Economic and Social Commission for Asia and the Pacific

CAPSA WORKING PAPER No. 84

Status and Prospects of Feed Crops in Thailand

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United Nations
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UNESCAP-CAPSA

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Status and Prospects of Feed Crops in Thailand

"UNESCAP-CAPSA: Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific"

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Centre for Alleviation of Poverty
through Secondary Crops' Development
in Asia and the Pacific

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Foreword

During the last few decades a rapid increase has occurred in the demand for meat, milk and eggs throughout the world. This increase is attributed not only to increases in population but to a large increase in per capita consumption connected to changes in lifestyles and to economic growth.

By 2002, in general, the increasing demand for livestock products will equal or exceed the demand for food from direct plant origin (cereals, vegetables and pulses). This process is known as “the Livestock Revolution”.

Coarse grains, pulses, roots and tuber crops are very important components of farming systems in Asia and the Pacific. Feed is one of the important end products of CGPRT crops.

Responding to this need, UNESCAP-CAPSA implemented a research project “Prospects of Feed Crops in Southeast Asian Countries (FEEDSEA)” in collaboration with partners from four Southeast Asian countries namely: Indonesia, Malaysia, the Philippines and Thailand. It is a continuation of the research project “Prospects of Feed Crops in South Asia (FEED)” conducted from 2001 to 2003 with the participation of four countries in South Asia, namely: India, Nepal, Pakistan and Sri Lanka.

It is my pleasure that the first output of this project **Status and Prospects of Feed Crops in Thailand** is now available to the public. This volume covers topics such as investigating and identifying opportunities for improvements in rural income through new and different utilization of CGPRT crops in the feed industry in Thailand.

I thank Ms. Chamras Rojanasaroj and her team for their earnest and fruitful work. Dr. Budiman Hutabarat, Senior Researcher, Indonesian Center for Agricultural Socio Economic Research and Development (ICASERD), and Dr. Erna Maria Lokollo provided useful comments and guidance at various stages of the study as the regional advisor and programme leader respectively. I also thank Mr. Matthew L. Burrows for his editing services throughout the publication of the report, and Ms. Agustina Mardyanti for typing and formatting the final document. I would like to express my highest appreciation to the Government of Japan for funding the project.

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J.W. Taco Bottema
Director
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In carrying out the study, our research team and I would like to thank Dr. Adisak Sreesunpagit, the former Secretary General of the Office of Agricultural Economics who readily recognized that the project would be very beneficial to both Thailand and its neighbours which studied the same feed crops. Along with him, Dr. Suthiporn Chirabhanda, the current Secretary General, shared a similar view. Moreover, he fully supported our research team and was in favour of having me appointed as the country expert. We would also like to express our gratitude to Dr. Kajonwan Itharattana, the agricultural economic policy expert and Mr. Sakol Ooraikul, the agricultural production and marketing expert, both of whom gave us valuable guidance and spirit throughout the study.

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Chamras Rojanasaroj

Executive Summary

The ESCAP CGPRT Centre, which in 2004 became UNESCAP-CAPSA, initiated a project on the Prospects of Feed Crops in Southeast Asia (FEEDSEA) with the participation of

four countries in the region. They include Indonesia, Malaysia, the Philippines and Thailand; countries typical to the region. One of the major project objectives is to investigate which of the countries has any feed crops and if there is the potential to produce adequate feedstuffs for domestic consumption, or better still, produce an exportable excess supply to the region. A meeting was held among representatives of the four countries, the CGPRT project management team and those concerned in Bogor, Indonesia in August 2003 to consider the methodology for the research and which feed crops in each of the four countries should be studied.

The study in Thailand is facilitated by the availability of data in the Department of Agriculture, the Department of Agricultural Extension, the Department of Livestock Development and the Office of Agricultural Economics under the Ministry of Agriculture and Cooperatives, the Department of Customs and the Fiscal Policy Office under the Ministry of Finance and the Department of Trade Negotiations under the Ministry of Commerce.

The econometric modeling involving maize, soybean, cassava, and rice includes predictions of future production. Regarding the demand for feedstuffs, the estimations are based on increases in the livestock population.

With the collaborative effort of researchers from the Department of Agriculture, the Department of Agricultural Extension and economists from the Office of Agricultural Economics, analysis of the strengths, weaknesses, opportunities and threats of four feed crops is attempted as well as policies that would enhance the productivity of the farming systems involving the four crops.

The GDP of the Thai agricultural sector has grown little whereas the sector's share of national GDP shows a downward trend. The rise in GDP of the livestock sub-sector is a consequence of increases in the production of broilers and hogs which are exported in large quantities in the forms of frozen and chilled meats and meat products with large export potentials. In line with the booming livestock industry, the production of compound feed has followed to meet demand in spite of the somewhat higher prices over the feed produced on farmers' own farms. Based on the demand for feed of each major type of livestock in 2002, the total demand for feed from the Thai livestock industry is 11.938 million tons which is predicted to increase to 17.367 million tons in 2015, expected to be spurred by dairy farming in response to increasing demand for dairy products in addition to the increasing production of swine and broilers.

Regarding the supply of feed crops, with better price incentives to produce and better management skills in the use of modern technology, the production of rice continues to be on the rise. In spite of the government's scheme to reduce the planted area of cassava, little reduction has been achieved. As a result, the supply of the two feed crops has always been in abundance whereas the supply of maize and soybean seems to be bleak but the expansion of the broiler and swine industries has been strong. While maize is a good source of energy for livestock, it can be totally substituted with milled rice products. It can be inferred that production of maize can potentially suffice the domestic needs of the livestock industry.

Similar to fish meal and meat meal, soy meal is an excellent source of protein for livestock. However, having a higher protein content, fish meal and meat meal are often more expensive but require less concentration in livestock rations. Consequently, the cost of manufacturing compound feed is least when using soy meal. Unfortunately, the outbreak of mad cow disease in meat meal exporting countries prompted livestock farmers to use more soy meal. Hence, to satisfy domestic demand, the potential for soybean production is quite bleak.

It can be considered fortunate that the Thai government has implemented a policy to assist its neighbouring countries to raise their farmers' income, and at the same time alleviate its own domestic shortages of feedstuffs by initiating feed crop production enhancement projects, locating the resource bases for producing maize and soybean in neigbouring countries through bilateral economic cooperation.

1. Introduction

1.1 Background and justification

An agriculture-based country, Thailand has long produced agricultural surplus for export. In the early days the major exports included rice, teak and para rubber. Nowadays, while some of the above exports have declined or even stopped, rice remains the major export item and new exportables have emerged, particularly broiler meat. However, agricultural gross domestic product has varied somewhat from year to year against the national GDP. The GDP during the 1998-2002 period showed an annual average growth rate of 4.21 per cent while the agricultural GDP grew much less at just 0.25 per cent. Livestock GDP grew relatively spectacularly at 5.87 per cent. It is notable that during 1998-2002 Thailand's annual agricultural exports grew at a rate of 5.63 per cent whereas the growth in the exports of livestock and livestock products was 10.55 per cent on average.

Thailand has been self-sufficient in meat protein for domestic consumption for many years and has exported some animal products too. Therefore, meat production is sufficient to meet the rising domestic demand generated by population growth and better standards of living. In the past, people's meat intake came from varieties of domestic animal breeds, which were fed by indigenous feed, such as paddy rice for poultry, natural forages for cattle, banana stems and broken rice with rice bran for pigs, etc. After importing commercial breeds for crossing with domestic breeds, the improved breeds required appropriate feed to yield the best returns. In this regard, the Department of Livestock Development has helped farmers by providing standard feed formulas. Farmers can then find the feed ingredients in the market and can mix them by hand themselves. These ingredients include maize, soybean meal, fish meal, broken rice and rice bran.

Thailand has many types of livestock that are locally produced on a large-scale, but only for domestic consumption purposes. Swine production continues to be commercialized, with the majority of hog meat being used for domestic consumption. While there are a number of meat substitutes, prices tend to fluctuate, and consequently small farmers often encounter losses and are forced out of business. There remain the big farmers and integrated private businesses who operate using modern farming technologies. Evaporative cooling systems are employed, among other things, for quality pork. Livestock are raised in enclosed houses where the air is conditioned and the temperature is always regulated. The government's focusing on the production of quality pork, and from 2004 will begin a campaign for food safety. In spite of the continuing effort, Thai pork has hardly gained recognition overseas and has not been exported so far due to Thailand's failure to be free from foot and mouth disease. However, the swine population continued to grow at 1.62 per cent during 1998-2002.

The domestic production of broilers grew at 6.10 per cent during 1998-2002. They are reared predominantly by large private businesses operating under contract farming having small farmers as out growers. The share of production using the evaporative cooling system is on the increase. Among the livestock, raising broilers in Thailand is subject to the most restrictive sanitary measures as countries importing the broilers and broiler products set strict hygienic standards in an attempt to protect their consumers. Exports of the commodity are in the form of fresh frozen meat and processed products. Such items contribute even larger shares in the export of livestock and meat products.

The production of milk also shows good potential as the population of milk cows grew 3.69 per cent between 1998-2002 in response to the incentives of guaranteed raw milk prices. The government's school milk programme requiring ready-to-drink milk to be prepared from the local raw milk prompted manufacturers participating in the scheme to purchase raw milk.

The government is committed to allot an annual budget to the programme to have all children in kindergarten up to primary school drink 200 cc of milk per day, 230 days a year.

Livestock that is in decline includes layer hens, meat and layer ducks. The production of hen eggs is currently mostly consumed domestically, leaving little exportable supply to prevent any petition of complaints due to a serious depression in the egg price. Imports of the parent stock is thus regulated by the government to ensure production is in line with domestic demand. As a result, private imports of the parent stock have been kept at the same quantity in past years and overseen by the Department of Livestock Development which grants import permits for the livestock.

Local consumption of duck meat is not as great as that of broilers and pork since the preparation of duck meat dishes is not common. The cost of producing duck eggs is usually higher than that of hen eggs while the retail prices are nearly the same.

It may be summed up that great potentials for livestock production exist in Thailand for both internal consumption and exports. In addition, the country has abundant fish protein arising out of both culture and capture. Of course, the expanding livestock industry, which has on the whole had its husbandry and culture activities up-scaled and advanced, demands an increasing volume of compound feed which is mostly fed to the local animals. The standards of the feed distributed are always regulated with statues which include mainly the use of agro-chemicals and the levels of protein. As the demand for feed ingredients increases, domestic shortages often occur and opportunities arise to import, principally soybean meal, maize, fish meal, etc. At the same time, in order to keep any impact of the imports on the interested parties to a minimum, rules and regulations are enforced on the importers.

Before Thailand expanded its animal meat exports, it had enough feed ingredients for domestic use and some surplus was exported. However, the increase in demand for feed ingredients due to the expansion of livestock production has led to imports of some feed ingredients instead of the usual exportable surplus. Now, imports of some ingredients are greater than domestic production. Mixing feed ingredients by hand for many livestock species is hard work and results in an unharmonized feed. Consequently, feed industries play a role in livestock production. Feeds from the industry meet most nutritional requirements for each stage of growth of each type of animal, have a long shelf life and can be distributed throughout the country. The feed industry tries to be competitive but has to operate within domestic feed laws, which the Department of Livestock Development determine and enforce.

1.2 Objectives

Major objectives of the study include:

1. To review and analyze the historical data of feed crop production and consumption in Thailand.
2. To analyze future trends of demand and supply for feed crop products in Thailand.
3. To evaluate potentials, weaknesses, opportunities and constraints for expanding feed crop farming in Thailand.
4. To propose possible cooperation for trade and development of feed crops among Southeast Asian countries.
5. To formulate policy options to promote sustainable development of feed crop farming in Thailand.

1.3 Scope of study and commodity coverage

Thailand has been producing a variety of coarse cereals, roots and tubers that can be processed into feed including soybean, maize, sorghum, cassava and sweet potato. The farm commodity in major use is soybean in the form of meal and maize. Currently the use of cassava

is on the gradual rise for monogastric animals. Aside from the coarse cereals, roots and tubers, stalks of corn and sorghum are now used as silage. Quality silage is obtainable when the stalks are young. In this study, focus is on the major feed crops, both for the current situation and what is expected in the future. Other related crops may be referred to where appropriate to seek their production potentials if any of them are determined to be in relatively great demand as they have linkages with the feed industries.

1.4 Organization of the report

The analysis and a model for the commodity under study has been formulated, which serve as the major components of the research project, and are incorporated in the report. The report consists of 9 chapters. Regarding the modeling, a description will encompass concepts and methods which lead to the model. Following the basic data relating to Thailand will include the situation of the general economy with respect to population, agricultural production, consumption and trade, production and consumption of livestock products, use of feed crops as ingredients in manufacturing feed, policies on the production and trade of feed crops, their production potentials and policies on Thailand's farm trade with countries in Southeast Asia. Conclusions are presented in Chapter 9 together with suggestions. The report is supported with tables and figures.

2. Research Methodology

2.1 Conceptual framework

2.1.1 Definition

Feed ingredients: The feed ingredients in this study are maize, soybean meal, fish meal, broken rice and shredded cassava. They are used in large quantities in the feed industry, except cassava, which is only used in small amounts.

Feed crops: Feed crops in this research are utilized mainly in the feed industries in Thailand and comprise of maize, soybean, rice and cassava in the form of the actual raw product or its by-products that are used in concentrates.

2.1.2 Analytical approach

Two approaches are undertaken in this study:

1. Descriptive analysis is applied to elucidate the SWOT analysis and describe the situation of feed crops.
2. Quantitative analysis is used to calculate the requirement of feed ingredients and the production of feed crops in the next few years. Derived demand and supply functions are the theories that are used to project the future requirement and production.

2.2 Model formulation

2.2.1 Model for soybean

a) Planted area function

$$\ln ASB = A_0 + A_1 \ln FPSB_{t-1} - A_2 \ln FPM_{t-1} + A_3 \ln ASB_{t-1}$$

b) Yield function

$$\ln YSB = B_0 - B_1 PFRERC + B_2 RAIN_{t-1}$$

c) Production function

$$Prod = ASB \times YSB$$

d) Demand for soybean

$$\ln DSB = -C_0 - C_1 \ln IPSB + C_2 \ln POP$$

e) Demand for soybean meal function

$$\ln DSM = -D_0 - C_1 \ln IPSM + D_2 \ln BP$$

Definition of variables

ASB	= planted area of soybean (rai)
YSB	= yield of soybean (kg/rai)
Prod	= production of soybean (tons)
DSB	= demand for soybean (tons)

DSM = demand for soybean meal (tons)
IPSB = import price of soybean (baht/kg)
RAIN = rainfall (m.m.)
POP = population (million heads)
FPSB = farm price of soybean (baht/kg)
FPM = farm price of maize (baht/kg)
T = time trend
PFRERC = price of fertilizer
IPSM = import price of soy meal
BP = quantity of broilers

2.2.2 Model for rice

a) Production function

$$\ln PROD = A_0 + A_1 \ln Pfarm_{t-1} - A_2 \ln Pfer_{t-1} + A_3 \ln Water - A_4 D_1 + A_5 T$$

b) Demand for rice for consumption function

$$\ln CONS = B_0 - B_1 \ln Pr + B_2 \ln Pw - B_3 \ln GDP$$

c) Export function

$$\ln EXPT = C_0 - C_1 \ln Pfob - C_2 \ln PRODw + C_3 \ln GDPw + C_4 D_{32}$$

Definition of variables

PROD = production of rice (million tons)
Pfarm = farm price of rice (baht/ton)
Pfer = fertilizer price (baht/ton)
Water = quantity of water available in dams (million m3)
D_1 = dummy variable for unfavourable weather
T = technology
CONS = demand for consumption of rice (million tons)
Pr = retail price of rice (baht/ton)
Pw = substitutable goods prices (baht/ton)
GDP = gross domestic product (baht/head/year)
EXPT = demand for rice exports (million tons)
Pfob = export price (baht/ton)
PRODw = production of rice in competing countries/trading partners (million tons)
GDPw = gross domestic product of competing countries/trading partners (US$/head/year)
D_{32} = dummy variable for the abnormal exporting year

2.2.3 Model for maize

a) Production function

$$\ln Prod = A_0 + A_1 \ln SiloPrice_{t-1} - A_2 \ln SuPrice_{t-3} - A_3 \ln CasPrice - A_4 \ln Fer - A_5 D$$

b) Demand for maize as feed function

$$\ln CON = -B_0 - B_1 \ln SiloPrice + B_2 \ln BrokenRice + B_3 \ln EggPrice_{t-1} + B_5 \ln Pig$$

Definition of variables

Prod	= production of maize (million tons)
SiloPrice	= wholesale silo maize price (baht/ton)
SuPrice	= farm price of sugarcane (baht/ton)
CasPrice	= farm price of cassava (baht/ton)
Fer	= wholesale fertilizer price (baht/ton)
D	= dummy variable for a drought year
CON	= demand for maize as feed (million tons)
BrokenRice	= wholesale broken rice price (baht/ton)
EggPrice	= wholesale egg price (baht/unit)
Broiler	= wholesale broiler price (baht/kg)
Pig	= quantity of swine (1,000 heads)

2.2.4 Model for cassava

a) Production function

$$SCAS = A_0 + A_1 PCAS_{t-1} + A_2 AREA - A_3 D$$

b) Demand for domestic use of shredded and pelleted cassava

$$\ln QDCSP = B_0 - B_1 \ln PWCS$$

c) Demand for exportation of pelleted cassava

$$\ln QCP = C_0 - C_1 \ln PROT + C_2 \ln PBL$$

Definition of variables

SCAS	= production of cassava (1,000 tons)
PCAS	= cassava farm price (baht/ton)
AREA	= area planted to cassava (1,000 rai)
D	= dummy variable for government policy on reducing the planted area
QDCSP	= demand for cassava as feed (shredded and pelleted) (1,000 tons)
PWCS	= wholesale shredded cassava price (baht/ton)
QCP	= demand for exportation of pelleted cassava (1,000 tons)
PROT	= c.i.f. import price at Rotterdam harbor (baht/ton)
PBL	= German barley price (bath/ton)

2.3 Sources and coverage of data

Most of the data was collected from the relevant agencies under the Ministry of Agriculture and Cooperatives, Ministry of Commerce, Ministry of Finance, and National Economic and Social Development Board.

The period of data is 1993-2002, and the data covers:

- Area
- Production
- Price
- Yield
- Consumption
- Import and export
- Gross Domestic Product
- Population
- Indexes
- Time trend
- Dummy

3. General and Socio-economic Features

3.1 Population

Of Thailand's population of 48.78 million two decades ago in 1983, 30.281 million (62.08 per cent) earned a living from agriculture and 18.499 million from non-agricultural activities. Ten years ago, in 1993, the country had a total population of 57.129 million. The farming population rose to 31.154 million (0.26 per cent annual growth rate) and the non-farming population was 25.975 million, or 45.47 per cent of the total. Consequently, this implies that during the period of 1983-1992 the Thai population shifted more towards non-agricultural activities as a way to earn a living.

In 2002, the Thai population boomed to 63.850 million, 30.950 million of which relied on agriculture, i.e. 48.75 per cent. Taking the agricultural and non-agricultural population segments into consideration, it is found that the farming population during 1993-2002 declined by 0.15 per cent, whereas the non-farming population increased by 2.84 per cent. It should be noted that, in 2002, the farming population rose above the 2001 total due to the national economic crisis which forced part of the non-farming community to return home and turn to farming. (Table 3.1)

Table 3.1 Population of Thailand

Unit: 1,000 heads

Year	Non-agriculture population	Agriculture population	Total	% agriculture population
1983	18,499	30,281	48,780	62.08
1988	22,111	30,981	53,092	58.35
1993	25,975	31,154	57,129	54.53
1994	26,795	31,130	57,925	53.74
1995	27,633	31,096	58,729	52.95
1996	28,490	31,055	59,545	52.15
1997	29,364	31,005	60,369	51.36
1998	30,252	30,941	61,193	50.56
1999	31,149	30,859	62,008	49.97
2000	32,050	30,756	62806	48.97
2001	32,953	30,631	63,584	48.17
2002 *	32,900	30,950	63,850	48.47
Growth rate (1993-2002)	2.84	-0.15	1.30	-

Source: National Economic and Social Development Board (NESDB), and Office of Agricultural Economics (OAE).
Note: * Forecast.

3.2 General economy

During the past 20 years, Thailand's agricultural production structure has been constantly changing which can be seen through the declining proportions of the gross domestic product in agriculture against the national GDP, (Table 3.2) even though agricultural GDP kept increasing annually. In 1982 agricultural GDP was 18.55 per cent dropping to 10.27 per cent in 2002. A similar trend can be seen for agricultural exports against total exports. In 1982, the share of agricultural exports was 67.50 per cent of total exports falling to 23.75 per cent in 2002 despite the agricultural export value being on the rise. (Table 3.3)

The national economy grew but its non-agricultural sectors grew even larger and faster than the agricultural sector. This indicates that Thailand is becoming more industry oriented as

the share of agricultural trade continues to decline. An in-depth examination finds that some industrial commodities have their origins in agricultural raw materials. Agro-industry generates significant value-added and export earnings.

Table 3.2 Gross Domestic Product

Year	GDP (million baht)				
	Total	Agricultural sector	% of total	Livestock	% of agricultural sector
1982	841,569	156,098	18.55	15,283	9.79
1986	1,133,397	177,537	15.66	20,752	11.68
1990	2,183,545	272,935	12.50	32,850	12.06
1994	3,629,341	383,198	10.56	35,675	9.31
1998	4,626,447	564,879	12.21	43,914	7.77
1999	4,637,079	502,826	10.84	49,734	9.89
2000	4,916,505	510,985	10.39	41.451	8.11
2001	5,123,418	532,084	10.38	53,883	10.12
2002 *	5,410,000	556,000	10.27	56,100	10.08
Growth rate (1998-2002)	4.21	0.25	-	5.87	-

Source: NESDB.
Note: * Forecast.

3.3 The agricultural sector

The agricultural sector in Thailand is composed of 6 sub-sectors, namely, crops, livestock, forestry, fisheries, agricultural services and simple agricultural processing. The major commodities usually come from crops and livestock. Having been a major sub-sector, forestry is currently in decline, whereas that of simple agricultural processing is emerging. In the distant past the Thai economy depended heavily on large exports of agricultural raw materials. Currently, agro-processing continues to play increasing roles in raising the value-added and raising farm income.

Currently, more and more emphasis is put on the development of agro-industry as some agricultural commodities are produced in excess of demand and price depression often occurs.

Holistically, the Thai economy continues to grow but mostly in the non-agricultural sector as mentioned earlier. (Table 3.2) Growth of the agricultural sector was only 0.25 per cent during 1998-2002 due to both production and trade problems. Most agriculture is still rainfed. Drought and intermission of the monsoon occurred in some years while major floods were also present causing losses to the harvested area. As a result production targets were rarely attained. In terms of trade, strong competition and trade protection often depressed the prices of many Thai farm commodities. Heavy farm subsidies and import controls, with non-tariff barriers, sanitary constraints and too high production standards from developed countries forced medium and small economies like Thailand, with smallholders as the majority, to readjust their production policies and structures requiring large investments. Thailand's major farm commodities being produced surplus to domestic demand include rice, cassava, para rubber, sugarcane, broilers and tiger prawns. Those insufficiently produced for domestic utilization are maize, soybean, palm oil, cotton, peanuts and mungbean.

3.4 Contribution of trade

As a developing country, Thailand is not able to afford sufficient public spending to fully assist its farm producers as is being done in developed countries. In fact, Thailand implements an export subsidy programme with the condition that manufacturers have to use local materials to a specified ratio in order to partly help the local farm producers. Investors who are granted Board of Investment (BOI) privileges are not required to pay tax on imported machinery and

corporate income tax is withheld for a certain period whereas the exporters have to help themselves when exporting.

Those who are not granted BOI privileges are entitled to an export tax refund for imported raw materials. WTO country members are allowed to protect their farm producers when there is evidence indicating that over importing is affecting its producers by allotting an import quota and fixing an in-quota tariff and a higher tariff for the out-quota imports. In this regard, Thailand permits liberal imports at zero tariff or a level lower than the bindings. However, the country is committed not to harm its producers.

3.5 Commodity balance sheet

During 1998-2002, based on Table 3.3, Thailand's total exports grew by 8.32 per cent which is lower than the growth rate of imports at 13.44 per cent. Similarly, growth in exports and imports of farm commodities were 5.63 and 11.33 per cent respectively, despite the country producing more. It implies that both locally produced and imported farm products were brought into processing.

During 1998-2002, maize and soybean production were less than usual because the two crops are rainfed and affected by floods and drought. Although during the same period cassava production increased, production in 2002 stood at less than in the previous two years because cassava production is very responsive to world prices of cassava pellets and slices.

Examining the figures in Table 3.4, imports of maize, soybean and its by-products, i.e. soybean meal, were more than that produced domestically. Besides human consumption, the rest of the soybean is usually processed into oil and meal. Huge quantities of cassava have been destined for export in the form of pellets, shredded cassava and flour. Domestic use of cassava, formerly non-existent, is now gaining momentum in feeding ruminants, e.g. cattle and dairy cattle. The use of cassava products is not popular for smaller animals such as swine and poultry.

Table 3.3 Exports and imports

Unit: million baht

Year	Export						Import					
	Total	Agricultural sector	% of total	Livestock*	% of agricultural sector	Animal feed	Total	Agricultural sector	% of total	Livestock*	% of agricultural sector	Animal feed
1982	159,728	107,820	67.50	2,676	2.48	1,584	196,616	24,796	12.61	2,238	9.03	1,540
1986	233,383	133,228	57.08	5,844	4.39	2,479	241,358	40,133	16.62	3,519	8.77	1,840
1990	588,157	224,168	38.11	11,670	5.21	3,848	852,982	125,711	14.73	13,622	10.84	8,524
1994	1,135,513	336,141	29.60	21,360	6.35	5,144	1,369,260	179,675	13.12	20,793	11.57	12,158
1998	2,242,534	585,687	26.12	42,050	7.18	10,408	1,774,050	226,827	12.78	31,784	14.01	15,245
1999	2,209,458	550,116	24.90	29,538	5.37	9,664	1,907,391	228,097	11.96	29,906	13.11	16,524
2000	2,764,352	626,286	22.66	34,027	5.43	11,596	2,494,133	275,459	11.04	32,451	11.78	19,580
2001	2,888,936	676,677	23.42	49,331	7.29	11,704	2,752,346	323,123	11.74	41,354	12.80	25,354
2002	2,923,941	694,403	23.75	53,731	7.73	13,617	2,774,840	325,957	11.75	35,123	10.77	23,348
Growth (1998-2002)	8.32	5.63	-	10.55	-	4.64	13.44	11.33	-	5.38	-	13.66

Source: Department of Customs.
Note: * live animals, animal products and milk products.

Table 3.4 Commodity balance sheet

Unit: million tons

Year	Maize				Soybean								Cassava*			
					Soybean				Soybean Meal							
	Production[1/]	Import[2/]	Export[2/]	Consumption[1/]	Prod.[1/]	Imp.[2/]	Exp.[2/]	Cons.[1/]	Prod.[1/]	Imp.[2/]	Exp.[2/]	Cons.[1/]	Prod.[1/]	Imp.[2/]	Exp.[2/]	Cons.[1/]
1998	4.617	0.142	0.144	4.615	0.319	0.687	*	1.006	0.606	0.957	-	1.563	15.591	-	4.120	3.114
1999	4.286	0.387	0.020	4.653	0.317	1.008	*	1.325	0.766	1.331	-	2.097	16.507	-	5.300	3.916
2000	4.462	0.006	0.281	4.187	0.313	1.290	*	1.603	0.707	1.299	-	2.006	19.064	-	4.661	4.515
2001	4.466	0.006	0.275	4.197	0.279	1.363	*	1.642	0.671	1.560	-	2.231	18.395	-	5.752	4.405
2002	4.230	0.005	0.163	4.072	0.261	1.529	*	1.790	0.799	1.752	-	2.551	16.868	-	3.802	4.295
Gr	-1.33	-3.47	33.23	-3.47	-5.15	20.95	-	14.65	4.30	14.66	-	10.98	2.69	-	-0.78	7.90

Source: [1/] OAE.
[2/] Department of Customs.
Note: Cassava * [1/] Production: fresh cassava roots.
[2/] Export: shredded cassava and pellets.
[3/] Consumption: shredded cassava.

4. Review of the Current Situation

4.1 Livestock production and consumption

Major livestock production in Thailand includes swine, broilers, layer hens, duck meat, layer ducks, dairy cows, beef cattle and buffalo. Most production continues to grow in response to both internal and export demand. In particular, broilers have long been one of the major export items in the form of frozen broiler meat and chicken products; and dairy cows of which the farming is continuously promoted by the government.

The production of broilers rose incredibly to 1,005 million birds in 2002 or 5.09 per cent growth from 829 million birds in 1998. Sixty to seventy per cent of broiler meat production is destined for domestic consumption with the rest for export. Hog production increased to 9.88 million heads in 2002, up 1.73 per cent per year from 9.38 million heads in 1998. Almost all pork products are consumed locally, totaling about 9.59 million heads in 2002. Dairy cow farming grew at a rate of 3.69 per cent per year with raw milk production at 437 thousand tons in 1998 increasing to 660 thousand tons in 2002. Almost all production of raw milk was processed into ready-to-drink milk products for the domestic market.

However, the production of layer hens, duck meat, layer ducks, beef cattle and buffalo experienced a declining trend. The decreased production of layer hens was less remarkable with the quantity of eggs produced in 2002 being 8,333 million against 8,583 million in 1998 or a –0.84 per cent growth rate per year. Nearly all egg production is locally consumed, with just a little excess supply for export. Production of duck meat fell by 12.24 per cent per year due to limited demand as prices for the ducks are relatively higher than that for broilers and Thai consumers do not favour the product. The number of the layer ducks fell by by 1.7 per cent per year because hen eggs are much more in favour. However, duck eggs are preferable when preparing Thai desserts as too are preserved eggs called “ten-thousand-year salted eggs” (a kind of duck egg preserved in potash or ammonia which has a typical black colour). Regarding cattle and buffalo, their population decreased by 2.24 and 8.83 per cent per year respectively. This is because of the reduction in pasture and public grazing lands which is the result of expanding housing construction. This is the limiting factor of production expansion in spite of various promotion programmes.

Table 4.1 Annual livestock inventory as of January 1, 1998-2002

Units: million heads

Year	Cattle	Buffalo	Dairy cattle	Hen layers	Duck layers
1998	5.159	2.286	0.336	42.59	11.00
1999	4.756	1.912	0.349	40.76	10.48
2000	4.602	1.712	0.362	41.68	10.60
2001	4.640	1.524	0.374	40.25	10.26
2002	4.664	1.613	0.389	40.68	10.20
Growth rates	-2.24	-8.83	3.69	-1.04	-1.70

Source: Office of Agricultural Economics.

Table 4.2 Production of livestock and livestock products

Units: millions

Year	Swine (mln heads)	Broilers (mln birds)	Eggs (mln pieces)	Meat ducks (mln birds)	Raw milk (thousand tons)
1998	9.379	829	8,583	20.98	437
1999	9.075	862	8,300	19.46	465
2000	9.493	902	8,540	17.80	520
2001	9.716	964	8,094	12.43	588
2002	9.876	1,005	8,333	13.67	660
Growth rates	1.73	5.09	-0.84	-12.24	11.17

Source: Office of Agricultural Economics.

Table 4.3 Livestock production and consumption in 2002

Item	Production	Consumption
Chicken (1,000 birds)	1,005,000	653,300
Swine (heads)	9,876,000	9,590,000
Cattle and buffalo (heads)	1,096,000	1,148,000
Eggs (million pieces)	8,333	8,294
Raw milk (tons)	660,000	652,000

Source: Office of Agricultural Economics.

4.2 Freshwater fish and marine production

Freshwater fish and marine fish production in Thailand comes from both culture and capture where the main aquaculture includes inland fish and black tiger prawns. In the five years, 1998-2002, however, tiger prawn production faced a slight decline of 0.13 per cent per year primarily due to outbreaks of disease and the product's price level. As much as 90 to 95 per cent of tiger prawn production is exported fresh chilled and frozen whereas the remaining of 5 to 10 per cent is consumed domestically. The inland fish culture grew markedly annually by 6.42 per cent, from 227 thousand tons in 1998 to 295 thousand tons in 2002.

Table 4.4 Freshwater fish and tiger prawn culture

Unit: thousand tons

Year	Freshwater fish	Tiger prawns
1998	227	249
1999	253	273
2000	271	303
2001	279	300
2002	295	236
Growth rates	6.42	-0.13

Source: Office of Agricultural Economics.

4.3 Feed crops and feed ingredients

Feed crops involved in animal feeding in Thailand include maize, soybean, rice and cassava. Maize is utilized directly whereas soybean is more commonly in the form of soy meal. Broken rice and bran are milling by-products and cassava chips and pellets are processed from cassava roots.

Compound feed ingredients for use in formula feeds are classified into major and minor groups. In the main group are maize, broken rice, bran, cassava chips, soybean, soy meal, fish meal and flour. The minor group of ingredients includes premix, vitamins, minerals, salt, antibiotics, etc.

In compound feed manufacturing, the main ingredients are commonly those principally composed of carbohydrates, sourced from maize, bran, broken rice and cassava slices, and the minor ingredients are mainly composed of soybean, fish meal and soy meal. For any type of feed there are usually several formulae; feeds having different combinations of the constituents depending on their price and nutritional value. A high priced feedstuff would normally be substituted by cheaper items. For example, broken rice is replaceable with maize, etc. In general, compound feed is usually composed of one or more constituents of the major nutrient group in percentages as follow:

- A swine feed is generally composed of 54 per cent broken rice, 25 per cent fine bran, 10 per cent soy meal and 4 per cent fish meal. Maize and broken rice are mutually substitutable. For a farmer making their own compound feed, the use of cassava slices is not popular, however, it is used in the feed industry.

- A broiler feed is commonly categorized into three stages of the broiler life. The main feedstuffs in use are maize, bran, soy meal and fish meal where the approximate proportions in the broiler rations are 52, 10, 28 and 6 per cent respectively.
- A layer hen ration is either industrially mixed or mixed privately on-farm which is commonly practiced. The main raw materials are maize, bran, soy meal and fish meal having approximate proportions of 53, 20, 17 and 5 per cent respectively.
- Dairy cow feed is largely fed to milking cows, comprising of raw materials that are locally readily available. The main raw materials include 50-55 per cent cassava chips, 10 per cent soy meal and 5 per cent maize. There are substitutes often in use: mungbean meal, peanut meal, copra meal, palm meal and kapok meal, etc.
- Black tiger prawn feed is readily compounded and concentrated with protein feedstuffs of fish meal and soy meal to the extent of 32 and 23 per cent respectively.

Table 4.5 Major ingredients of compound feed

Units: percentages

Ingredients	Swine feed	Broiler feed	Layer feed	Dairy cattle feed	Tiger prawn feed
Maize	-	52	53	5	-
Broken rice	54	-	-	-	-
Fine bran	25	10	20	-	-
Cassava chips	-	-	-	50-55	-
Soy meal	10	28	17	10	23
Fish meal	4	6	5	-	32
Wheat flour	-	-	-	-	24

Source: General formula, Livestock Development Department.

4.4 Historical review of the production of feedstuffs and uses

Since the recent past livestock production and aquaculture in Thailand have continued to grow, especially broilers and tiger prawns. Simultaneously, both the feed and raw materials are in greater demand. However, production of certain feedstuffs cannot be increased accordingly due to limitations of the planted area and the production efficiency has not been raised satisfactorily. As a result, some feedstuffs need to be imported, i.e. maize, soy meal and fish meal of superior quality, to satisfy the demand.

The major feedstuffs used in making feed are as follows:

1. **Maize** is the main ingredient used in manufacturing feed, for broilers and swine in particular. Formerly, Thailand was self-sufficient in producing maize, however, the rapidly expanding animal industry requires more maize so that Thailand continues to export less and less. The exporters were in competition with the feed mill operators in purchasing the local maize so that there were times of shortages and high prices. 1992 marked the first year of maize imports (347 thousand tons) which were aided by the government momentarily reducing the tariff of 6 per cent to zero with no special levy.
2. **Soy meal** production can satisfy 30-40 per cent of domestic demand and the rest is met by imports. As the demand for soy meal has risen, 10.98 per cent per year during 1998-2002, imports followed. Part of the soy meal locally produced came from soybean imports which are also on the increase. The increase can be explained by the liberal imports of soybean due to the reduced, zero per cent tariff. While a portion of the imports are crushed the other part is used as a feedstuff, a soy meal substitute.
3. **Broken rice and bran**. In the process of rice milling, about 15 per cent becomes broken rice and 11 per cent bran (coarse and fine). As Thailand is a leading rice producer and exporter, the volume of broken rice and bran by-products has been adequate for use as feed ingredients.
4. **Cassava** chips are used as one of the feed ingredients mainly for dairy cows. Although there has been a government promotion programme on more use of quality cassava

chips, current cassava production provides enough supply for local use which is now less than 5 per cent of production while the major cassava export items are pellets and flour.

5. **Fish meal**. Currently there are 119 fish meal mills with a combined annual production of 5-6 hundred thousand tons. While the majority of production has a protein content of less than 60 per cent, the superior grade product makes up about 10 per cent of the total. Requiring the fish meal of superior grade, the expanding tiger prawn culture has pressed for increasing fish meal imports.

Table 4.6 Production and use of feedstuffs

Units: thousand tons

Items	1993		1998		2002	
	Production	Consumption	Production	Consumption	Production	Consumption
Maize	3,672	3,300	4,617	4,615	4,230	4,072
Soy meal	385	960	606	1,563	799	2,551
Cassava [1/]	20,203	161	15,591	3,114	16,868	4,295
Fish meal, superior grade	523	645	624	611	570	589
Broken rice	1,521	1,317	1,781	1,701	1,967	1,573
Bran	2,176	1,873	2,548	2,206	2,814	1,853

Source: Office of Agricultural Economics.
Note: [1/] Production = fresh root cassava.
Consumption = shredded cassava.

4.5 Agro-industrial and feedstuff processing industries and policies

4.5.1 Agro-industries

Agro-industrial development has been increasingly important to the national economy because Thai agriculture in the past was oriented to export traditional farm produce but the value was limited. The value-added generated by agro-processing benefits farmers too. Farm produce requiring only simple processing can be produced in farm households at low cost and is mostly consumed locally, e.g. canned water chestnut, pineapple paste, etc. However, many farm commodities are industrially manufactured and become important export items, e.g. canned pineapple, canned lychee, dried lychee, dried fruits, canned baby corn, fresh, frozen and processed meat, cigarettes, cassava chips and pellets, etc.

Table 4.7 Export of agro-industrial products

Year	Chicken meat [1/]		Cassava chips and pellets		Canned pineapple		Lychee and its products		Canned baby corn	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1998	284	25,293	4,120	11,455	316	10,471	7	527	58	1,823
1999	265	21,195	5,300	12,406	604	16,461	60	2,097	55	1,495
2000	310	24,439	4,661	7,699	580	12,079	171	5,052	58	1,732
2001	399	35,483	5,752	8,949	547	13,024	139	3,652	66	1,969
2002	434	36,112	3,802	8,207	504	14,063	156	3,726	65	1,817

Source: Department of Customs.
Note: Q = quantity : 1,000 tons.
V = value : million bath.
[1/] Fresh, frozen and processed chicken meat.

4.5.2 Feedstuff processing industries

More than 1,000 mill operators manufacturing compound feed registered with the Ministry of Industries in 2002. They comprise of those making feed for livestock, inland and marine animals together with those making feedstuffs such as fish meal, cassava chips, soy meal, etc. Besides, there have been both small-scale and large-scale operators manufacturing feed for private use. Only those that intend to sell have to request a marketing license of livestock feed from the Department of Livestock Development and anyone who wants to sell

feed for aquatic animals has to obtain a sale permit from the Department of Fisheries on an annual basis. Moreover, one is required to deliver a sample of feed of individual formula for examination to proceed with quality control. In 2002 alone, 170 feed manufacturing plants registered to sell their compound feed. These plants are scattered around the country but concentrated in the Central Region, i.e. 70.59 per cent (Table 4.8), as the Central Plains is both the major producing area of feed crops and has a concentration of livestock production and aquaculture too.

Table 4.8 The number of compound feed manufacturing plants in Thailand, 2002

Region	Number	%
Central	120	70.59
Northeast	26	15.29
North	15	8.82
South	9	5.29
Total	170	100.00

Source: Department of Livestock Development and Department of Fisheries.

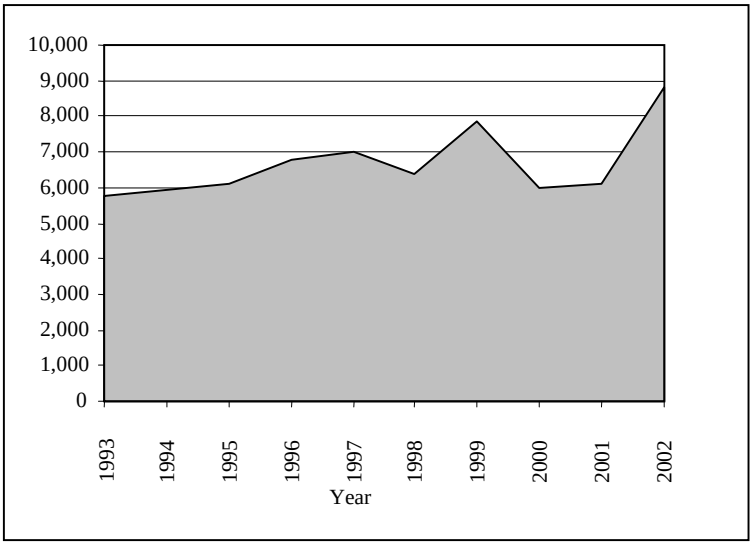
Table 4.9 Animal compound feed production registered at the Ministry of Industries, 2002

Unit: 1,0100 tons

Item	Production	%
Broiler	3,354	37.67
Layers hens	1,735	19.49
Swine	3,113	34.97
Cattle	38	0.43
Dairy cattle	386	4.34
Duck	260	2.92
Others	16	0.18
Total	8,902	100.00

Source: Department of Livestock Development.

Figure 4.1 Animal compound feed production, 1993-2002



Source: Department of Livestock Development.

Table 4.10 Compound feed production registered at the Department of Livestock Development, 1993-2002

Unit: 1,000 tons

Year	Production
1993	5,749.8
1994	5,908.9
1995	6,102.9
1996	6,800.0
1997	7,002.4
1998	6,398.2
1999	7,872.5
2000	5,963.3
2001	6,116.8
2002	8,848.3

Source: Amornthewaphat, Natchanok. Status of Animal Feed Industries in Thailand, Nov. 2003

4.5.3 Agro-industrial policies

Thailand has implemented agro-industrial development policies with the major objectives of generating value-added and enhancing quality improvement of farm commodities by arranging for the safety of food and agricultural products, an accreditation system for agro-industrial plants, and advisory services, with funding of any factory modifications as required. Currently there are about 12,000 small-scale food and agro-processing plants including rice mills. Of which only 264 plants, i.e. 2 per cent are accredited for HACCP standards due to a lack of investment and understanding of the rules for handling GMP and HACCP practices. The government distributes funds for enhancing the standards of the SME industries making food and agricultural products in particular, via both the SME Bank and other financial sources.

With respect to investment promotion, activities in agricultural production are of prime importance based on the rules of the Board of Investment (BOI). An activity with a minimum investment of one million baht (excluding the land asset and the operating capital) will have access to tax privileges. Feed manufacturing is certainly one such activity. Initially such an activity was extensively granted BOI privileges. However, later on, feed mills located themselves more and more around Bangkok's perimeter and as a result, BOI ruled in favour of only giving its privileges to feed mills located in a designated promotion zone. The privileges include exemption from tariffs for machinery imports, exemption from corporate income tax for 8 years and a further reduction for 5 years of 50 per cent, and exemption or reduction of the tariffs on the raw material imports or the necessary supplies.

4.6 Agricultural policies

4.6.1 Production policies

In order to enhance the competitiveness as a quality source of agricultural and agro-industrial commodities, Thailand has implemented a policy on restructuring potential production under a more liberalized market mechanism by classifying 3 groups of farm commodities. Firstly, an export-oriented group of rice, cassava, broilers, and tiger prawns, etc. Secondly, a commodity group for domestic consumption, i.e. maize, swine, layer hens, beef cattle and dairy cattle and, thirdly, a deficit commodity group of soybean, etc. Besides, public policy has been implemented to enhance the production efficiency and reduce costs, with research on production, technological development and transfers to the farmers. With regards to crops, research and development (R&D) on the variety and production system of the economic crops is conducted for quality and adequacy of supply and agro-economic zoning by commodity with a provision of incentives for production system restructuring.

Regarding livestock development, research on products, artificial insemination, breed upgrading, feeds and feeding, animal health and veterinary care are currently conducted together with activities of livestock farm registration. Regarding fisheries, ongoing research is being carried out on culture, marine industrial development and aquaculture system improvement together with production zoning.

With regards to processing and quality enhancement, a government body has been recently set up to supervise farm commodity standards and simultaneously promote exports with the tools of central and specialized laboratories, certification where necessary of the crop commodities, examination and certification of livestock commodities, quality analysis of meat and meat products, and certification and quality analysis of marine products.

4.6.2 Price policies

Since the prices of agricultural commodities often fluctuate markedly, a major objective of the public price policies has been to stabilize them so that the prices received and therefore the earnings of farm producers would become more constant. However, for a long time public price policies have been designed to remedy farm price depressions and the major policy measures of market intervention of farm purchases and farm mortgage schemes have long been introduced and mostly implemented through the Farmers Aid Policy and Measure Committee (Kor Chor Khor) which sets the criteria and method of farm marketing assistance and farm inputs. It also sets a target farm price and approves funding when the market price is low or expected to be lower than the target price over a period of time. Such intervention ceases when market prices rise or are expected to rise. The commodities under such an intervention programme, which has often been entrusted to a responsible agency, include rice, maize, cassava roots, coffee beans, fruits, etc. and livestock commodities including hogs, broilers and eggs. Comparatively, the funds used in the intervention programme were very small compared to the total product value. For example, the budget used in the rice mortgage programme was less than 1 per cent of the total farm value. The agencies responsible for the farm mortgage schemes and the market intervention programmes have been the Ministry of Agriculture and Cooperatives (MOAC), the Ministry of Commerce (MOC) and the Ministry of Finance (MOF)

4.7 General marketing and trade policies

4.7.1 Monetary and exchange rate policies

Thai policy on the exchange rate after World War II up to 1997 was principally tied to a basket of currencies or a pegged exchange rate. The baht was also initially tied to gold. Afterwards, it was involved in a pegged exchange rate during 1981 to the middle of 1997. Under the pegging system, the Exchange Equalization Fund: EEF was responsible to notify and protect the baht in relation to the US dollar. However, since July 1997 Thailand changed its stance to a managed float exchange rate in which the value of the baht in relation to other currencies has been fixed by the market mechanism of current supply and demand for the currencies in the domestic and overseas markets which may vary over time depending on the economic condition. As such, the Bank of Thailand may intervene through the purchase or sale of US dollars in times of necessity to keep an effective exchange rate relatively stabilized and also to attain the goal as specified in the national economic policy.

4.7.2 Policy reform initiatives

4.7.2.1 Feedstuff policy

The fast expanding livestock industry and the resulting greater demand for feedstuffs, maize and soybean in particular, have impelled the government to implement policy on enhancing farm production efficiency and cost reduction. Regarding soybean production, which

is often in great shortage, a promotion programme designed to both designate suitable areas and improve yields has long been underway.

Since 1982, soybean imports required a permit and mills were forced to buy locally produced soybean at a fixed price. Since 1983, the collection of tariffs on the imported soybean and soy meal at 0.30 baht per kg or 6 per cent of the import value began with a special levy of 10 per cent over the tariffs. Since 1984, importers of soy meal must seek approval through a quota allotment and importers have also been required to buy crushing mill's soy meal at a specified ratio.

With respect to maize, before 1970, liberal imports were allowed at a tariff of 2.75 baht per kg or 87 per cent tariff. Imports of fish meal were occasionally permitted at 10 per cent of the import duty.

It was from 1990 and thereafter that the increasingly expanding livestock and aquaculture industries prompted more demand for soybean, maize and fish meal. Consequently, a liberal import policy on the 3 feedstuffs was implemented with adjustments for a tariff of 6 per cent added with a surcharge in the case of the import price being lower than the domestic price.

Since 1995, Thailand has complied with WTO rules and as such, the special levy measure was entirely abolished and a tariff quota system has been introduced instead for soybean, soy meal and maize. Being a fisheries product, fish meal is not under the Agreements on Agriculture, therefore, currently, the fish meal of superior grade (60 per cent protein content and above) is subject to a tariff of 15 per cent. That below 60 per cent protein is charged 6 per cent import tax. Maize is charged with a 20 per cent tariff rate. However, an out-quota import of the product is charged a special levy of 180 baht per ton. Imports of soybean and soy meal have been liberalized at zero tariff for the in-quota and 6 per cent rate for the out-quota.

The imports discussed above are regulated by the National Food Policy Committee which decides the in-quota allotment, tariff and a special levy according to annual production and the marketing situation of the commodities.

4.7.2.2 Feed policies

The Feed Quality Control Act has long been in force establishing and regulating feed quality by the share of protein, fat, fiber and moisture in a feed formula. Furthermore, it prescribes the use of chemical products, packages, characteristics of a feed, adultery and degradation.

Amendments to the act currently relate feed quality control to feed combinations and the compound feed by type and age of the livestock and to the quality of the feedstuffs too. A compound feed manufacturer is required firstly to register his feed formula and a feed dealer has to seek a license from the Feed Quality Control Division, Department of Livestock Development prior to the business operation.

The investment incentive provisions of the BOI take into account the type of feed, location of the plant and the export programme. Initially during 1969-1977, the agency promoted extensively, however, as went on time, more feed mills began to concentrate around Bangkok and neighboring provinces which caused concerns and, as a result, investment promotion zones have been designated.

Control of feed exports have been administered formerly. As domestic production of feed is adequate, exports of feed supplements and compound feed are not under any extended control but their quality is monitored and controlled.

The retail price of feed is regulated by the Ministry of Commerce and any request for a feed price increase must be made and approved by the agency.

5. Demand for Feedstuffs and Feed Crops

5.1 Consumption structure and characteristics

Rice is among the four feed crops under study. Although it is the staple food in Southeast Asia, milled rice by-products (for example, broken rice) are fed to livestock as sources of both energy and protein. The feeding is for all types of livestock, but mostly to hogs for which the contribution of milled rice by-products is 50-55 per cent.

Half of the local supply of soybean is usually processed for consumption and the rest is for crushing purposes. Soy meal, the crushed by-product, is used as a feedstuff. The imported soybean supply, about 6 times that of the locally produced volume, also goes to crushing (80 per cent) and the remaining 20 per cent is for steaming to make full-fat feedstuffs for livestock at the early stages of life, for example, weaning pigs. Soy meal, one of the major protein sources, is used for all types of livestock too, but mostly for broilers and its contribution in animal rations is 28 per cent. By origin, 6 per cent of the total soy meal in use is made from locally produced soybean, 25 per cent of it produced from imported soybean and another 69 per cent is available from direct imports.

Locally produced maize is almost all utilized as sources of energy and protein for livestock, the majority of which are broilers and layer hens. In livestock rations, maize contributes 50-55 per cent.

With respect to cassava, 78 per cent of the equivalent cassava root is manufactured for export with the rest being used locally. Exports are in the forms of cassava flour and chips in the proportions of 36 and 42 per cent of the fresh root respectively. Locally, it is used in the forms of cassava flour and chips in the proportions of 17 and 5 per cent respectively of the fresh root. Another 5 per cent of the root constitutes 50 per cent of the chips in dairy feed.

Most of the feedstuffs are used by large-scale companies manufacturing feed which are integrated through contract farming with either broiler, layer hen or hog farmers. The development of integrated private companies has incorporated many related activities such as breeding, making feed, raising, processing and marketing as well as the government policies which facilitated these developments. Several hog and layer hen farmers who operate by themselves prefer to make compound feed for private use enabling cheaper production costs.

Use of feedstuffs during 1998-2002 has been on the rise in line with the increasing livestock population.

Table 5.1 Demand for feedstuffs, 1998-2002

Unit: million tons

Item	Year				
	1998	1999	2000	2001	2002
Maize	3.517	3.456	3.554	3.652	3.790
Soybean meal	1.793	1.740	1.815	1.855	1.896
Broken rice	2.068	1.547	1.673	1.497	1.556
Cassava slices	0.186	0.192	0.197	0.184	0.193

Source: Animal Feed Association of Thailand.

5.2 Consumer price behaviour

Consumer prices fluctuate largely depending on farm prices which vary according to world production, prices and the number of buyers. In the case of broken rice and cassava slices which are produced domestically as well as exported in large quantities, they are shipped by a small number of exporters. Similarly, the wholesale prices fluctuate along with local production

and farm prices too. Since 2000, Thailand has produced and exported larger rice quantities. Consequently, milled rice-products are in greater volume encouraging lower wholesale prices for broken rice than in past years.

Exports of cassava chips have been facing decline, thus depressing the wholesale prices. Maize is monopolistically bought by a small number of feed mills which fix their buying prices that are transmitted to local and farm prices. In a year of maize shortages and high prices of broken rice substitutes, imports are made at a price lower than the local price. Since 2001, Laos has been the single outsource of Thailand's maize imports. The imported price is very low and even lower than the wholesale price of local maize.

Since the trade in soybean and soy meal has been liberalized, the locally produced crop has had its minimum price fixed by the government. In spite of this the import prices for both commodities have continued to be lower than the wholesale prices of both domestic farm products.

Table 5.2 Wholesale prices and import prices of feedstuffs, 1998-2002

Unit: baht/kg

Year	Broken rice	Soybean		Maize		Cassava slice
	Wholesale[1/] price	Wholesale[1/] price	Imported[2/] Price	Wholesale[1/] price	Imported[2/] Price	Wholesale[1/] price
1998	8.69	11.36	11.07	4.97	4.90	3.01
1999	7.91	10.62	7.99	4.64	4.28	2.43
2000	5.28	11.01	8.70	4.76	4.26	1.81
2001	5.31	11.25	9.20	4.36	1.99	2.27
2002	5.79	11.90	9.06	4.68	2.05	2.77

Source: [1/] Center for Agricultural Information, Office of Agricultural Economics.
[2/] Department of Customs.

5.3 Response to government policies, market and non-market forces

In this section, how the demand for rice, maize, soybean and cassava responds to market forces and other pertinent factors are analyzed by building econometric models, from which estimates are derived as shown below:

5.3.1 Rice

Domestic demand

$$\underset{t-stat}{\ln CONS} = 7.74 - \underset{(-3.18)}{0.016}\ln Pr + \underset{(3.03)}{0.11}\ln Pw - \underset{(-5.23)}{0.26}\ln GDPt$$

$R^2 = 0.77$ D.W. = 1.62
Sample period = 26 (1977-2002)

Export equation

$$\underset{t-stat}{\ln EXPT} = 24.86 - \underset{(-5.33)}{0.24}\ln Pfob - \underset{(-5.79)}{1.49}\ln PRODw + \underset{(13.98)}{0.67}\ln GDPw + \underset{(4.49)}{0.20}D32$$

$R^2 = 0.90$ D.W. = 2.08
Sample period = 26 (1977-2002)

On the basis of the domestic demand equation for rice, the major factors affecting demand are the retail price of milled rice, the retail price of wheat flour; a rice substitute, and income per capita. The response of the demand to changes in price and income is slightly elastic, i.e. an increase of 1 per cent in the retail price of rice would cause a 0.06 per cent

reduction in the demand. On the other hand, a 1 per cent rise in the retail price of wheat flour would increase the demand for rice consumption by 0.11 per cent. Furthermore, a rise of 1 per cent in income would induce a reduction in the demand for rice by 0.26 per cent. Comparatively, among the major factors, income most strongly affects the demand for rice, and when the population's income rises, the demand for rice declines as people turn to better protein sources.

With reference to the equation on rice exports, the factor most affecting Thai rice exports is the f.o.b. price, the rice supply in Thailand's trading partners or in the major competitors, the average income per capita in the main trading partners and the dummy variable representing the abnormal phenomena in 1989 when droughts affecting rice production in almost all rice producing countries boosted Thai rice export volume. Rice export quantities respond with little elasticity to the f.o.b. prices and population's income, that is, an increase of 1 per cent in the f.o.b. price of rice would reduce the exportable rice supply by 0.24 per cent. However, if the income of people in Thailand's trading partners is raised by 1 per cent, the exportable rice supply would rise by 0.67 per cent. On the contrary, the response of rice exports to rice production in Thailand's trading partners or competitors is elastic; an increase of 1 per cent of rice production in Thailand's trading partners or competitors would have Thai rice exports fall by 1.49 per cent.

5.3.2 Maize

Demand for feed

$$\begin{array}{lccccccc} \ln CON & = -2.00 & -0.42 \ln SiloPrice & +0.19 \ln BrokeRice & +0.21 \ln EggPrice_{t-1} & +0.31 \ln Broiler & +1.09 \ln Pig \\ t\text{–stat} & & (-2.52) & (2.01) & (1.49) & (1.92) & (4.58) \end{array}$$

$R^2 = 0.91$ D.W. = 2.11
Sample period = 26 (1977 - 2002)

The equation for domestic demand for maize indicates that the major factors affecting demand include the wholesale price of maize, the price of broken rice which is a maize substitute, the price of the eggs, price of the broilers and number of hogs. The estimation of the response of maize demand to changes in prices shows that maize prices predominantly affect maize demand, having an elasticity of -0.42. This means an increase of 1 per cent in the maize price would induce a fall of 0.42 per cent in maize demand. Following the maize price are the price of the broilers, the price of the eggs and the price of broken rice, with elasticities of 0.31, 0.21 and 0.19 respectively. That is, in case of a rise of 1 per cent in the prices of broilers, eggs and broken rice, the demand for maize would increase by 0.31, 0.21 and 0.19 per cent respectively. Also, an increase of 1 per cent in the swine population would induce a greater demand for maize by 1.09 per cent.

5.3.3 Soybean and soy meal

Demand for soybean

$$\begin{array}{lccc} \ln DBS & = -11.53 & -0.05 \ln IPSB & +6.33 \ln POP \\ t\text{–stat} & & (-2.16) & (7.16) \end{array}$$

$R^2 = 0.91$ D.W. = 1.56
Sample period = 21 (1982 - 2002)

Soybean is mostly used for food which can not be substituted by other beans. The equation for domestic demand for soybean shows that the c.i.f. price of soybean and the population are factors most influencing the demand for soybean. The analysis of the response of

soybean demand to changes in price and population showed that the population has most affect on soybean demand, having an elasticity of 6.33 per cent. This means that if the population was to increase by 1 per cent, the demand for soybean would jump by 6.33 per cent, whereas if the c.i.f. price of soybean increased by 1 per cent it would cause a fall in soybean demand by 0.05 per cent.

Demand for soy meal

ln DSM = -0.11 – 0.08 ln IPSM + 2.27 ln BP
t-stat (-5.78) (18.88)

R^2 = 0.96 D.W. = 1.65
Sample period = 21 (1982 - 2002)

Factors affecting the demand for soy meal are the c.i.f. price of soy meal and the broiler population and these variables are already explained in the equation for the demand for soy meal above. The estimation of the response of the demand for soy meal to the c.i.f. price is of little elasticity. A 1 per cent increase in the c.i.f. price of soy meal would decrease the demand for soy meal by 0.08 per cent. On the other hand, the number of broilers shows a strong influence on soy meal. This means that a 1 per cent increase in the broiler population would increase the demand for soy meal by 2.27 per cent.

5.3.4 Cassava

Domestic demand for cassava chips and pellets

lnQDCSP = 0.014 – 0.0004lnPWCS
t–stat (–4.88)

R^2 = 0.67 D.W. = 1.86
Sample period = 25 (1977 - 2001)

Cassava has just been used in the feed industry recently and only in small quantities. In the past it has been mostly used for food, particularly cassava flour.

Since segregation of the data on cassava slices and pellets cannot be made, an aggregate demand equation has been formulated. As domestic consumption is mostly shredded cassava, the major factor affecting the consumption demand is therefore the wholesale price of cassava chips. The estimation of the domestic demand response on the chips and pellets to changes in the prices of cassava slices is slightly elastic. A 1 per cent increase in the price of the slices would reduce demand by only 0.0004 per cent.

Pellet export equation

lnQCP = 0.01 – 0.001lnPROT+ 0.001lnPBL
t–stat (–3.56) (2.01)

R^2 = 0.69 D.W. = 1.97
Sample period = 25 (1977 - 2001)

Since the Netherlands is the importing nation for countries in the EU; Thailand's major market of the pellets, the main effect on the pellet export quantities are the c.i.f. price at Rotterdam port and the barley price in Germany, the major destination of the Thai pellets. However, the estimation indicates little impact of the two factors. A 1 per cent increase in the c.i.f. price in Rotterdam would reduce Thai pellet exports by 0.001 per cent whereas a 1 per cent rise in the German barley price would raise exports by only 0.001 per cent.

5.4 Development of products

The feed industry is one of the major agro-industrial developments of the country as it productively absorbs farm produce and the by-products of agro-industrial plants to generate value-added and, at the same time, promote exports of livestock products. More than 60 per cent of the feed cost constitutes the cost of production of most types of the livestock, and hence, producing quality feed raises the potential of livestock production.

Since animal husbandry is scattered around the country and most of the feed mills are concentrated in the Central Region, production of feed is classified into two types, namely concentrates and complete compound feed. Concentrates are livestock feed nutrients of protein, vitamins and minerals which the farm operators mix themselves with the carbohydrate feedstuffs before feeding whereas the complete compound feed comprises of the whole range of available feed nutrients for ready feeding.

In an effort to have the introduction of food standards well recognized along with safety awareness in the whole food chain and consequently to enhance exports of livestock products, the Department of Livestock Development, overseeing both the production of livestock and feed has introduced a quality assurance system in part to win the confidence of both the domestic and overseas consumers, by adopting Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP) and has subsequently, since 2001, trained government and private officials in this regard. As a result, feed mills are undergoing 'facility improvements' to work with GMP and HACCP and, as of 2002, 23 feed plants were GMP certified and 11 feed factories out of 170 were HACCP certified as well.

5.5 Projections to 2015

As the Thai staple food, rice is traditionally cultivated and consumed no matter how much its prices swing up or down. Table 5.3 demonstrates that the demand for rice in the form of paddy for the Thai people continues to grow following population increases. The demand for soybean, despite being not much used for direct consumption purposes, for crushing for oil and meal is very great, making the total demand for soybean greater. The real demand for maize will not necessarily be much as it can be substituted by other farm products.

Again, the demand for cassava, which is not for direct consumption and the local use as feed is not great, will continue to be ordinary. The trend for cassava chip exports will rise gradually whereas pellet exports will face decline.

Table 5.3 Demand projections for feed crops and feedstuffs, 2003-2015

Unit: million tons

Year	Feed crop		Feedstuff			
	Paddy rice [1/]	Soybean [1/]	Broken rice [2/]	Maize [1/]	Soy meal [1/]	Shredded cassava [1/]
2003	14.470	1.796	2.032	4.373	3.433	0.403
2004	14.512	1.904	2.060	4.464	3.638	0.404
2005	14.567	2.018	2.080	4.587	3.849	0.401
2006	14.623	2.137	2.100	4.627	4.067	0.403
2007	14.687	2.263	2.124	4.732	4.291	0.403
2008	14.746	2.395	2.143	4.838	4.521	0.402
2009	14.804	2.533	2.163	4.946	4.757	0.403
2010	14.863	2.679	2.183	5.060	5.000	0.403
2011	14.921	2.832	2.203	5.176	5.249	0.402
2012	14.981	2.993	2.224	5.326	5.504	0.402
2013	15.039	3.162	2.225	5.346	5.765	0.402
2014	15.097	3.338	2.225	5.382	6.032	0.403
2015	15.155	3.524	2.226	5.419	6.306	0.403

Source: [1/] Model forecasting.
[2/] Author's estimation: the broken rice is obtainable as 7.9 per cent of the paddy rice.

To conclude, the demand for all types of feedstuffs relies heavily on increases in the livestock population requiring a specifically increasing volume of broken rice, despite the substitutability of maize. In the event a feedstuff becomes expensive, feed mill operators opt for another type that is cheaper. An increase in the demand for feedstuffs, i.e. maize, soy meal, broken rice and cassava chips follows the increase in the livestock population. Therefore, the demand for them will increase to 11.302 thousand tons in 2015 from 7,890 thousand tons in 2003 while the total requirement for compound feed will is projected to increase to 17,367 thousand tons in 2015 from 12,067 thousand tons in 2003. The demand for the four types; maize, soy meal, broken rice and shredded cassava are expected to be 5,744, 2,741, 2,381 and 436 thousand tons in 2015 from 3,912, 1,758, 1,938 and 282 thousand tons in 2003.

Most of the maize and soy meal would go to broiler production; 3,546 and 1,909 thousand tons in 2015 from 1,953 and 1,052 thousand tons in 2003 respectively, and broken rice would mostly be used in the swine industry; 1,788 thousand tons in 2015 from 1,455 thousand tons in 2003 (Table 5.4).

Table 5.4 Demand for the feedstuffs and feed projected on the basis of demand by livestock type, 2003-2015

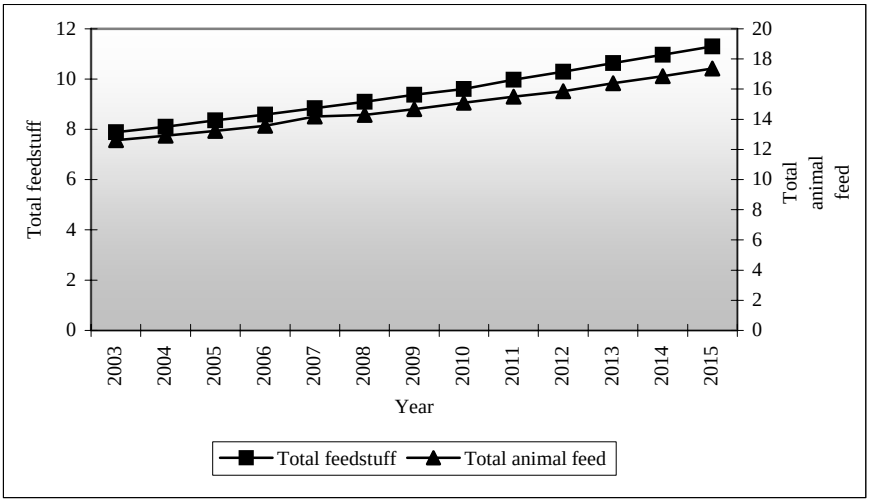
Year	Broiler		Hen Layer		Swine	Feedstuff					Total[2/]
	Maize	Soy meal	Maize	Soy meal	Broken rice	Maize	Soy meal	Broken rice	Shredded cassava	Total[1/]	Animal feed
2003	1.953	1.052	0.838	0.137	1.455	3.912	1.758	1.938	0.282	7.890	12.607
2004	2.053	1.105	0.839	0.137	1.480	4.206	1.818	1.971	0.293	8.108	12.905
2005	2.158	1.162	0.841	0.137	1.506	4.169	1.884	2.005	0.303	8.361	13.219
2006	2.267	1.221	0.843	0.137	1.532	4.276	1.953	2.041	0.314	8.584	13.574
2007	2.383	1.283	0.845	0.138	1.559	4.409	2.028	2.076	0.326	8.839	14.186
2008	2.504	1.348	0.846	0.138	1.586	4.551	2.100	2.112	0.337	9.100	14.287
2009	2.632	1.417	0.848	0.138	1.613	4.698	2.181	2.148	0.350	9.377	14.680
2010	2.766	1.489	0.850	0.139	1.641	4.857	2.203	2.185	0.362	9.607	15.086
2011	2.907	1.565	0.852	0.139	1.669	5.020	2.354	2.221	0.378	9.973	15.509
2012	3.055	1.645	0.853	0.139	1.698	5.194	2.443	2.262	0.392	10.291	15.864
2013	3.211	1.729	0.855	0.140	1.728	5.386	2.540	2.301	0.406	10.633	16.395
2014	3.375	1.817	0.857	0.140	1.758	5.565	2.640	2.341	0.421	10.967	16.862
2015	3.546	1.909	0.860	0.140	1.788	5.744	2.741	2.381	0.436	11.302	17.367

Source: Calculation of number of livestock multiplied by standard feed formula

Note: [1/] Total feedstuffs include maize, soy meal, broken rice and shredded cassava that are expected to be required by all livestock types.

[2/] Total animal feed is estimated based on the demand of each major livestock type.

Figure 5.1 Demand for total feedstuffs and total feed projected on the basis of individual demand by major livestock type, 2003-2015



Source: Calculation of number of livestock multiplied by standard feed formula

Note: - Total feedstuffs include maize, soy meal, broken rice and shredded cassava that are expected to be required by all livestock types.

- Total animal feed is estimated based on the demand for each major livestock types.

6. Supply of the Feedstuffs and Feed Crops

6.1 Production structure and characteristics

6.1.1 Rice

The milled rice by-products of this staple food are in annually abundant supply as major feed ingredients. Rice is produced in all regions of Thailand by the small farmers in more than 4.17 million households, with the average rice planted area of 16 rai, and having a non-glutinous rice to glutinous rice ratio of 3 : 1 from many rice varieties improved by the responsible state agencies. The majority of production comes from the Central Plains which is largely irrigated thus enabling two rice crops annually. The Central Region accounts for about 10 per cent of the national rice area. In a year of regular monsoon and no unpredictable incidence of pest and disease, the rice supply is usually plentiful. Annual cultivation of rice is the farmers' traditional way of life, regardless of normal rains or otherwise and irrespective of the price level of the crop in the previous year. Farmers have firstly to satisfy their family's consumption needs. Despite consuming more irrigation water and the presupposed government information suggesting possible water insufficiencies or a lowered farm gate price, a second cropping of rice commonly follows.

A part of the rice harvest is selected as seeds, another part for home consumption and the rest is for sale, except for those who own a storage facility in which case the last rice portion is kept awaiting a better price.

6.1.2 Soybean

Areas suitable to grow soybean are located in the north with approximately 120,000 farm families. The average planted area per household is just 7 rai as the crop needs more attentive irrigation, fertilizers and weeding, and recently farmers have turned to other crops paying better returns. Soybean is grown twice annually; a monsoon crop and a dry season crop. The rainy season crop is usually harvested in August to December, and the dry season crop in March to April.

6.1.3 Maize

Maize is mostly grown in the north and northeast by approximately 350,000 farm families. Being entirely rainfed, it depends on receiving enough rain, particularly during blossoming and earing. If insufficient, yield will decrease. The maize harvest is usually from April to May. The seeds in use are available from both state agencies and private businesses producing hybrid maize seeds. Privately produced seeds are much more expensive but return higher yields.

6.1.4 Cassava

Cassava grows quite well in the arid, sandy loam and most is planted in the northeast and the east by about 500,000 farm families with three improved varieties available having higher starch content. It is common practice for farmers to neglect weeding and only apply minimal amounts of fertilizer resulting in low yields. At times, farmers will leave their cassava crop to grow a competitive crop and then come back to pick the roots when they reach harvest time. There are even cases of harvesting too late results in roots with reduced starch content. Besides, some farmers do not take good care when picking, mixing foreign materials such as dirt, sand

and pieces of the cassava stems, thus affecting the prices received. Usually 80 per cent of cassava is planted during April to May with the remaining 20 per cent in September to October.

6.2 Producer price behaviour

6.2.1 Feed crop prices

As most Thai farm producers are smallholders, the farm price received has an immediate effect on family income. As a result, the government needs to implement a measure of market intervention early in the harvesting period just before the market is overwhelmed by the new harvests and the farm prices become depressed.

Rice

A rice mortgage scheme is implemented in some years at 90 per cent of the farm price. The paddy may be kept in farm storage or be delivered to a designated warehouse or to a private mill joining the scheme as directed.

Soybean

Compared with other crops of the same growing period, soybean supplements farm income well enough that the growers are unlikely to switch to other crops. However, to protect them, the government has made an agreement with importers and crushers of soybean, liberalizing soybean imports at zero tariff, but locally produced soybean must be purchased at a price agreed upon and overseen by the National Soybean and Oilcrops Committee represented by the Ministry of Commerce (MOC), Ministry of Agriculture and Cooperatives (MOAC), Ministry of Industry (MOI) and private businesses concerned.

Maize

Most maize production is sold immediately after harvest due to the necessity of households to repay outstanding debts and cover daily expenses. Maize harvests frequently have a high moisture content and are marketed at almost the same time. Consequently the oligopolistic maize buyers can select which maize to buy and the small farmers have little or no negotiating power while the feed millers (the buyers) can set their buying price and transmit it through the regional traders and assemblers to the farmers. In this regard, in a year of abundant maize supply and lowered world price, the National Food Policy Committee, represented by the MOAC, MOC and private concerns intervenes with a maize mortgage programme.

Cassava

Beside the dependence on starch content of the roots and contaminants, cassava farm price relies on world prices of cassava chips and pellets. In the event of low world prices for cassava products, exporters hold their exports and fix a lower price for the fresh cassava roots or they hold back buying with a false claim that the warehouses are full of stock. Consequently, in a year of depressed prices for the cassava roots, the government steps in with an intervention mechanism in the fresh root market. A quantity of the fresh roots being mortgaged are processed into starch and slices by the manufacturers who join the project and then sold.

6.2.2 Product prices

Public pricing policies of feed crops including rice, soybean and maize are already discussed in 6.2.1. However, their wholesale and retail prices are left open to market forces, except for the soy meal produced locally for which a minimum price is fixed by the government. Soy meal importers are required to purchase a set amount from local growers to be consistent with the local price for local soybean. In this regard, a crushing mill can sell soy meal

at a price higher than that produced from the soybean imports because it is fresh, non-GMO soy meal.

Compound feed has its wholesale price regulated by the Ministry of Commerce and the selling price cannot exceed the maximum set price. However, a feed mill operator may be permitted to have his feed price adjusted upwards if he can justify it and the MOC rules in favour of the request. After an MOC notification, a new price can then be administered.

6.3 Response to government policies, market and non-market forces

In this section, analysis of the response of production of rice, maize, soybean and cassava to market and non-market forces and government policies is discussed by developing econometric models as analytical tools. The results of the estimation are presented below:

6.3.1 Rice

Supply equation

$$\underset{\text{t–stat}}{\ln PROD} = 8.53 + \underset{(2.66)}{0.15\ln Pfarm_{t-1}} - \underset{(-2.48)}{0.16Pfer_{t-1}} + \underset{(4.56)}{0.10\ln WATER} - \underset{(-3.68)}{0.10D_1} + \underset{(2.87)}{0.01T}$$

$R^2 = 0.90$ D.W. = 1.94
Sample period = 26 (1977 - 2002)

The major factors affecting Thai rice production include the farm price received in the previous year, the price of imported fertilizer in the previous year, the availability of irrigation water, a dummy variable representing a year of abnormally serious drought and the time trend representing technological advancements. The estimation shows that rice production usually responds less to its affecting factors. A 1 per cent increase in the farm price received in the previous year would raise rice production by 0.15 per cent. A 1 per cent rise in fertilizer price would reduce rice production by 0.16 per cent. One per cent more availability of irrigation water would increase production by 0.1 per cent and technological progress shows a positive influence on rice production.

There are no significantly competitive crops for rice since rice is a cash crop which gives farmers good returns. Thus, most farmers grow only rice in a particular area, sometimes as many as three croppings per year.

6.3.2 Maize

Supply equation

$$\underset{\text{t–stat}}{\ln Prod} = 3.33 + \underset{(6.98)}{0.55\ln SiloPrice_{t-1}} - \underset{(-5.16)}{0.42\ln SuPrice_{t-3}} + \underset{(-1.81)}{0.08\ln CasPrice} + \underset{(3.03)}{0.35\ln Fer} - \underset{(4.81)}{0.14D}$$

$R^2 = 0.87$ D.W. = 1.98
Sample period = 26 (1977 - 2002)

The factors affecting maize production are the wholesale price of maize in the previous year, prices of its competitor sugarcane in the past three years, the prices of cassava roots and fertilizers, and lastly a dummy variable representing a year of abnormally serious drought. The estimation finds that maize production responds little to changes in the influencing factors. A 1 per cent increase in the wholesale price of maize would raise maize production by 0.55 per cent. A 1 per cent increase in the price of sugarcane and cassava would reduce maize production by 0.42 per cent and 0.88 per cent respectively. A 1 per cent increase in the fertilizer price would

reduce production by 0.35 per cent and an abnormal year of drought would cause a drop in maize production too.

6.3.3 Soybean

Area equation

$$\underset{\text{t-stat}}{\ln ASB_t} = 1.28 + \underset{(1.97)}{0.86 \ln FPSB_{t-1}} - \underset{(-3.79)}{0.85 \ln FPM_{t-1}} + \underset{(13.06)}{0.84 \ln ASB_{t-1}}$$

$R^2 = 0.78$ D.W. = 2.62
Sample period = 21 (1982 - 2002)

Yield equation

$$\underset{\text{t-stat}}{\ln YSB_t} = 5.26 - \underset{(-1.90)}{2.22 PFERC_t} + \underset{(3.23)}{0.0002 RAIN_{t-1}}$$

$R^2 = 0.82$ D.W. = 2.16
Sample period = 21 (1982 - 2002)

The acreage estimation model for maize indicates that the factors affecting the area given to the production of maize are the farm produce price of soybean received in the previous year, the farm produce price of maize received in the previous year as well as the harvested area of soybean. Results of the estimation show that the elasticity of the production in relation to the above-mentioned factors are similar. It means that if the farm produce price received in the previous year increased by 1 per cent, the area under soybean production would rise by 0.86 per cent. Furthermore, a 1 per cent increase in the area soybean under production in the previous year would raise the area planted with soybean by 0.84 per cent.

The yield estimation equation indicates the fertilizer price and the amount of rainfall in the pervious year to be the factors affecting soybean yield per unit area. A 1 per cent increase in the fertilizer price would reduce the yield per unit area by 0.19 per cent. On the other hand, a 1 per cent rise in the amount of rainfall would raise the yield by 0.27 per cent.

6.3.4 Cassava

Supply equation

$$\underset{\text{t-stat}}{SCAS} = 526.65 + \underset{(0.44)}{53 PCAS_{t-1}} + \underset{(8.06)}{2.14 AREA} - \underset{(-0.44)}{361.20 D}$$

$R^2 = 0.85$ D.W. = 1.76
Sample period = 25 (1977 - 2001)

Cassava is mostly grown in poor soil which is unsuitable for other crops, however, it can be substituted by maize in some areas but not many. The cassava supply equation describes the affecting factors as being the price received in the previous year for the fresh cassava roots, the planted area and a dummy variable representing the Planted Area Reduction Programme during 1984-1987. The supply estimation equation explains 85 per cent variation in the estimated cassava production. The statistical significance at the 99 per cent level supports the strength of the planted area variable. However, the coefficients of the price received for the fresh cassava roots and the dummy variable assures statistical non-significance. As the last two variables are the major factors in cassava production, they are included. The supply estimation equation implies that a thousand rai increase in planted area would raise the production of cassava by

2.14 thousand tons. The Planted Area Reduction Programme would reduce the production of cassava by 361.20 thousand tons.

6.4 Development of farming technologies and production arrangement

Thai agriculture is mostly operated by smallholders who ordinarily have little farm investment and lack fertile and suitable farmlands. Being rainfed, the majority of farmlands return low yields. As the youth of the farming community are not in favour of working on farms, those who are left are mostly elderly with little schooling who frequently resist the introduction of modern technology. In connection with technology oriented production development, training and promotion campaigns are often launched and agricultural development now looks brighter.

6.4.1 Rice

Improvements of rice varieties to become high-yielding, and pest and disease resistant has been quite remarkable. Solving the problems associated with acidic soils has been attempted and some varieties of rice that can grow well in acidic soils have been developed. The scented rice cultivars, including Hommali rice, are modified to be able to grow under different agro-climatic conditions. A breakthrough has been made of a new rice cultivation system that requires no prior tillage and the yields are comparable to the conventional tillage methods. Also a new stock of rice cultivars, upgraded by the state agency responsible is substituted every three years.

Harvesting rice is currently well mechanized, however, in the past, manual harvesting consumed much labour. After allocating rice for household consumption, the rest is immediately sold as most farmers have no rice barn for storage and they need the cash.

6.4.2 Maize

Improved seeds of hybrid maize are now used by almost all maize growers and modern farm technologies are employed from seeding through to harvesting. For example, spacing of the hills, number of maize plants per hill, application of fertilizers and post-harvest handling to ensure the maize grains are free from fungi, arranging a good drying yard and maintaining a good storeroom that is well ventilated and not subject to rains. Maize is usually sold right after harvest due to the non-availability of farm barns.

6.4.3 Soybean

The cultivation of soybean is quite well developed. Non-GM seeds are usually cultivated on well prepared plots of land. However, production expansion has yet to be realized because there has not been sufficient supply of the improved seeds produced by the state agency responsible and the farmers usually only grow the crop on small plots. Harvested soybean is kept in cloth bags waiting to be sold.

6.4.4 Cassava

As many as 90 per cent of cassava growers use seedlings with higher starch content improved by the state agency. However, cassava planted areas are normally classified as infertile. In this respect, farm recommendations are transferred on the use of green manure for improving the soils, but few farmers follow them. In terms of harvest management, mechanized picking of the cassava roots is recommended to keep the fresh roots unbroken and to stop contamination with dirt and pieces of the plants' stem.

6.5 Projections to 2015

On the basis of the models built and illustrated in Section 6.3, projections for the production of paddy, broken rice, maize, soybean and fresh cassava roots for the coming 13 years (2003-2015) are made and shown in Table 6.1. Assuming no variation in the variables from the existing to the coming periods, the estimation finds that the production of paddy as well as broken rice will see increases on a rather constant scale. Similar to maize production, almost all broken rice will be directed to feed utilization. On the contrary, no expansion of the soybean cultivated area will be observed because there is only the state agency responsible for the development of the production of non-GMO soybean seeds. The productivity of the crop can only be increased with the enhancement of production efficiency. With heavy reliance on exports, cassava production will face decline. Provided that cassava utilization is in part diverted to other uses, such as the production of ethanol, there could be opportunities and the potential to produce more. As a matter of fact, Thailand is now conducting research on the impacts of using ethanol made from cassava and molasses.

Table 6.1 Production projections to 2015

Unit: million tons

Year	Paddy	Maize	Broken rice [1/]	Soybean [2/]	Fresh cassava roots
2003	26.110	4.736	2.032	0.295	16.659
2004	26.476	4.766	2.060	0.299	16.479
2005	26.731	4.827	2.080	0.302	16.609
2006	26.984	4.806	2.100	0.305	16.582
2007	27.292	4.876	2.124	0.309	16.557
2008	27.540	4.951	2.143	0.313	16.583
2009	27.797	5.030	2.163	0.317	16.574
2010	28.053	5.121	2.183	0.320	16.571
2011	28.314	5.215	2.203	0.324	16.576
2012	28.581	5.332	2.224	0.328	16.583
2013	28.589	5.385	2.225	0.332	16.507
2014	28.596	5.439	2.225	0.336	16.431
2015	28.803	5.493	2.226	0.340	16.355

Source: [1/] The broken rice is assumed 7.9 per cent available in the paddy milling.
[2/] Constant area * projected yield.

7. Trading of Feedstuffs and Feed Crops

7.1 Domestic and international trading

7.1.1 WTO

Trading in feedstuffs and feed crops can be liberally operated locally. The buyers are the producers of feed both for sale and direct feeding in the company's livestock programmes. Meanwhile, there are those farmers who buy the feedstuffs for self-mixing.

In international trading, certain restraints that are agreed upon and committed to have to be observed, especially for farm commodities that come under WTO commitments to introduce tariff quotas in importing. There are 23 Thai farm commodities that are listed and tied to the quota tariff system. Three feed crops included in this study that are on the list are as follows:

Rice and broken rice

May be exported liberally. However, imports must be of the quantity and tariffs bound by the WTO Agreement on Agriculture. Trade records indicate small rice imports which are mainly of japonica type.

Soybean

Liberal imports and exports of soybean are permitted at zero tariff, the rate currently determined by the Thai government, which is lower than the WTO commitment.

Soy meal

An export permit must be sought from the National Food Policy Committee, represented by the MOAC, MOC, and the Animal Husbandry Association while imports can be made liberally at 5 per cent tariff.

Maize

Maize exports are liberal but imports are on a tariff quota basis. While the in-quota tariff is 20 per cent, out-quota imports may be made freely at 70-80 per cent tariff.

Cassava

The trade in cassava products is not affected by the WTO and, as a result, exports and imports may be made freely. However, trade records indicate no such imports.

7.2 Direction of trade

Domestic farm trade of the four commodities is good. Rice is mainly produced to satisfy local demand as the staple and the excess is exportable. Despite increasing the in-quota and reducing the tariff, the trade statistics show no imports. It is projected that exports of rice will become much greater.

The farm price for maize is not frequently depressed and the potential exists for increasing imports of maize from Lao People's Democratic Republic and Cambodia following Thailand's policy to expand its production bases to neighbouring countries. Consequently, the opportunity for a regionally sufficient maize supply may exist.

The import trends of soybean and soy meal may be ever increasing as long as the animal industry continues to expand together with the substitution ability of soybean and soy meal for

fish meal in producing feed and the potential to import from neighbouring countries based on Thailand's policy of expanding its production bases for both soybean and maize.

The opportunity for more international trade in cassava chips and pellets will decline with the EU market, since the EU has been reducing its internal support programme for its cereal production. Consequently, the reduction of subsidies lowered prices for EU produced cereals which are comparable to or even lower than Thai cassava products. Therefore, the EU has reduced imports.

A second major Thai market for cassava pellets and chips is Mainland China.

7.3 Export and import behaviour and structure

7.3.1 Price behaviour

Rice and broken rice

For a long-time there have been no imports of rice or broken rice. Exports are operated by a few exporters who form the Rice Exporters Association. Some of these exporters own and operate rice mills and, at the same time, collect rice and broken rice from others. The f.o.b. price of rice depends on and fluctuates with the world price. In times of a high international price and greater demand, domestic paddy and milled rice prices follow suit. In contrast, prices of rice by-products, i.e. broken rice and bran fall as mill operators try to cut them off in order to take in a new batch of paddy. A price slump of exported rice will be unlikely to induce a great paddy intake for milling, thus encouraging a lowered paddy price. Any milling that goes on is ordinarily destined for local consumption, which causes the quantities of broken rice and bran to decrease, thus pushing up their prices since the broken rice is used for both food and feed. As a result, feed producers turn to maize due to its relatively lower price to substitute the broken rice.

Maize

Exports and imports of maize rely largely on domestic production. Ordinarily, maize production is likely to be close to the demand. In compound feeds, the source of energy can come from either broken rice or maize which can be substituted fully. For example, when the price of broken rice is too high, feed producers will turn to maize. Any surplus of maize will be exported by one exporter. Usually some imports are made in a year which experiences a natural disaster thus hampering domestic production. The f.o.b. and c.i.f. prices of maize follow world prices at the Chicago Board of Trade, USA.

Soybean

As the domestic demand for soybean is usually quite high, it follows that soybean exports are negligible. Exports of soy meal may occur after an export permit is sought from the Ministry of Commerce. However, in reality, there have been no such exports.

Soybean is imported by the crushers and feed millers freely at zero tariff. They also have to purchase the crop at a price agreed upon with the government. Soy meal is imported by the feed millers, the Livestock Husbandry Association and big livestock farmers at 5 per cent tariff. The c.i.f. prices of both soybean and soy meal depend on the prices at the Chicago Board of Trade.

Cassava

The majority of cassava products are exported in the form of pellets, chips and flour. The prices for the pellets and chips rely on world prices at Rotterdam. In the EU market, a fall in the prices of cereals will pull down the prices for both cassava pellets and chips.

7.4 Trade responses to market and non-market forces

Maize

Thailand has been able to produce enough maize to satisfy domestic demand. Currently, the booming livestock industry has put increasing demand on maize while maize exports face decline. In this regard, the exporters contest the feed mill operators when purchasing maize. Shortages sometimes occur that signal imports. In addition, the government is expanding Thailand's maize and soybean production bases in neighbouring countries which adds to imports. However, in some years over-production can occur that depresses farm prices during the harvest. This prompts the government to take market intervention measures by mortgaging maize and facilitating exports.

Soybean and soy meal

Insufficiency of soybean production prevails yearly. Most of the demand is to be used for processing into soy meal. Some soybean is used as a direct feedstuff instead of soy meal. The free trade policy on soybean and soy meal tends to encourage imports, of soybean in particular, due to the zero tariff.

Broken rice and bran

As a leading producer and exporter of rice, Thailand usually has enough broken rice and bran to satisfy feedstuff demand. As the paddy in-flow to the mills depends on the international price of and demand for rice, the production and prices of broken rice and bran thus depend on it. A better rice price in the world market boosts the demand for export, also the paddy supply to the mills and, hence, an increase in broken rice and bran supply with a lowered price. On the other hand, a lower international rice price affects broken rice and bran prices which induce more use of the maize substitute.

Cassava

The major cassava export items include pellets, chips for use as feedstuffs, and flour. Opportunities to expand the export of the first two items seem not too bright due to the reduction in demand from the EU; the major Thai market. The EU's common agricultural policy reduces subsidies to guarantee its grain prices, thus lowering them. China's (Thailand's major market for chips) demand for the product depends on China's own maize production. In 2001, for example, China's production of maize ran short, increasing the shredded cassava imports from Thailand.

7.5 Export and import projections to 2015

Following the building of feed crop models in Section 5.3 and analyzing consumption behaviour, we can conclude that maize and soybean production will be completely utilized domestically. Only rice and cassava have an exportable surplus supply. In this respect, exports of paddy show an increasing trend at an annual rate of 1.639 per cent, while the exports of cassava slices increase very little at a rate of only 0.405 per cent, whereas exports of the pellets face decline at a rate of -0.048 per cent.

Import opportunities exist for soybean but only in times of local shortages. The import volume more or less relies on the difference between total demand and domestic production. Soybean imports will grow at a rate of 6.46 per cent (Table 7.1).

Table 7.1 Export and import projections to 2015

Units: million tons

Year	Exports			Imports
	Rice*	Cassava		Soybean[1/]
		Shredded	Pellets	
2003	11.528	0.221	5.033	1.501
2004	11.887	0.224	5.105	1.605
2005	12.087	0.215	5.024	1.716
2006	12.285	0.220	5.038	1.832
2007	12.526	0.219	5.036	1.954
2008	12.715	0.218	5.017	2.082
2009	12.914	0.219	5.021	2.216
2010	13.109	0.219	5.015	2.359
2011	13.311	0.219	5.006	2.508
2012	13.516	0.220	5.004	2.665
2013	13.718	0.221	5.002	2.830
2014	13.924	0.222	5.000	3.002
2015	14.133	0.223	4.998	3.184
Growth rate (%)	1.639	0.405	-0.048	6.460

Source: [1/] Author's estimation.

: A forecast of soybean imports is derived from the difference between the demand for soybean and production (Table 5.3 – Table 6.1).

Note: * Paddy equivalent

8. Measures to Meet Excess Demand

The major feed crops in Thailand; cassava, maize and soybean are mostly rainfed. They are usually grown in areas of similar agro-climatic conditions. Consequently, they are switchable placing their prices or crop returns in the hands of the farming community. Horizontal expansion of farm production is not an option as it was in the past as a result of strict conservation and protection of forest areas. In this regard, enhancement of farm production efficiency has been made possible through the efforts to increase crop yields and intensify the utilization of the limited arable lands with the use of modern farm technology, post–harvest technology and crop rotation.

8.1 Government and private company initiatives

8.1.1 Production technology

In the past, it was the role of the public sector to formulate farm initiatives, that is, the Ministry of Agriculture and Cooperatives (MOAC) and the academic institutes at the university level. Farm technology is currency transfered by the three interested parties, i.e. the government, the private concerns, and the farmers themselves. Private businesses have done excellently in improving and distributing certain crop cultivars, for example, maize.

8.1.2 Research and development co-operation

Most Thai research and development (R&D) activities on feed crops have been undertaken by the public sector which focuses on pioneering new crop cultivars with a major aim to replace the former varieties of which their weaknesses or faulty points were found after prolonged cultivation or when they were introduced to different agro-climatic conditions. Currently R&D on crops is conducted by both the government and the private sector and even by farmers in areas of good local knowledge and where there is practical use of modern technology. R&D activities are often jointly launched by different interested parties due to the limited personnel or budget constraints of the public sector.

Cassava is the single feed crop that the private sector has set up within the Thai Tapioca Development Institute. It’s an independent organization that has a major objective to support all cassava related research, including variety, cultivation, harvesting and utilization as feed and other uses.

With respect to maize, the government and private concerns conduct R&D activities. Having completed a project, the government extends the results to the farmers as well as any interested parties, however, private R&D activities are disseminated only to the farmers participating in the production project.

8.1.3 Trade co-operation and liberalization

Thailand is one of the few developing countries producing an exportable excess farm supply. Therefore, in most forums dealing with trade agreements and other economic co-operation, major agricultural commodities are often agreed upon to be placed on the exclusion list in an effort to protect domestic farm producers as well as allow them sufficient time to readjust themselves. Commitments to such agreements influencing feed crop farmers are as follows:

8.1.3.1 Farm trade under the WTO Agreements on Agriculture

In the first phase of the Uruguay Round, 1995-2004, 23 Thai farm commodities put on the exclusion list were allowed for import on a tariff quota basis. Among them are the following feed crops: rice, maize, soybean and soy meal. The annual allotment of the quota and the fixing of tariffs are administered by a committee responsible for screening and seeking a cabinet ruling. The commitments from the first phase are to be terminated in 2004. In the government guidelines for the trade negotiations in the second phase there would be seven farm additions including cassava.

8.1.3.2 Free Trade Area (FTA)

To better facilitate and expedite trade relations beyond the forum of the WTO many member countries use a variety of economic activities to obstruct and delay any possible conclusions and agreements. As a result, Thailand opts to administer a policy of bilateral negotiations and agreements or FTA. An agreement of this type is cordial, mutual and transparent in implementation, thus enhancing bilateral economic strength.

8.1.3.3 One way free trade

To solve some feedstuff shortage problems, a policy has been implemented for one way free trade to Cambodia, Myanmar and Lao Peoples' Democratic Republic of eight agricultural commodities which include the three feed crops; soybean, maize and rice. Through this agreement, tariffs were reduced to zero. Consequently, the three neighbouring countries have become a part of the resources of feed crop supply for Thailand in time of internal shortages. In addition, Thailand grants technical assistance for feed crop production to these neighbours.

8.2 Farmer participation in feed crop development

It is usual that Thai farmers often take part in the development of some crop varieties by allotting a small farm plot for field trials as required by the state or private concerns. They are aware that it takes time and continuity for trial results to be practical in a different environment.

8.2.1 Feed crop farming

Production of the three major feed crops; rice, maize and cassava is domestically adequate, except for soybean that has always been in short supply and therefore imports have had to be made annually.

The government has implemented a policy for feed crop production in areas that have potential. Crop zoning has been implemented to administrate the supply and reduce the cost of production. However, some farmers are unable to assume the risks of changing to a new crop or enterprise and so the government tries to provide incentives in the form of soft farm loans, etc.

8.2.2 Response to market development

In response to market demand, both domestic and overseas, concerning food safety in particular, a production policy stressing product safety and no agro-chemical residuals has been launched recently along with the Good Agricultural Practices (GAP) principle. One such project jointly conducted between the government, the private sector and the farm producers is the Clean Cassava Project, wherein a public campaign has been conducted to raise the awareness of farmers and the drying yard operators for clean cassava roots and chips with no or as little as possible contamination. The campaign aims to gain the confidence of overseas markets for clean chips and pellets.

The government aims to develop a farm commodity market to include feedstuffs so that the marketing will be in line with the supply and demand. The aim is to reduce the risks to a

minimum and establish the Futures Market Committee in 2004 which will begin its work on rice.

8.2.3 Response to manufacturing development

Development of feed crops is expected to influence the manufacturing sector in two ways as follows:

8.2.3.1 Direct impacts

Feed crops as raw materials are on the upstream of development while the production of livestock and aquaculture is downstream with the food processing plants midstream. Therefore, an increase or decrease in the production at one stage together with a condition of product quality can influence production at other stages. A change in production also impacts prices of feedstuffs which are passed on to the cost of production at all other stages.

8.2.3.2 Impacts on industrial development

Some feed crops can be raw materials in non-agricultural industry, for example, the energy industry uses cassava chips to manufacture ethanol. The product is a fuel substitute. In this connection, in Thailand, a pilot project on ethanol production has been set up to study its economic feasibility.

8.2.4 Measures to mobilize farmers involvement

8.2.4.1 Equity consideration

The MOAC has proposed crop zoning based on the production potential of an area, the environment and economic considerations. It has also conducted a public hearing of all interested parties including farmers who produce the major crops. It is now at the stage of formulating incentives for inviting farmer participation once the crop zones are announced.

8.2.4.2 Poverty alleviation

Poverty in the agricultural sector is well known to the government which has launched several measures to raise farm family income away from the traditional monocropping which gives a return just once a year from their crop sale. The measures are described briefly as follows:

The village fund

The fund is aimed to serve as a revolving fund, interest free, for farmers who are expected to operate enterprises, such as processing farm produce for value-added, household cottage products made from the farm residuals, etc.

Community enterprise

The government organizes the registration and certification of enterprises operated by farm institutions and other farm organizations in an attempt to regulate their production, to grant them certain tax incentives and to support them with soft loans. It gives an alternative for the farmers and their communities to work on farm processing.

The royally-initiated New Farm Theory

The concept is intended for farmers to operate an integrated farm both to satisfy their households' needs and for commercial purposes to divert marketing risks and the risk associated with an annual sale of only one crop. In addition, the government attempts to provide marketing channels of the one-tambon (one village), one-product: OTOP for both domestic and overseas marketing.

8.3 Potentials and constraints to feed crop expansion

8.3.1 SWOT analysis

8.3.1.1 Rice

Strengths

1. Thai farmers are skillful in producing rice.
2. Thailand has vast plains in almost all regions that are suitable for growing rice.
3. It has exportable excess supply and has become one of the leading rice exporters.
4. Thailand has good rice cultivars with distinctive characteristics, Hommali fragrant rice in particular, which is world famous.

Weaknesses

1. Most of the paddy fields are non-irrigated, especially in the northeastern region.
2. The rice yield per unit area is low.
3. Part of the farmer population lacks good farm management skills. As a result, the supply of rice is in excess in some years.

Opportunities

1. More rice markets are accessible through FTAs, resulting in low tariffs, the Chinese market in particular.
2. Thailand is good at producing organic rice and is expected to have good market access following the rising world market trend for organic farm products.

Threats

1. The farmers lack sufficient post-harvest management, especially for the second rice crop, which in some growing areas the harvesting period coincides with the monsoon season leading to a high moisture content in the rice which is often not dried before sale since the farmers or their organizations do not have enough grain dryers.
2. The local rice marketing system lacks efficient management leading to high marketing costs which restrict competitiveness.

8.3.1.2 Maize

Strengths

1. A non-GM crop.
2. The improved seeds are well distributed to the farmers.
3. The prevalent improved maize variety has better animal nutrients than the imported maize.

Weaknesses

1. Maize planted areas vary from year to year due to competition with cassava. Therefore, the crop which has more prospective returns will be sown. Consequently, in some years there is a shortage of local maize supply.
2. Harvesting the first maize crop coincides with the monsoon period, August to September. Having a high moisture content in the maize can cause aflatoxin in the feed when handled inappropriately post-harvest.

Opportunities

1. Thailand will have Cambodia, Lao Peoples' Democratic Republic and Myanmar; its neighbours, as potential maize sources under recent trade cooperation agreements.
2. Thailand would gain more market access from bilateral and multilateral trade agreements.

Threats

1. Most of the maize planted areas are rainfed and, as a result, product supply often fluctuates.
2. Expansion of the planted area is not simple as there are several competitive crops, i.e. cassava, second rice and soybean.

8.3.1.3 Soybean

Strengths

1. A non-GM crop which is in favour with consumers.
2. There are adequate domestic food and feed industries to absorb production.

Weaknesses

1. Most soybean farmers grow it as a minor crop.
2. Domestic farm prices do not adequately motivate the cultivation of better quality soybean.
3. Soybean requires much care and tending to.

Opportunities

1. Soybean has a variety of food products which it can be processed into.
2. Soybean is a favourite health food.

Threats

1. Insufficient research and development activities on soybean varieties.
2. Soybean import prices are at a level lower than the prices of locally produced soybean and of better protein quality.

8.3.1.4 Cassava

Strengths

1. Cassava can be grown in any soil and even in infertile soils which are also rainfed.
2. Little pest and disease attack.
3. A non-GM crop.
4. Harvesting can be deferred.
5. A carbohydrate source in animal feed and human food with relatively low price compared to other carbohydrate sources.
6. Improved cassava varieties are well distributed to growers nationwide.

Weaknesses

1. The farm prices received for cassava roots fluctuate following product price cutting by the exporters.
2. Producers of cassava roots are mostly smallholders of low financial status. As a result, they lack farm investment, especially in the improvement of soil fertility for enhancing farm yields.

Opportunities

1. Abundant annual supply of cassava roots for local linkage industries.
2. More markets are potentially accessible following the bilateral free trade agreements, the Chinese market in particular.

Threats

1. Thai cassava commodities have to rely largely on foreign markets because local livestock farmers tend to have a negative attitude towards its use as feed.
2. Almost all cassava planted areas are currently rainfed and enhancing productivity is potentially very difficult.
3. The private sector has not been lured with enough incentives to set up business ventures in manufacturing a variety of cassava products.

9. Conclusions and Recommendations

Greater demand for feed continues to follow increases in livestock production while an increase in the population's income tends to raise the consumption of livestock products. The expansion of the livestock industry, made possible through the upgrading of local breeds for commercial purposes constantly raises the demand for feed which often causes shortages in some of the domestically produced feed crops, most commonly soy meal, a by-product of crushing soybean. As a result, imports of soybean have been several times more than the quantity produced locally. It was such that in 2002, the volume of soybean imports for soy meal production was seven times more than that which was locally produced, with 50 per cent of domestic soybean production going for food and the other half for crushing. In addition, Thailand imported more than double the amount of soy meal than what was locally produced.

Almost all domestically produced maize is destined for feed as the Thai population is not in favour of eating corn. Thailand produces rice in huge quantities which is its top farm tradable. Consequently, rice by-products are in large supply too even beyond the feed requirement. The same applies to cassava which is over produced but used in much smaller amounts per year for feed.

The major livestock and livestock products that were produced in 2002 include 1,000 million broilers, 9.876 million swine and 0.660 million tons of raw milk, having production growth rates of 5.09 per cent for broilers, 1.73 per cent for swine and 11.17 per cent for raw milk. On the other hand, Thailand is experiencing declining growth trends in eggs and duck meat due to the decreasing local prices. The production of cattle and buffalo has not yet been commercialized by the small farmers. Their population at the beginning of the year and production throughout the year declined. As such, 1.096 million heads of cattle and buffalo were produced in 2002 which is considered a shortage due to poor price incentives and imports of live cattle and buffalo to the tune of 167,056 heads from neighbouring countries which can be made at even lower prices.

In the feed industry, production was 4.023 million tons or 38.26 per cent of the total feed for broilers and 3.244 million tons or 30.85 per cent of the total hog feed, requiring 3.790 million tons of maize, 1.896 million tons of soy meal and 1.556 million tons of broken rice. The demand forecast for feed in 2003 is 12.607 million tons which can be broken down as 4.348 million tons for broilers, and 3.515 million tons for hogs.

For the sustainability of the production of each feed crop to satisfy demand at a favourable farm price, maize production should be set at 5 million tons in order not to over produce since maize is replaceable with broken rice. This will maintain a favourable farm price of maize.

To have maize for use throughout the year, the government should attempt to promote relay planting in the uplands or promote competitive crop cultivation in parts of the maize producing areas to have a reduction effect and, at the same time, promote maize planting in the paddy fields to ensure a year round distribution effect. Also, an extension programme is suggested to see farmers try to improve maize quality for a better price.

The price received for rice provides an incentive to produce more horizontally with more use of farm inputs but there has been no farther technological adoption, e.g. use of improved high yielding varieties. So, the government will have to promote this.

The national area planted to rice is 68 million rai, 7 million rai of which is irrigated and the rest is mostly rainfed. The government should seek to develop water sources in areas prone to drought, especially in the northeast; the major rice producing area. Without such an effort, a reduction in rice production is likely.

Farmers often neglect their cassava crop. In times of financial need, it is harvested early. At other times, it is picked late after the growers have attended to a more profitable crop. Thus, the farm price received for the fresh roots is frequently low for a low starch content. Therefore, an extension programme may be needed to have the farmers pay more attention to the appropriate harvesting period when the starch content is highest and a better price is paid.

The government should arrange for the grading and standardization of soybean to ensure fairness to growers who grow quality soybean. In addition, farmer training programmes should be organized to raise awareness for keeping the moisture content of soybean within the standards during post-harvest handling. Interestingly, the government is conducting R&D and a multiplication programme for domestic soybean varieties as they are suitable for human food being a non-GMO farm product.

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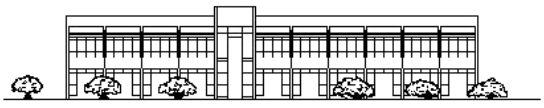

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