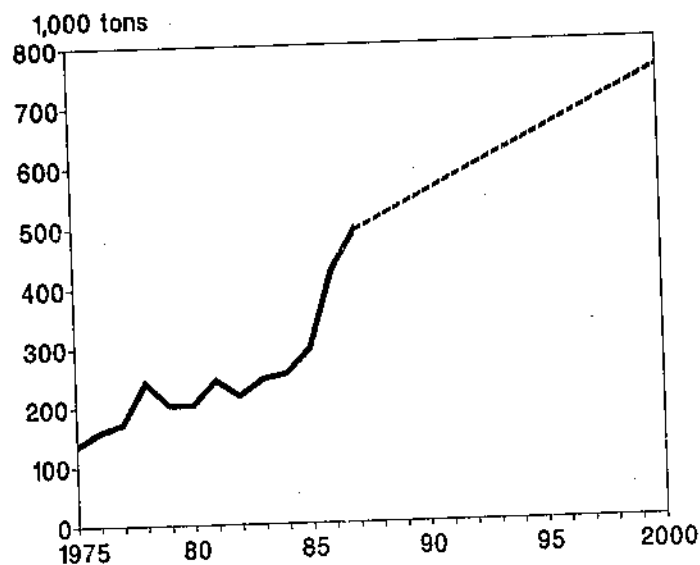
Total protein meal demand might be much less, 1.6 million tons, if the hog market situation continues to be regulated and production stagnates at the current level. However, the livestock industry, even under scenario 1, would still demand 1.3 million tons of protein meal, well above projected production. The rapid growth scenario would require 2.1 million tons.

It is difficult to forecast whether, given strong demand from the livestock sector, Thailand will continue to ban soybean imports. An alternative to importing meal would be to import beans and expand the domestic crushing industry. This alternative will be largely influenced by competing oil producers and domestic oil demand, especially from the tuna packing industry, which requires large quantities of soy oil. Soy oil currently accounts for 20 percent of domestic vegetable oil use. A linear projection of per capita consumption of all oil shows a slight vegetable oil deficit by 2000 and soy oil is assumed to continue to comprise only 20 percent of the total. Crushing the domestic beans for feed would produce 118,000 tons of soy oil, 56 percent above the projected soy oil demand. Unlike South Korea and Taiwan, which currently import an average of about 1 million and 1.8 million tons, respectively, of soybeans (1984/85 to 1987/88), Thailand could import soybean meal and avoid the risk of surplus soy oil supplies. However, in other east Asian countries, rapid economic growth has been accompanied by a sharp increase in vegetable oil demand. If this occurs in Thailand, vegetable oil demand could rise more rapidly than projected. The domestic oil industry may then expand, and beans, rather than meal, could be imported.

Thailand has the potential to become a major market for oilseeds or oilseed meal despite a rapid rise in domestic soybean production and policies developed to increase self-sufficiency. Thailand currently imports soybean meal from Argentina, India, and

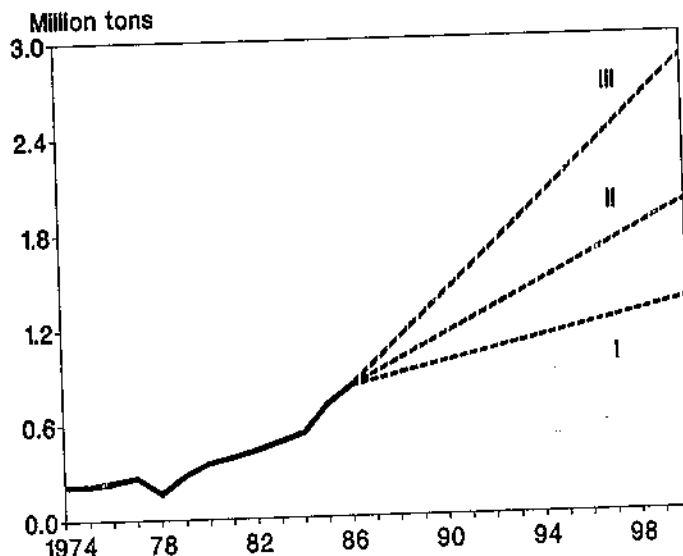
China. The rapid increase in Thailand's demand would probably allow U.S. firms to expand soybean exports, at least in other markets currently served by future suppliers of the Thai market, if not to Thailand itself.

Figure 32
Protein meal production projections, Thailand 1/



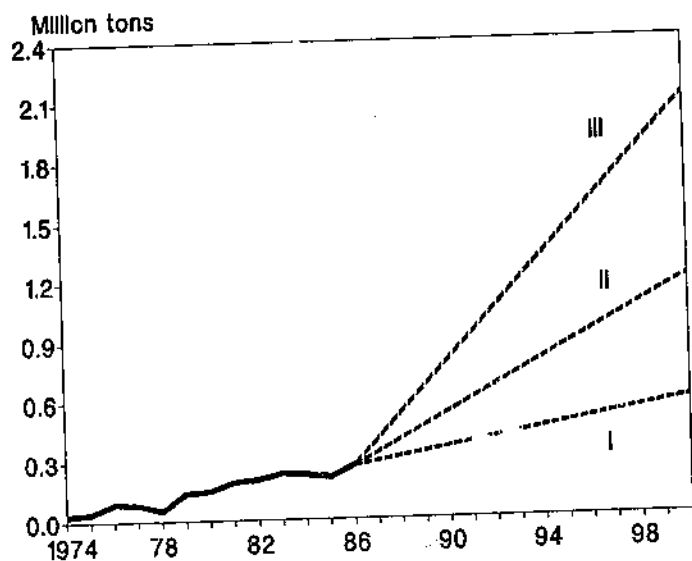
1/ Includes fishmeal and soybean meal.
Source: 1975-86, USDA.

Figure 33
Protein meal consumption projections, Thailand 1/



1/ Soybean equivalent.
Source: 1974-86, USDA.

Figure 34
Protein meal import projections, Thailand



See appendix table 8.
Source: 1974-86, USDA.

Conclusions

Thailand's Coarse Grain Export Market Share To Contract, and Oilseed or Meal Imports To Expand, Creating Opportunities for U.S. Exports

Thailand's strong growth will consume more of the country's coarse grain production for domestic consumption, dampening its exports, and opening up possibilities for the United States to supply some of the export markets previously served by Thailand. Thailand's oilseed or oilseed meal imports will likely expand, creating additional export opportunities for the United States. However, Thailand will continue to be a strong force in the Japanese market for poultry meat.

Thailand's economy can be expected to expand at a rapid pace over the next 10-15 years as it progresses to become one of the newly industrialized economies of east Asia. A stable government has engineered policies to encourage diversification in industry, agriculture, and foreign investment. As a result, Thai incomes are rising and consumer demand is increasing.

The Thai diet is also changing. As incomes rise, people are eating more meat and less rice. Japanese import demand for poultry meat led to the rapid development of a modern, vertically integrated poultry production and processing sector in Thailand. The resulting decline in costs of production and improved marketing led to a rise in domestic consumption as well as exports.

The hog sector has also begun to modernize, although as much as 20 percent of hogs are still raised in traditional backyard operations. Despite improved production processes, domestic pork consumption has been hampered by Government regulations that inhibit efficient meat processing and marketing. The Government is attempting to dismantle these regulations both to improve domestic marketing and to encourage exports. Disease problems so far block Thailand's entrance into Asia's pork export market. However, increased domestic demand alone could lead to large-scale expansion of the hog sector.

To date, the feed demand of Thailand's growing livestock sector has only begun to curtail coarse grain export availability. Future growth may have important effects on Thailand's ability to expand coarse grain exports. If increased demand for feed exceeds growth in grain production, exportable supplies could be cut substantially. While there may be a tradeoff between exports of grain and exports of finished livestock products, the Thai Government can be expected to continue encouraging exports of products with greater value-added components.

Thailand has the capability to increase yields and area planted to corn and sorghum. So far, the price incentives have not been enough to convince farmers to invest in high-yielding hybrid seed or the necessary fertilizer to increase yields, or to substitute corn and sorghum for other field crops.

Rising domestic feed demand may cause domestic prices to rise as exporters compete with feed manufacturers for supplies. However, Thailand is a price-taker in the world coarse grain export market. If world coarse grain supplies remain ample and world prices low, Thailand's market share can be expected to decline as domestic consumption increases at the expense of exports.

This study assumes that corn prices will remain low enough to limit the willingness of farmers to substantially increase cash outlays for inputs. Under this assumption, corn exports will decline more than 45 percent from the 1984/85-1986/87 average to 1.8 million tons. A further decline should be anticipated if annual per capita income growth continues to rise at a faster rate than 4 percent and the demand for poultry and pork increases commensurately. On the other hand, higher domestic feed prices could inhibit livestock growth and, at the same time, encourage coarse grain production, allowing Thailand to maintain exports at a higher level than projected here.

Substantial rice exports will continue, even with increased feed demand. Although rice for feed makes up 60 percent of feed grain consumed in Thailand, that ratio is falling. If rice feed prices rise in response to reduced supplies, livestock producers will shift to coarse grains as they did in 1988, after drought reduced the 1987/88 rice crop. It is unlikely that rice will be diverted from domestic food use or exports to the livestock sector. At 4-percent growth in annual per capita income, projected rice supplies should be sufficient to meet projected feed demand without hindering an 8.5-percent growth in domestic food consumption.

and a possible expansion in rice exports of 43 percent from the base year to 6 million tons by 2000.

Cassava has not played a significant role in domestic feed so far. However, its importance could increase quickly, at least in the short term, if the lucrative EC market dries up or grain prices rise substantially. In the longer run, some land currently planted to cassava could be diverted to corn or sorghum production.

Protein meal will continue to remain in short supply despite a projected fourfold increase in production by 2000. This implies that Thailand will need to supplement domestic meal by almost 1.7 million tons. Increased imports of soybean meal or revisions in soybean import restrictions to allow soybean imports may follow. Increased soybean imports will result in an expansion of domestic crushing, and displacement of other oils for domestically produced soy oil or re-export of soy oil if domestic meal prices are sufficiently high.

Serious data problems limit our ability to accurately predict changes in Thai agriculture. The projections in this study are meant to indicate the probable effects of economic growth in Thailand on the feed and livestock industry. Substantial growth or changes in dairy, duck, or aquaculture production could affect the results, as could technological developments, problems of disease or contamination, and changes in world markets. Even so, growth and modernization of feed and livestock production and marketing can be expected to increase both domestic and export meat availability, increase the demand for imported protein meals, and constrain coarse grain exports.

While Thailand has competed successfully with the United States in world coarse grain markets, it is unlikely that its market share will expand in the next 10-15 years. A market share decline is more likely. Domestic demand for meat will encourage growth in the poultry and hog sectors and place increasing demands on domestic coarse grain supplies. Strong poultry exports to Japan would also put pressure on feed demand. Even the slow economic growth scenario implies a drop in corn export availability by the year 2000.

As a result, the United States may be able to expand its own coarse grain exports into the Southeast Asian markets currently dominated by Thailand, as well as smaller markets in the Mideast and Africa. Additional opportunities exist for the United States to export soybean meal to Thailand as the country enters the ranks of major livestock producers in Asia. However, the United States can expect continued competition from Thailand for world rice and poultry meat markets.

Conclusions

- Thai incomes and consumer demand are rising. Result: Thais will eat more meat, less rice.
- Thailand's livestock sector will expand, creating additional demand for feed. But further expansion and modernization of pork industry may be blocked unless Government strictures are loosened.
- With more feed, especially corn, going to domestic livestock production, less will be available for export. Furthermore, Thailand already imports substantial amounts of protein meal and will probably need more.
- The role of cassava in domestic feed rations remains uncertain. Use depends on price and price depends on the EC's import demand. If the EC reduces imports, the cassava price would fall, which might cause producers to raise other crops instead of cassava.
- Likely outcomes by year 2000:
 - Decline in Thailand's corn exports, creating opportunities for U.S. corn exports to Southeast Asia, Africa, and Mideast.
 - Increase in oilseed or oilseed meal imports.
 - Continued strength in Thailand's exports of rice and poultry meat.

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Appendix: Data Issues

Accurate food consumption data are difficult to obtain. The Thai Government collects monthly food price data from retail establishments. Every few years, the Government also conducts cross-sectional Household Expenditure Surveys (the latest survey was conducted in 1980). Researchers have had to develop several methods to calculate aggregate consumption for specific commodities. One method is to divide the expenditures for individual products by their average retail prices. Mann and the Thai Development Research Institute used this method to estimate cross-section elasticities for food products (18, 32). Since, however, expenditure surveys are not taken regularly, it is impossible to conduct time series analysis. Moreover, the survey data are less timely and not always available. Therefore, we derived a meat consumption time series using the identity:

$$\text{Consumption} = \text{Production} + \text{Imports} - \text{Exports.}$$

Here, domestic consumption includes changes in stocks.

A time series of meat production and consumption is especially difficult to derive because data are difficult to obtain for production, slaughter, and consumption of animals that do not enter the commercial sector. The poultry and hog sectors became commercialized only within the last decade. Cattle and buffalo are still raised mostly for draft and usually slaughtered when they become too old to work. Data collection is also hampered by the prevalence of illegal slaughter of cattle and hogs. Tight restrictions on slaughterhouse ownership and high taxes on each animal slaughtered have led to widespread black market activity. Most researchers analyzing the livestock sector assume that 50 percent of hogs and 75 percent of the cattle slaughtered in Thailand are slaughtered illegally, but estimates vary widely.

The Government maintains statistics on the number of animals legally slaughtered. For this study, it is assumed that Government statistics report 50 percent of hogs slaughtered and only 25 percent of the cattle slaughtered. Poultry production data have been provided by private industry.

Appendix table 1—Supply and distribution of rice in Thailand, 1960/61-1989/90

Crop year ¹	Area harvested	Yield	Production (milled)	Beginning stocks	Total exports ²	Total consumption
	1,000 ha	MT/ha	----- 1,000 metric tons -----			
1960/61	5,643	1.11	6,275	594	1,576	4,699
1961/62	6,179	1.05	6,525	594	1,271	5,254
1962/63	6,191	1.17	7,255	594	1,418	5,837
1963/64	6,354	1.20	7,646	594	1,896	5,750
1964/65	5,971	1.25	7,499	594	1,895	5,604
1965/66	5,960	1.21	7,245	594	1,508	5,737
1966/67	7,000	1.12	7,885	594	1,483	6,336
1967/68	5,807	1.09	6,353	660	1,068	4,942
1968/69	6,336	1.08	6,890	1,003	1,023	5,173
1969/70	7,259	1.21	8,851	1,697	1,064	7,963
1970/71	6,854	1.30	8,956	1,521	1,576	7,669
1971/72	7,095	1.27	9,071	1,232	2,112	7,013
1972/73	6,780	1.20	8,192	1,178	849	7,802
1973/74	7,680	1.28	9,834	719	1,046	8,228
1974/75	7,512	1.17	8,835	1,279	933	7,425
1975/76	8,357	1.20	10,098	1,756	1,870	8,266
1976/77	8,167	1.21	9,944	1,718	2,915	7,616
1977/78	8,750	1.05	9,188	1,131	1,573	7,518
1978/79	8,935	1.29	11,530	1,228	2,696	8,131
1979/80	8,654	1.20	10,400	1,931	2,700	8,110
1980/81	9,200	1.25	11,463	1,521	3,049	7,955
1981/82	9,105	1.29	11,732	1,980	3,620	8,082
1982/83	8,940	1.25	11,139	2,010	3,700	8,112
1983/84	9,606	1.34	12,902	1,337	4,528	8,273
1984/85	9,629	1.36	13,137	1,438	3,993	8,495
1985/86	9,833	1.36	13,374	2,087	4,321	8,637
1986/87	9,659	1.29	12,453	2,503	4,355	8,330
1987/88	9,237	1.29	11,908	2,271	4,300	8,100
1988/89(e)	10,000	1.35	13,530	970	6,000	8,387
1989/90(f)	10,300	1.38	14,190	443	5,000	8,833

(e) estimate.

(f) forecast.

¹Jan./Dec. marketing year.

²Exports take place Jan.-Dec. of the second year.

Source: USDA. Data are current as of Sept. 1989.

Appendix table 2—Supply and distribution of corn in Thailand, 1960/61-1989/90

Crop year ¹	Area harvested	Yield	Production	Total exports	Total consumption	For feed use
	1,000 ha	MT/ha	----- 1,000 metric tons -----			
1960/61	285	1.90	544	519	10	2
1961/62	298	2.00	598	589	15	4
1962/63	321	2.07	665	722	15	4
1963/64	388	2.21	858	923	20	6
1964/65	541	1.72	935	896	25	10
1965/66	562	1.81	1,021	1,132	29	10
1966/67	590	1.90	1,122	1,180	35	15
1967/68	598	2.19	1,315	1,214	55	25
1968/69	606	2.48	1,507	1,289	104	45
1969/70	680	2.50	1,700	1,502	176	85
1970/71	829	2.33	1,938	1,663	220	105
1971/72	1,019	2.25	2,300	2,111	280	135
1972/73	997	1.31	1,315	1,039	295	140
1973/74	1,044	2.25	2,350	2,131	341	160
1974/75	1,240	2.01	2,500	1,979	500	250
1975/76	1,312	2.18	2,863	2,386	369	306
1976/77	1,285	2.08	2,675	2,116	653	450
1977/78	1,205	1.39	1,677	1,217	477	350
1978/79	1,386	2.01	2,791	2,078	691	500
1979/80	1,424	2.31	3,300	2,150	1,050	750
1980/81	1,450	2.21	3,200	2,142	1,108	1,044
1981/82	1,750	2.49	4,350	3,260	1,050	1,010
1982/83	1,850	1.86	3,450	2,136	1,160	1,115
1983/84	1,825	2.16	3,950	2,846	1,174	1,132
1984/85	1,955	2.23	4,350	3,180	1,290	1,245
1985/86	2,266	2.36	5,350	3,674	1,270	1,250
1986/87	1,815	2.37	4,309	2,916	1,630	1,600
1987/88	1,754	1.56	2,736	802	2,000	1,900
1988/89(e)	1,600	2.63	4,200	1,560	2,650	2,600
1989/90(f)	1,400	2.71	3,800	700	3,050	3,000

(e) estimate.

(f) forecast.

¹July/June marketing year.

Source: USDA. Data are current as of Sept. 1989.

Appendix table 3—Supply and distribution of sorghum in Thailand, 1963/64-1989/90

Crop year ¹	Area harvested	Yield	Production	Beginning stocks	Total exports	Total consumption	For feed use
	1,000 ha	MT/ha	-----1,000 metric tons-----				
1963/64	4	2.00	8	0	0	5	4
1964/65	9	2.22	20	3	13	1	0
1965/66	29	2.51	73	9	54	2	1
1966/67	56	2.03	114	26	103	4	3
1967/68	43	1.62	70	33	94	3	2
1968/69	35	1.85	65	6	54	7	6
1969/70	38	1.97	75	10	57	20	7
1970/71	38	2.63	100	8	80	10	8
1971/72	47	2.87	135	18	131	11	9
1972/73	116	1.03	120	26	97	12	10
1973/74	118	1.44	170	37	188	15	12
1974/75	186	1.50	280	4	207	40	35
1975/76	202	1.48	300	37	170	81	75
1976/77	229	1.09	250	86	165	91	84
1977/78	190	1.05	200	80	104	95	88
1978/79	220	1.04	230	81	174	97	90
1979/80	230	1.13	260	40	189	104	99
1980/81	234	1.49	350	7	255	90	85
1981/82	266	1.24	330	12	252	77	60
1982/83	236	1.00	236	13	190	22	20
1983/84	251	1.30	327	37	290	29	20
1984/85	284	1.32	374	45	342	27	23
1985/86	241	1.33	320	50	268	45	35
1986/87	223	1.26	280	57	157	145	85
1987/88	204	1.10	225	35	24	215	210
1988/89(e)	210	1.43	300	21	50	250	245
1989/90(f)	220	1.45	320	21	100	225	220

(e) estimate.

(f) forecast.

¹Oct./Sept. marketing year.

Source: USDA. Data are current as of Sept. 1989.

Appendix table 4—Supply and distribution of soybeans in Thailand, 1964-1989

Crop year ¹	Area harvested	Beginning yield	Total production	Total stocks	Domestic imports	Total exports	Food use	Crush	Use
	1,000 ha	MT/ha	1,000 metric tons						
1964/65	34	0.91	31	0	0	2	17	4	11
1965/66	18	1.06	19	12	0	6	23	5	15
1966/67	44	.86	38	2	0	6	29	10	15
1967/68	58	.91	53	5	0	3	40	20	15
1968/69	46	.98	45	15	0	5	39	20	15
1969/70	47	1.02	48	16	0	6	44	25	15
1970/71	58	.86	50	14	0	6	48	30	15
1971/72	54	1.00	54	10	0	7	57	35	17
1972/73	80	.90	72	0	0	14	58	35	18
1973/74	120	.87	104	0	0	7	87	56	23
1974/75	132	.83	110	10	0	24	86	55	23
1975/76	118	.97	114	10	0	8	95	57	30
1976/77	94	1.21	114	21	4	12	97	60	30
1977/78	131	.73	96	30	11	7	130	79	47
1978/79	145	1.10	159	0	0	10	122	65	45
1979/80	100	1.02	102	27	10	6	112	65	40
1980/81	105	.95	100	21	6	3	123	70	45
1981/82	125	1.06	132	1	3	2	117	60	48
1982/83	101	1.12	113	17	0	1	125	65	52
1983/84	156	1.15	179	4	0	1	160	80	65
1984/85	193	1.27	246	22	0	1	227	120	92
1985/86	241	1.28	309	40	0	2	300	180	100
1986/87	282	1.26	356	47	0	0	373	240	110
1987/88	303	1.12	338	30	31	0	399	260	110
1988/89(e)	365	1.23	450	0	3	0	450	300	110
1989/90(f)	380	1.32	500	3	0	0	502	350	112

(e) estimate.

(f) forecast.

¹April/March marketing years, 1964/65-76/77; Sept./Aug. marketing years 1977/78-89/90.

Source: USDA. Data are current as of Sept. 1989.

Appendix table 5—Supply and distribution of cassava in Thailand, 1960-88

Crop year ¹	Area harvested	Root production	Tapioca products ²	Domestic total use ³	Exports ⁴
	1,000 ha	1,000 metric tons			
1960	72	1,222	479	0	269
1961	99	1,726	677	0	443
1962	123	2,077	814	0	401
1963	140	2,111	828	0	239
1964	105	1,557	610	0	739
1965	102	1,475	578	45	719
1966	130	1,892	742	48	688
1967	141	2,062	808	54	839
1968	171	2,611	1,024	64	932
1969	191	3,079	1,232	72	1,318
1970	224	3,431	1,372	80	1,117
1971	221	3,114	1,246	91	1,309
1972	335	4,952	1,981	102	1,836
1973	428	6,416	2,566	208	2,389
1974	480	6,240	2,496	116	2,384
1975	594	8,100	3,240	121	3,718
1976	700	10,138	4,055	129	3,953
1977	831	11,840	4,736	142	6,287
1978	1,055	16,358	6,543	153	3,987
1979	795	11,101	4,995	200	4,083
1980	1,121	16,540	7,443	300	5,216
1981	1,243	17,744	7,569	300	6,263
1982	1,087	17,788	6,649	215	7,813
1983	1,018	18,989	7,022	300	4,938
1984	1,335	19,985	7,994	400	6,852
1985	1,376	19,263	7,705	480	7,125
1986	1,205	15,255	6,102	460	6,748
1987	1,371	19,554	7,821	460	6,568
1988	1,478	22,180	8,872	665	6,200

¹Calendar year.

²Pellet equivalent. Includes flour, chips, and pellets.

³Product basis; includes animal feed and starch.

⁴Includes roots, pellets, chips, and flour.

Source: Thai Agricultural Statistics, USDA and Titapiwatanakun.

Appendix table 6—Supply and distribution of soybean meal in Thailand, 1961/62-1989/90

Crop year ¹	Oilseeds crushed	Production	Beginning stocks	Total imports	Total exports	Total consumption
<i>1,000 metric tons</i>						
1961/62	0	0	0	0	0	0
1962/63	0	0	0	0	0	0
1963/64	0	0	0	0	2	1
1964/65	4	3	0	0	3	1
1965/66	5	4	0	0	2	6
1966/67	10	8	0	0	3	14
1967/68	20	17	0	0	9	8
1968/69	20	17	0	1	5	16
1969/70	25	20	0	0	1	23
1970/71	30	24	0	1	0	28
1971/72	35	27	0	0	5	22
1972/73	35	27	0	3	0	48
1973/74	56	45	0	9	0	52
1974/75	55	43	0	10	0	55
1975/76	57	45	0	57	0	104
1976/77	60	47	0	67	0	129
1977/78	79	62	0	39	0	90
1978/79	65	51	0	132	0	183
1979/80	65	51	0	139	0	194
1980/81	70	55	0	189	0	236
1981/82	60	47	0	201	0	252
1982/83	65	51	0	230	0	293
1983/84	80	63	0	223	0	323
1984/85	120	100	0	180	0	324
1985/86	180	144	0	233	0	423
1986/87	240	190	0	230	0	438
1987/88	260	208	0	190	0	430
1988/89(e)	300	240	0	180	0	460
1989/90(f)	350	280	0			

(e) estimate.

(f) forecast.

¹April/March marketing years, 1961/62-76/77; Sept./Aug. marketing years 1977/78-89/90.

Source: USDA. Data current as of Sept. 1989.

Appendix table 7—Supply and distribution of fishmeal in Thailand, 1964-1989

Years	Production	Beginning stocks	Total imports	Total exports	Domestic Use	Consumption soymeal equiv.
			<i>1,000 metric tons</i>			
1964	2	0	0	2	0	0
1965	7	0	0	7	0	0
1966	7	0	0	7	0	0
1967	3	0	0	3	0	0
1968	3	0	3	3	3	4
1969	64	0	1	13	52	75
1970	61	0	0	18	43	62
1971	73	0	0	28	45	65
1972	92	0	0	24	68	98
1973	94	0	0	22	72	104
1974	92	0	3	27	68	98
1975	113	0	0	49	64	92
1976	124	0	0	79	45	65
1977	179	0	1	110	70	101
1978	151	0	0	128	23	33
1979	151	0	0	114	37	53
1980	189	0	0	114	75	108
1981	170	0	0	83	87	125
1982	194	0	0	93	101	145
1983	190	0	0	85	105	151
1984	195	0	0	75	120	173
1985	280	0	0	68	212	306
1986	300	0	0	73	227	328
1987	400	0	0	73	327	473
1988	430	0	0	73	357	516
1989	450	0	0	70	380	549

Source: USDA. Data current as of September 1989.

Appendix table 8—Supply and distribution of total protein meals in Thailand, 1961/62-1989/90¹

Marketing years ²	Oilseeds, crushed	Beginning production	Total stocks	Total imports	Total exports	Total consumption
1,000 metric tons						
1961/62	0	0	0	0	0	0
1962/63	0	0	0	0	0	0
1963/64	0	0	0	0	10	5
1964/65	32	15	0	0	22	2
1965/66	41	24	0	0	14	9
1966/67	44	27	4	0	13	23
1967/68	55	32	0	3	18	17
1968/69	53	32	0	2	31	89
1969/70	106	118	0			
1970/71	84	107	0	0	32	75
1971/72	90	122	0	1	42	81
1972/73	246	202	0	2	45	159
1973/74	237	210	0	5	36	179
1974/75	213	196	0	31	39	188
1975/76	185	209	0	40	59	190
1976/77	189	221	0	92	93	220
1977/78	209	290	0	81	130	241
1978/79	208	261	0	52	157	156
1979/80	224	267	0	138	131	274
1980/81	240	312	0	147	131	328
1981/82	191	271	0	191	112	350
1982/83	188	296	0	203	107	392
1983/84	205	304	0	232	93	443
1984/85	284	356	0	225	83	498
1985/86	338	490	0	213	81	622
1986/87	383	553	0	268	90	731
1987/88	414	681	0	293	84	890
1988/89(e)	459	747	0	265	85	927
1989/90(f)	497	801	0	260	83	978

(e) estimate.

(f) forecast.

¹Total includes fishmeal, soybean meal, palm kernel meal, cottonseed meal, peanut meal, and copra meal.

²Aggregate of different marketing years.

Source: USDA. Data current as of Sept. 1989.

Appendix table 9—Thailand's rice exports by destination

Destination	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
<i>Metric tons</i>											
North America:											
United States	0	0	0	6,815	15,109	18,433	29,766	54,724	65,055	80,615	96,223
Other	8,000	0	38,129	896	23,335	78,023	162,576	138,272	19,624	43,950	156,654
Subtotal	8,000	0	38,129	7,711	38,444	96,456	192,342	192,996	84,679	124,565	252,877
South America:											
Brazil	0	296,651	41,784	61,678	0	105,538	55,495	156,876	289,025	0	0
Other	0	13,050	5,928	0	0	0	21,040	4,830	95,540	0	4,649
Subtotal	0	309,701	47,712	61,678	0	105,538	76,535	161,706	384,565	0	4,649
Western Europe:											
Italy	1,900	25,565	42,797	27,513	31,790	53,725	121,590	114,089	70,106	51,412	35,637
Netherlands	8,053	9,378	70,943	30,776	23,581	46,489	105,258	152,133	126,895	23,990	37,093
Other EEC	10875	10,471	15,691	18,699	20,094	29,535	45,176	72,433	105,512	41,397	78,320
EEC Subtotal	20,828	45,414	129,431	76,988	77,265	129,749	272,024	338,655	302,503	116,799	151,050
Other	0	0	22	132	859	1,885	3,409	5,767	38,773	13,662	10,875
Subtotal	20,828	45,414	129,453	77,120	78,124	131,634	275,433	344,422	341,276	130,461	161,925
Eastern Europe	0	9,881	0	53,884	50,005	61,229	22,715	2,916	1,791	6,312	20,802
USSR	0	61,532	203,751	277,984	40,500	0	0	193,883	189,837	115,040	10,090
Middle East:											
Cyprus	38,500	0	165,101	0	161	449	704	786	873	776	839
Iran	0	0	0	349,714	319,002	389,100	415,665	299,812	174,424	571,148	250,009
Saudi Arabia	42,019	42,216	104,164	140,385	98,938	70,631	130,716	149,030	184,321	120,159	148,076
Other	186,282	265,084	189,897	66,624	217,863	253,726	294,571	340,159	315,337	364,086	428,611
Subtotal	266,801	281,170	459,162	556,723	635,964	713,906	841,656	789,787	674,955	1,056,169	827,529
Africa:											
Benin	1,000	9,792	0	6,290	22,227	11,870	19,913	20,421	82,096	347,907	232,270
Cameroon	0	0	0	6,770	166,577	67,731	149,939	93,441	160,372	127,912	82,467
Ivory Coast	0	0	0	157,481	136,120	87,454	52,651	5,249	53,922	83,394	96,840
Malagasy	0	0	0	20,765	268,820	124,170	171,144	98,638	67,990	64,550	213,567
Mauritania	31,821	0	0	52,602	20,675	45,825	106,336	50,824	40,935	56,556	66,731
Mozambique	0	325	3,308	9,003	23,702	31,888	77,313	122,917	152,984	216,334	187,358
Nigeria	482,760	198,422	197,469	198,318	185,834	488,036	189,898	297,623	40,360	4,000	0
Senegal	61,170	22,949	327,380	226,495	309,404	271,466	326,017	65,490	219,490	101,166	100,950
Tanzania	6,902	2,760	20,000	4,790	43,442	9,910	52,672	26,710	101,154	75,671	22,412
Other	44,453	167,953	25,708	87,697	258,516	133,042	256,381	432,625	652,562	524,071	543,456
Subtotal	628,106	626,301	573,865	770,125	1,435,317	1,271,392	1,402,264	1,213,938	1,571,865	1,601,561	1,546,051
Asia and Oceania:											
Bangladesh	131,478	131,473	0	0	55,567	0	396,834	75,520	14,443	310,777	31,876
China	0	70,600	18,195	210,745	320,535	46,759	99,884	66,337	255,633	310,581	366,123
Hong Kong	94,232	103,450	127,815	115,474	115,161	147,242	156,877	172,992	179,886	181,906	213,016
India	0	0	0	52,300	0	221,668	277,978	272	1,500	8,455	683,811
Indonesia	163,669	615,512	644,729	199,580	181,212	334,163	20,422	50,476	21,764	17,000	27,034
Malaysia	156,713	101,466	153,858	237,232	387,998	307,413	344,694	326,490	210,349	175,583	277,645
Singapore	140,007	193,474	180,538	157,568	174,136	185,581	199,823	194,903	2,798	231,740	260,628
Vietnam	28,598	105,057	55,019	0	89,400	1,600	51,991	0	0	0	11,425
Other	40,629	40,310	50,207	239,297	60,182	64,991	176,108	202,600	116,703	107,325	85,597
Subtotal	755,325	1,361,342	1,230,361	1,212,196	1,364,191	1,309,477	1,724,611	1,090,590	1,049,076	1,343,367	1,957,155
World Total	1,669,061	2,721,471	2,682,433	3,016,521	3,660,745	3,622,572	4,535,556	4,000,238	4,298,044	4,377,475	4,781,078

Source: Ministry of Commerce, Royal Thai Government. Not official USDA data.

Appendix table 10—Thailand's corn exports by destination

Destination	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
<i>1,000 metric tons</i>												
North America:												
United States	0	0	0.4	0	0	0	10.0	0	2.6	0	0	0
Other	0	0	2.1	0	0	0	0.7	1.0	1.0	3.0	0	0
Subtotal	0	0	2.5	0	0	0	10.7	1.0	3.6	3.0	0	0
South America	0	0	0	0	0	0	0	0	0	0	0	0
Western Europe	.8	2.3	9.2	1.8	6.2	6.0	76.2	4.0	31.3	2.0	.3	.1
Eastern Europe	0	0	3.0	21.0	26.1	0	0	0	0	49.5	0	0
USSR	0	0	50.9	284.1	252.6	110.7	171.7	424.0	0	0	0	0
Middle East:												
Iran	0	0	0	72.5	273.9	31.5	0	0	4.0	0	0	0
Iraq	15.9	88.9	151.9	82.9	6.0	1.5	25.5	6.4	39.4	0	0	0
Jordan	0	42.0	0	0.6	99.1	33.3	61.9	124.4	29.0	35.1	0	0
Kuwait	31.2	30.1	32.1	59.1	238.7	82.9	161.7	98.2	201.4	1.0	0	0
Saudi Arabia	108.0	96.2	157.4	133.4	201.3	320.6	448.8	377.4	215.0	322.2	166.9	46.6
Other	12.5	40.1	17.9	30.4	55.4	20.3	28.7	54.4	58.3	166.5	21.8	34.7
Subtotal	167.5	297.3	359.3	270.1	874.4	490.1	726.6	660.7	547.2	524.7	188.6	81.3
Africa:												
Angola	2.2	30.9	0	113.0	0	0	0	0	0	0.6	0	0
Kenya	0	0	0	11.7	0	0	0	387.2	0	0	0	0
Mozambique	0	0	3.0	0	0	0	13.9	70.9	3.0	4.6	0	3.3
Nigeria	0.1	7.2	23.9	3.0	5.9	53.0	5.0	4.8	2.6	0	0	0
Reunion	1.0	0.0	0.5	7.0	0	0	0	9.7	0	0	0	0
Somalia	9.9	5.5	0.0	0.0	22.0	0	0	0	0	0	0	0
Tanzania	0.6	1.2	0.0	3.7	35.7	13.6	14.0	157.3	3.5	51.9	0	0
Zaire	0	0	0	0	0	0	16.0	16.8	0	0	0	0
Other	0	22.2	3.0	4.5	12.4	6.1	35.9	19.0	16.7	22.4	1.3	2.6
Subtotal	13.8	67.0	30.4	143.0	76.1	72.6	84.7	665.6	25.8	79.6	1.3	6.0
Asia and Oceania:												
China	0	66.3	33.8	130.4	143.3	94.6	161.5	33.7	66.5	590.5	82.4	0
Hong Kong	148.4	181.5	227.1	163.9	131.2	258.3	254.0	41.5	88.7	171.0	143.6	99.4
Indonesia	5.5	21.7	37.3	20.0	0	217.5	45.7	31.1	42.6	56.9	59.9	12.7
Japan	400.0	545.4	469.8	111.0	20.5	185.6	6.8	6.3	25.4	61.0	5.5	1.9
Korea, South	0	0	0	0	51.0	21.7	70.2	150.9	460.3	1,036.8	49.2	458.7
Malaysia	195.9	340.7	393.0	414.4	449.9	556.7	533.9	638.2	910.6	937.7	773.4	420.0
Philippines	20.9	81.6	10.0	44.8	49.1	126.3	178.4	91.0	138.6	0	56.1	0
Singapore	172.2	313.0	269.0	289.5	365.1	464.8	378.7	337.0	367.5	338.6	206.9	91.5
Taiwan	389.7	0.0	72.1	165.2	99.9	191.0	7.3	50.7	4.6	36.8	29.3	4.2
Other	3.3	37.9	20.8	7.1	2.0	5.4	2.0	43.6	35.7	61.0	20.6	29.9
Subtotal	1,335.7	1,588.0	1,532.9	1,346.4	1,312.0	2,121.9	1,648.5	1,424.0	2,140.5	3,290.4	1,426.8	1,118.3
World total	1,517.9	1,954.6	1,988.2	2,175.3	2,547.4	2,801.2	2,718.5	3,179.3	2,748.4	3,949.1	1,617.0	1,205.6

Source: Ministry of Commerce, Royal Thai Government. Not official USDA data.

Appendix table 11—Thailand's sorghum exports by destination

Destination	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	<i>Metric tons</i>											
North America:	0	0	0	0	0	0	0	0	0	0	0	0
South America:	0	0	0	0	0	0	0	0	0	0	0	0
Western Europe:						1,513	0	0	2,024	500	401	0
Germany, W.	0	0	0	0	0	2,958	0	0	0	0	0	0
United Kingdom	0	0	0	0	5,500	0	0	0	0	20	65	0
Other	0	0	0	0	5,500	4,471	0	0	2,024	520	466	0
Subtotal	0	0	0	0	5,500	4,471	0	0	2,024	520	466	0
Eastern Europe:	0	0	0	0	0	0	0	0	0	0	0	0
USSR	0	0	0	0	40,800	0	0	0	0	0	0	0
Middle East:								4,338	1,627	0	0	0
Jordan	0	0	0	25	0	500	0	0	2,813	0	198	197
Kuwait	0	0	35	0	0	280	0	0	0	0	0	0
Oman	0	0	0	0	0	0	0	0	0	0	0	0
Saudi Arabia	39,042	119,760	137,613	136,568	106,968	222,719	135,333	206,878	139,920	79,777	12,818	0
U.A.E.	0	0	0	6,564	74	25	0	0	15	58	1,355	150
Yemen, Dem.	0	0	0	0	0	0	0	5,500	0	0	0	0
Other	0	0	0	0	0	0	200	0	0	0	0	0
Subtotal	39,042	119,760	137,648	143,157	107,042	223,524	135,533	216,716	144,375	79,835	14,371	347
Africa:								2,958	0	1,972	0	0
Ethiopia	0	0	0	0	0	0	0	6,528	12,786	0	0	0
Ivory Coast	0	0	0	0	0	0	0	0	3,000	1,000	0	0
Kenya	0	0	0	0	0	0	12,868	0	0	0	0	0
Mozambique	0	0	0	0	0	0	0	0	0	0	0	0
Niger	5,070	5,250	0	0	25,101	6,784	0	0	21,803	0	0	0
Senegal	12,228	0	0	0	0	3,570	0	0	3,583	7,169	0	0
Somalia	0	0	0	0	0	0	0	1,809	34,285	0	0	0
Sudan	0	0	0	0	0	0	0	0	10,500	0	0	0
Tanzania	0	0	0	0	0	0	0	0	25,233	7,565	0	3,150
Other	150	297	100	0	24,439	14,998	62,417	0	25,233	7,565	0	3,150
Subtotal	17,448	5,547	100	0	49,540	25,352	75,285	11,295	111,200	17,706	0	3,150
Asia and Oceania:										5,009	0	0
China	0	0	0	0	0	0	0	0	0	0	200	0
Hong Kong	14,655	20,880	6,393	7,023	930	4,970	400	203	0	0	31,450	19,000
Indonesia	0	0	0	0	0	4,962	2,500	0	0	31,450	19,000	0
Japan	4,230	568	1,562	54	42	3,651	7,740	6,960	13,911	18,365	8,245	345
Korea, South	0	0	0	0	0	0	0	0	0	0	0	0
Malaysia	19,329	5,548	6,620	8,702	3,102	1,845	40	45	0	85	0	121
Philippines	0	0	0	0	0	0	0	0	0	0	0	0
Singapore	6,520	85	50	3,068	3,706	3,780	4,610	3	50	0	15	0
Taiwan	34,240	5,877	14,661	18,588	9,953	16,200	200	0	44,978	74,450	103,671	18,701
Other	0	0	0	0	0	100	0	3,884	0	0	0	0
Subtotal	78,971	32,758	29,286	37,435	17,736	35,508	15,490	11,095	58,939	129,359	131,131	19,167
World total	135,464	158,065	167,034	180,592	220,618	288,855	226,308	239,106	316,538	227,420	145,968	22,664

Source: Ministry of Commerce, Royal Thai Government. Not official USDA data.

Appendix table 12—Average retail prices of livestock products and fish, Thailand

Year	Beef and buffalo ¹	Pork ¹	Chicken ¹	Fish ^{1,2}	Consumer Price Index 1980 = 100 ³
-----Baht per pound-----					
1975	29.6	30.8	22.1	18.6	62.9
1976	30.3	31.6	21.7	17.1	65.5
1977	30.7	35.7	25.1	18.9	70.4
1978	29.5	34.7	23.6	21.1	76.0
1979	33.2	57.6	27.1	18.7	83.5
1980	48.8	45.7	28.9	27.5	100.0
1981	55.7	48.8	30.1	27.3	112.7
1982	56.7	47.8	30.2	32.5	118.6
1983	55.2	52.2	29.9	32.7	123.0
1984	55.2	51.4	29.7	32.3	124.1
1985	52.0	42.5	28.0	31.1	127.1

¹Statistical Yearbook of Thailand, various years.

²Average price of chub mackerel and catfish.

³International Financial Statistics.

Appendix table 13—Per capita meat and egg consumption in Thailand¹

Year	Total meat	Poultry ²	Pork ³	Beef and buffalo ³	Eggs ²
-----Kilograms-----					Dozen
1975	14.76	3.85	7.11	3.80	NA
1976	18.42	4.15	9.27	5.00	NA
1977	19.00	4.42	9.55	5.04	4.57
1978	21.05	4.74	11.46	4.86	4.16
1979	21.87	5.10	12.24	4.53	5.31
1980	22.67	7.17	10.76	4.75	5.28
1981	22.79	7.79	10.45	4.55	5.52
1982	23.19	8.14	10.31	4.74	5.89
1983	21.95	7.03	9.78	5.14	6.44
1984	21.72	7.20	9.70	4.82	6.73
1985	21.37	7.64	8.90	4.83	6.62
1986	22.16	7.62	9.81	4.73	NA

NA = Not available.

¹See Appendix for discussion of data derivations.

²Derived from Chesley, USDA, and private industry estimates.

³Derived from Agriculture Statistics of Thailand.

2131
9

Appendix table 14—Total meat and egg consumption in Thailand¹

Year	Total meat	Poultry ²	Pork ³	Beef and buffalo ³	Eggs ²
					Million dozen
-----1,000 tons-----					
1975	615.00	161.33	297.67	156.00	NA
1976	732.34	178.27	398.07	156.00	NA
1977	770.96	194.59	420.37	156.00	201.36
1978	886.38	213.76	516.63	156.00	187.79
1979	956.14	235.37	564.76	156.00	245.00
1980	1,001.39	338.04	507.35	156.00	249.01
1981	1,022.37	369.92	496.45	156.00	262.07
1982	1,050.42	394.52	499.89	156.00	285.62
1983	987.46	347.54	483.92	156.00	318.61
1984	1,007.66	362.77	488.89	156.00	339.10
1985	1,078.28	392.37	529.91	156.00	339.77
1986	1,068.24	399.03	513.21	156.00	NA

NA = Not available.

¹See Appendix for discussion of data derivations.

²Derived from Chesley, USDA, and private industry estimates.

³Derived from Agriculture Statistics of Thailand.

Appendix table 15—Thailand's estimated feed use

Feed	1983	1984	1985	1986	1987
Corn	1,150	1,200	1,250	1,300	1,450
Rice ¹	950	1,100	1,100	1,200	1,300
Rice bran ²	1,600	1,700	1,600	1,700	1,700
Sorghum	20	35	45	35	35
Tapioca ³	0	75	250	0	0

NA = Not available.

¹Includes broken and glutinous rice.

²Includes solvent extracted and regular rice bran.

³Commercial feed only.

Source: U.S. Department of Agriculture, Annual Agricultural Situation Report (various editions).

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