RICE SUPPLY AND DEMAND IN THAILAND :

THE FUTURE OUTLOOK

Thailand Development Research Institute Foundation

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CHAPTER I

INTRODUCTION

Thailand's economy has traditionally been an agrarian one. Not only is agriculture an important source of the country's gross domestic product, but it also constitutes a major share of the Thai export trade. Generally, goods produced by this sector are considered as traded goods, that is they are traded in the international markets. Movements in these markets thus have considerable impacts on their prices, and consequently on farmers' incomes.

Recently, the dominance of agricultural sector in the Thai economy has declined. Its share of national income has consistently declined from one-fifth of the country's gross domestic product (GDP) in 1980 to around one-eighth in 1991. Furthermore, the export share of agricultural commodities has been substantially reduced from 68 % in 1981 to 38% in 1991. As agriculture has gradually lost its comparative advantage, the manufacturing exports and tourism quickly replaced it as the major source of economic growth. Thailand is currently on the path to becoming a newly industrial country.

Due to a large land surplus in the past, the growth of Thai agriculture was facilitated through the expansion of cultivated land, specifically for the production of staple crops. A limit of land frontier since the early 1980s and a declining price trend for agricultural commodities in the world market since the second-half of 1980s has consequently slowed agricultural growth. At the same time, the rapid development of manufacturing and service sectors have significantly induced investments in these sectors and thus led to a rise in demand for inputs. A high growth rate in non-agriculture has created not only widening income disparities between agricultural and non-agricultural households, but it also has effects on rural resource utilization, particularly farm labors.

In Thailand rice has traditionally been an export commodity and a staple food crop. Despite the fact that its importance has declined over the past few decades, rice still represents a dominant of the total crop value. Out of 20.4 million tons of rice supply in 1991, two-third is used for domestic consumption, the surplus is exported. Thailand is a major supplier in the international rice market. The good grain quality of Thai rice and a relatively high comparative advantage in production costs have contributed to this success.

The strong influences of domestic and export markets have stimulated the expansion of cultivated areas as well as output growth, however, the inelasticity of land supply has switched the concerns toward productivity improvements. Significant developments in rural infrastructure, extension work, and public research have resulted in the sustaining the rice supply growth through the adoption of rice cropping intensity and modern technology. A consequence of these agricultural development in Thailand and also in other parts of the world has affected the international rice market. Since both domestic and international rice markets are closely linked, the effect of price movements in the international market inevitably transmits to the domestic market. Essentially, these would remarkably result a reduction in farmers' income if the world price declined due to increased supplies.

Rice production in Thailand is now in a transitional phase. A massive encroachment of forest area in the past has reduced the ratio of forest land to agricultural area which now creates problems of environmental degradation. This can be observed by irrigular rainfall pattern and a prolonged drought in many rainfed rice regions. Even in irrigated areas, water resource scarcity, particularly in the dry season, is increasingly intensified. These extensive impacts of environmental degradation, coupled with a low rice price reduce the comparative advantage of rice farming compared to other crops. Furthermore, high growths rate in non-agricultural sectors in recent years has created the competitive use of the country's resource. A remarkable increase in demand for labor in the non-agricultural sector, has both temporally and permanently drawn farm workers out of agriculture. A continuous rise in wage rate and a shortage of hired labor supply, specifically during the peak season, raises the production cost. It is doubted in the near future that Thailand can maintain her domestic surplus of rice and her competitiveness in the export market.

In recent years, changes in economic conditions and the country's urbanization have produced some effects on food consumption patterns in Thailand. Because rice is a traditional staple, a rise in income per capita has stimulated the consumers to adjust their consumption behaviors toward a more luxurius diet, specifically meat and horticultural commodities. Some economists even argued that the income effect of rice consumption in Thailand is negative (Ito et al., 1985; Ito et al., 1989). If this is the case, the domestic demand for rice consumption will adjust downward and will consequently pressure the export surplus and also on the export and domestic prices.

This study is aims to investigate the future rice demand and supply and also the export surplus. The paper is organized in seven chapters. After the introduction in chapter I, chapter II reviews public policies toward agricultural development in general and rice in particular. Chapter III discusses trends in rice production, consumption, trade and also input use for rice. Importantly, the rice labor productivity and sources of productivity growth will be examined. Chapter IV analyzes the food consumption pattern and the rice consumption demand. Since urbanization plays influential role in determination of rice consumption patterns, the rice demand is disaggregated into rural and urban households. Income and price elasticities of quantity demand will be derived and further employed in the demand prediction. The acreage and yield responses for rice are examined in chapter V. Information obtained from the rice supply response provides important knowledge for estimation of quantity supply elasticities which are very useful for future rice supply prediction. Chapter VI demonstrates potential growths of rice supply and demand under different scenarios. This information is crucial to predict the rice export surplus accurately and very useful for policy recommendation. The last section is conclusion.

CHAPTER II

AGRICULTUTRAL DEVELOPMENT AND RICE POLICIES

2.1 Agriculture in the Thai Economy

Thailand's economy was basically dependent on agriculture. Not only is the majority of the country's resources employed in agriculture, but also a large amount of foreign exchange is derived from agricultural exports. In 1961, the agricultural sector accounted for 37.39% of the Gross Domestic Product (GDP), and 82% of the labor force was actively working in agricultural activities.[1] Out of total foreign exchange earnings, the export value of agricultural commodities share was 84.37%. Rice accounted for about 58% of total crop revenue. Furthermore, the export value of rice contributed 36% of total foreign exchange earnings. After implementing the National Economic Development Plans, the growth in agriculture, as well as the diversification of crops have improved rapidly. Besides rice, other crops, particularly maize, sugar, and cassava have increased their roles in the crop composition and have contributed to the export commodities. Since the early 1980s, a rapid growth of non-agricultural sector has reduced the important role of agriculture in the economy. During 1986-91, agriculture accounted for only 15.29% of total value added which is less than half of that of the industry. Thailand is becoming a newly industrial country with average economic growth rates at about 7% per annum during 1981-1991 (Table 2.1).

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[1] The First National conomic Development Plan was started in 1961. Except for the First Plan which covered 6 years period, other subsequent plans covered for 5 years period. Presentlt, the Sventh Plan (1992-1996) has been implemented.

Table 2.1

Shares of Thailand's Gross Domestic Product (GDP)

at 1988 prices and per capita income, 1971-91

Year	Agri culture	Manufac-turing	Construction and mining	Other	Total	Average Per capita income
	GDP Share (%)					
1991-65	36.14	14.44	6.62	42.80	100.00	8,627
1966-70	30.71	16.06	8.20	45.03	100.00	10,874
1971-75	25.39	18.96	6.75	48.90	100.00	13,804
1976-80	22.72	19.42	6.90	50.96	100.00	17,102
1981-85	19.39	23.19	6.19	51.23	100.00	20,834
1986-91	15.29	26.54	7.13	51.04	100.00	27,625
1961-80	26.18	17.69	8.82	47.31	100.00	12,693
1981-91	16.73	25.36	6.80	51.11	100.00	24,230
	Average Real GDP Growth by Sector					
1961-65	4.90	10.22	11.73	7.18	7.17	
1966-70	5.40	10.40	11.58	11.89	9.83	
1971-75	3.60	9.31	-1.33	5.52	5.28	
1976-80	3.77	8.88	4.82	8.42	7.72	
1981-85	3.90	4.60	9.59	8.25	5.17	
1986-91	3.18	12.70	11.55	8.54	9.05	
1961-80	4.40	10.07	6.43	8.32	7.52	
1981-91	3.95	9.92	11.73	7.75	6.98	

Note : Calcultated from National Income Statistic

Source : NESDB, National Income of Thailand, various issues.

Since the implementation of the National Economic Development Plans, agricultural development in Thailand can be devided into two phases. The first phase (1961-1980) witnessed the growth of Thai agriculture and the rapid expansion of cultivated land (TDRI, 1992). In this period, a massive public investment, particularly in irrigation and transportation, coupled with a boom of agricultural exports stimulated incentives for private investment in crop production as well as in marketing activities. Development of public road networks, which began in the 1960s, lowered transportation costs and provided agricultural products easy access to the markets. Public investment in large-scale irrigation projects, which began in the 1950s and bore fruit in the late 1960s, made it possible for farmers in Central Plain to plant rice twice a year. Furthermore, an intensive malaria eradication during 1960s made it possible for farmers to settle in what was previously uninhabitable land. In the elevated and less fertile areas, farmers converted forest land into farm land and planted field crops, particularly maize and cassava in response to price incentive and market opportunities.[2] Since Thailand's economy has been integrated with the world market, the commodities boom in the late of 1960s and 1970s induced marked farm-land expansion.

The second phase (1980-1992) saw a decelerated expansion of cultivated land due to a limited land frontier and a declining trend in the world prices of agricultural commodities. An excessive exploitation of forest land in the past contributed to water resource scarcity and environmental degradation. A reduction level of under-ground water in some areas in the Northeast generated a increase in the salinity of the farm lands. Moreover, degradation of soil and water quality have largely affected crop productivity. Despite intensive technologies that have been increasingly adopted due to land scarcity, the adverse effect of decling export prices

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[2] The public forest land reduced from 54.58% (or 28.03 million ha) of the country area in 1961 to 26.61% in 1991; whereas, in the same period, the agricultural land rise from 20.52% (or 10.54 million ha) of the country land area to 41.45%.

of agricultural commodities coupled with environmental degradation has strongly reduced the agricultural performance.

2.2 Trends in Public Investment

Expansion of agricultural production in the past has been accompanied by heavy investment in public infra-structure. The government has invested heavily not only in road networks, but also in irrigation projects. Furthermore, significant portions of government resources have been allocated to develop and promote technological change.

2.2.1 Irrigation

The development of modern irrigation in Thailand can be dated back to a period of King Rama V when Homan van der Heide, a Dutch engineer submitted his proposal to built an irrigation system for the whole of the lower Chaow Phraya with a series of storage and diversion dams in 1903 (Ministry of Commerce and Communication, 1930; Ingram, 1971; Siamwalla et al., 1990).[3] However, serious efforts in this regard began in the 1950s when the first large irrigation project, the Chao Praya project, was constructed in Chainat province during 1951-1957 (NGO, 1979). The project was to benefit low-land rice farmers in the Central Plain. Since the inception of Thailand's First Economic Development Plan in 1961, irrigation infrastructure has received much attention from the government as can be seen by the number of projects and costs of investment in all four regions of the country (Table 2.2)

[3] Prior to the arrival of van der Heide, a canal system was built in the late 1880s by a private company owned by the members of the Thai elite in what is now the Rangsit area, in exchange for a land grant from the king. This cannot be regarded as an irrigation project because there was no attempt to control the water supply that would be deliverable to the farms. The main benefit of this project is to open up a large new area for cultivation by having access to water transport which the canal provide (Asawai, 1987). The only part of van der Heide's project to have been immediately implemented was one which improved the water condiditions of the Rangsit canal system (Siamwalla et al., 1990).

Table 2.2

Area and cost of large and medium scale irrigation project

in Thailand (at 1986 price)

Region	Year of Construction	No. of Project	Investment Cost (M/baht)	Irrigated Area (ha)	Cost (baht/ha)
North-eastern	1956-65	31	395	81,804	4,825
	1966-75	21	1,291	28,219	45,769
	1976-85	47	12,105	218,796	55,325
North	1956-65	9	4,841	308,320	14,538
	1966-75	34	7,064	212,240	33,288
	1976-85	94	9,546	230,434	41,425
Central Plain	1956-65	76	3,453	892,872	3,869
	1966-75	36	2,516	287,216	8,756
	1976-85	67	5,904	313,382	18,844
Southern	1956-65	11	27	21,008	1,281
	1966-75	12	681	45,072	15,113
	1976-85	44	6,248	231,618	26,975
The Whole Kingdom	1956-65	127	8,356	1,304,004	6,406
	1966-75	103	11,552	572,747	20,169
	1976-85	252	33,803	994,230	34,000
Tatal		482	53,711	2,870,980	18,706

Source : Adopted from Siamwalla and Na Ranong (1980).

Between 1961-65 and 1985-90, irrigated rice area (in terms of the project areas) rose doubled or rose about 1.36% per annum, from 1.65 million ha to 2.21 million ha, respectively. However, the total irrigated rice area was rather small comparing to the total wet season rice area (Table 2.3). In Thailand, most large-scale and medium-scale irrigation projects were established in 1950s and early 1960s. High investment cost and low rate of return has shifted the development interest toward the small-scale projects during 1970s. Despite a small ratio of the irrigated area, irrigated rice in wet season accounted about 23.91% of the total rice production during 1985-90.

The impact of irrigation is more easily discerned during dry season cultivation, when the irrigated area increased from 0.33 million ha in 1974 to a peak of 0.84 million ha in 1988, before dropping to 0.58 million ha in 1990 (Table 2.4). Dry season yields in irrigated areas were about two times higher than the averaged wet season rice yield in the later half of 1980s.

Despite the excess demand for water during dry season, the government has been reluctant to invest in new storage dams due to a rising public awareness of environmental impacts. It is expected that the growth of irrigation area will further decline due to a rapid decline in the budget growth in the 1970s and 1980s.

2.2.2 Road network

Historically, the most important mode of transportation for Thai people were the water-ways. Railway was first developed in 1892 to link Bangkok and other regions. However, a limited road network restriceted the farmers access to the markets and trading information which in turn raised costs. A massive improvement on road system during 1960s and 1970s has provided an incentive to farmers to raise their crop production. Furthermore, the increasing road network in this period reduced the cost in acquiring a new cultivated land. When this factor was

Table 2.3

Average irrigated and non-irrigated rice area, 1961-90*

Year	Area			Budget	
	Wet Season Irrigated Project Area (1000 ha)	Ratio of Project Area to whole Kingdom (%)	Annual Growth in Irrigated Area (%)	Budget** in 1986 Price (1,000,000 baht)	Annual Growth (%)
1961-65	1650.2	25.38	-	480.76	-
1966-70	1787.8	24.30	1.67	1,030.73	22.88
1971-75	1848.0	23.70	0.67	633.77	-7.70
1976-80	1996.0	22.12	1.28	404.01	-7.25
1981-85	2250.2	24.28	2.55	380.15	-1.18
1986-90	2211.2	23.91	-0.35	554.76	9.19

Source : Royal Irrigation Department

* Five years average.

** For large-and medium-scale projects

Table 2.4

Dry season irrigated rice area, 1974-90

Year	Dry Season Area (1000 ha)		
	Irrigation Project Area	Outside Project Area	Whole Kingdom
1974	306	25	331
1975	370	7	377
1976	408	30	438
1977	407	70	477
1978	565	116	681
1979	260	76	336
1980	516	0	516
1981	572	0	572
1982	607	27	634
1983	607	110	717
1984	569	137	706
1985	556	81	637
1986	509	71	580
1987	563	158	721
1988	700	142	842
1989	666	65	731
1990	492	91	583

Source : Royal Irrigation Department.

combined with the influence of market forces, the effect was to accelerate the expansion of cultivated areas as well as crop diversification.[4]

Table 2.5 shows the budget for road investment (in real term) per land holding area. It is observed that the average budget per ha was 10.55 thousand baht during 1961-65 and that was raised to 74.35 thousand baht during 1986-91. However, its average annual growth from 1966-70 to 1971-75 was rather high or about 39.46%. The growth tends to decline from 1971-75 to 1976-80 and from 1976-80 to 1981-85. During 1981-85 and 1986-90, the annual growth substantially improved to be 9.42%.

2.2.3 Trends in agricultural research and extension

Agricultural growth had been based on cultivated land expansion. An approaching land frontier has switched government policy towards promotion of agricultural research and extension. In Thailand, the public sector has played a major role in research and extension activities.

Public investment in crop research began about five decades ago and the emphasis then was on establishing research infrastructure, human resources, and research facilities. Initially research activities were centered in Bangkok and later slowly spread to other regions (Setboonsang and Khaoparisuthi, 1990). The main government agency involved in food crop research is the Department of Agriculture (DOA). There are other agencies involved in crop research, but their activities are limited. In 1990, the DOA had 25 research centers and 26 research stations located throughout the country.

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[4] The construction of the Friendship Highway to link up between the Central Plain and Norteast during the First National Plan (1962-1966) created a big boom of upland crop areas, particularly corn belt areas. Before that Agricultural Extension was a unit in Department of Agriculture.

Table 2.5

Road investment at 1986 price (1000 baht/ha) by region

Year	Regions									Ave. annual growth rate (%)
	Northeast		North		Central Plain			South	Total	
	UPNE	LONE	UPN	LON	WT	MD	ET			
1961-65	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
1966-70	0.62	0.23	0.52	0.36	0.21	5.13	0.38	3.10	10.55	
1971-75	2.27	1.19	1.49	1.62	0.53	17.92	1.48	4.89	31.37	39.46
1976-80	2.88	1.59	2.05	2.17	0.84	24.04	2.06	6.10	41.72	6.60
1981-85	3.34	1.86	2.52	2.76	1.09	29.25	2.77	6.95	50.54	4.23
1986-91	4.39	2.44	3.38	3.88	1.67	44.54	4.03	10.03	74.35	9.42

Source : TDRI Data Base, Sectoral Economics Programe

Note : NA = Not Available

Research expenditures include materials, equipments, and personel costs. Using the DOA budget as an indicator for the crop research budget, it is found that the real budget (at 1986 price) increased from 146.22 million bahts average during 1961-1965 to 886.99 million bahts average during 1986-1991 (Table 2.6). To promote crops production and improve farmers' productivity, Department of Agricultural Extension (DOAE) was established in 1969. Since then the DOAE has played a vital role in dissemination of new technologies to farmers. The average DOAE budget (at 1986 price) has increased from 361.94 million bahts during 1971-75 to 1,354.47 million baht during 1986-91. However its budget growth has declined since the first half of 1980s.

1) Rice research investment

The thrust of rice research since the late 1960s was on improving the yield per hectare of irrigated rice using the output from the international research, in particular from the International Rice Research Institute (IRRI). However the impact of this research was small due to a small ratio of irrigated area. Research on rainfed rice production, which constitute more than 75% of the total cultivated area, is limited. Out of total DOA budget, rice research budget shared about 12.08% during 1986-91. The share is three-times lower than that during 1961-65 despite the real budget value of rice research has continuously increased. Increasing crop diversification is the cause for the declining share of the rice research budget.

Table 2.6

Average budgets (at 1986 Price 1/) of department of Agriculture (DOA) and Department of Agricultural Extension (DOAE) and their growth, 1961-91

Period	DOA			DOAE	
	Average Budget (mill. Baht)	Average Annual Growth (%)	Ave. Rice Research Budget (mill. Baht)	Average Budget (mill. Baht)	Average Annual Growth (%)
1961-65	146.22	-	53.88 (36.85)	na	-
1966-70	312.77	22.77	70.24 (22.46)	na	-
1971-75	377.73	4.15	69.00 (18.27)	361.94	-
1976-80	542.67	8.73	84.88 (15.64)	710.67	19.27
1981-85	727.38	6.81	96.84 (13.31)	1,321.79	17.20
1986-91	886.99	4.39	107.13 (12.08)	1,354.47	0.49

Note: Calculated from the Agricultural Statistic of Thailand

In parentheses show percentage shares of rice research budget under Rice Research Institute.

1/ Using capital formation index to adjust for the real value.

Source: Agricultural Statistic of Thailand, various Issues

Office of Agricultural Economics. Rice research budget obtained from Office of Secretary, Department of Agriculture.

2.2.4 Trend in agricultural credit policy

Despite the crucial role market forces played in the allocation of production resources in Thailand, a formal credit market constraint, in the past, generally prevented farmers from achieving higher production efficiency and income. Before the government sanction on agricultural credit markets, the formal farm credit institutes were undertaken by the BAAC and agricultural cooperative institutes which were able to provide a negligible amount of loan supply. Instead, the farm credit markets were dominated by the informal lenders, particularly middlemen, millers, and land-owners (Thisayamondol et. al, 1965; Narksawasdi, 1958). Government policy on improving formal agricultural credit was set up in the Third National Economic Plan (1972-1976) and was implemented in 1975. In order to increase formal lending institution and the credit supply, the Bank of Thailand (BOT) instructed all commercial banks to allocate 5% of their available loan supply for agricultural credits at the government's announced interest rate, which is lower than the market rate. Since then, the supply rates were adjusted ascendingly for almost every year. During 1979-1986, the supply rates were pegged at 13%. By this policy, the amount of formal agricultural credit supply increased from 2,893 million baht in 1975 to 55,523 million bahts in 1984. The policy has largely had an impact on the adoption of modern technologies as well as crop diversifications, particularly in irrigated areas of the Central Plain region. Presently, the credit purpose was extended to include rural business activities and was renamed the rural credit.

2.3 Trends in Crop and Fertilizer Prices

In a market economy prices play an essential role in the allocations of production resources. In Thailand, the domestic price trends has for the most part followed the world trends (TDRI, 1988). However, deviations of the domestic price from world price depend significantly on the degree of distortion, mainly as the result of government intervention, and the share of non-traded components.

A pattern of agricultural crop price index in real term is shown in figure 2.1. From 1961 to 1991, the real agricultural crop price index fluctuated widely. There were six short periods in which the agricultural price were exceptionally favorable; 1967, 1969, 1973, 1981, and 1988. On the other hand, the trend was generally unfavorable in 1964, 1971, 1978, 1985, and 1990.

Patterns of crop price movements for four main sub-groups are shown in figure 2.1(a), 2.1(b), 2.1(c), and 2.1(d). The trend of paddy real price index declined since 1975. Heavy government intervention on both domestic and export markets, particularly in the 1960s and early 1970s, resulted in a relatively more stable trend for paddy price with exception for some unfavorable short periods in 1964 and 1971. Since 1972, the index increased rapidly and reached its highest point in 1975. Since then it has declined gradually, except for the year of 1980 and 1981. The index reached its the lowest trough in 1986. Unlike that of paddy, price trends of upland crops, have declined since 1969. Tree crops and vegetables have had wide fluctuations in their prices. This may because the majority of crops and vegeables are highly perishable and sold mainly in the domestic markets.

The fertilizer real price index is shown in figure 2.1(e). Its trend was quite stable in the 1960s. The trend shot up during the oil price crisis in 1974-75. After that it declined downward substantially.

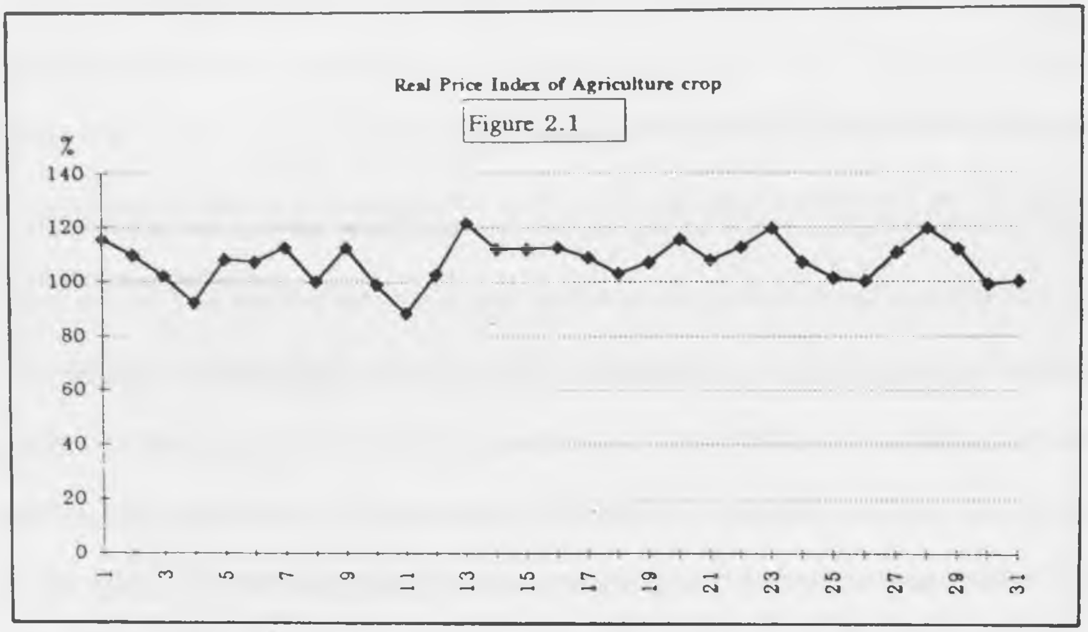
2.4 Government Policies for the Rice Prices

In Thailand, rice is a vital crop and as such has significant political importance. The country's production of rice exceeds domestic demand and the surplus is exported. Over the past few decades, Thailand has played a dominant role in the rice export market. Despite droughts or flooding which had negative effects on rice production, the destabilization of domestic rice prices was mainly due to a rapid rise in exports, which accelerated the increase in prices. Many government price policies were previously designed to restrict the export market. These price stabilization policies included an export tax program and a consumption subsidy program. In contrast, the price support program stabilized the domestic price, particularly during periods of low export demand. Until recent years, the price policy has mainly focused on the promotion of rice export due the surplus of domestic rice supply.

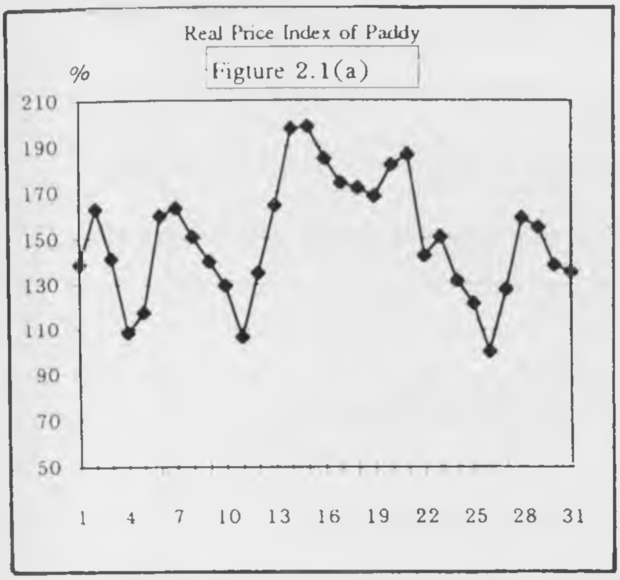
2.4.1 Export price policies

1) Export tax program

The government first started to intervene in the export market after World War II, when Thailand was forced to export rice as a war reparation. After her rice export trade was completely re-established few year later, the govenment retained the monopoly for rice exports. The Rice Office was established and the private exporters had to arrange to export rice under license from the Rice Office. A quota rent, dubbed the "premium" by traders, was applied and payments from rice traders were made to the Ministry of Commerce. In 1950s and 1960s,



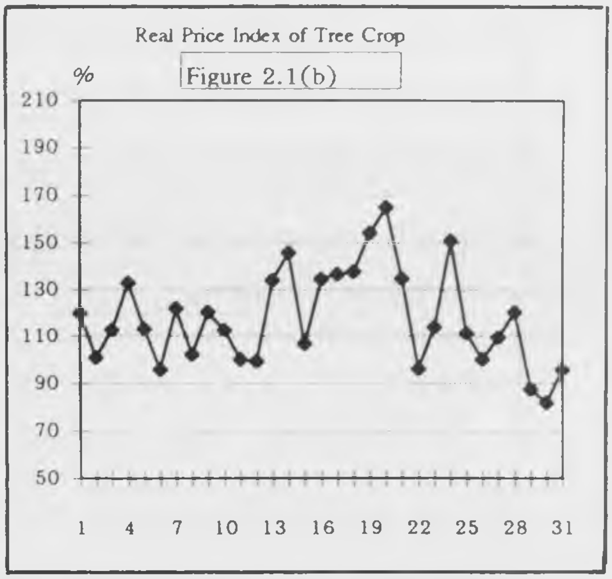
Year 1961 '65 '71 '75 '81 '85 '91



Real Price Index of Paddy

Figure 2.1(a)

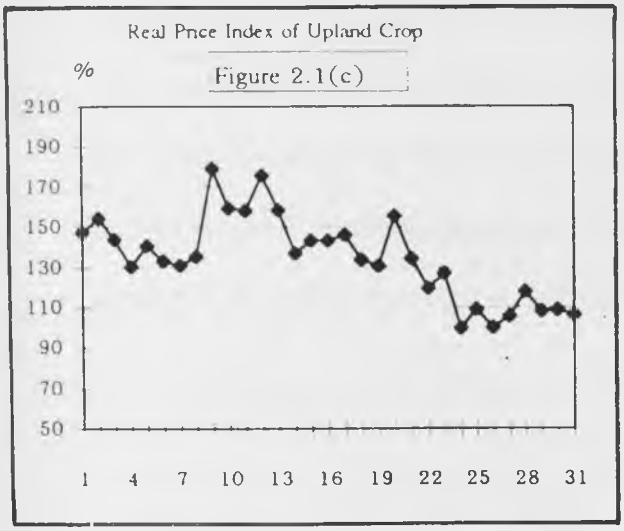
Year 1961 '65 '71 '75 '80 '85 '91



Real Price Index of Tree Crop

Figure 2.1(b)

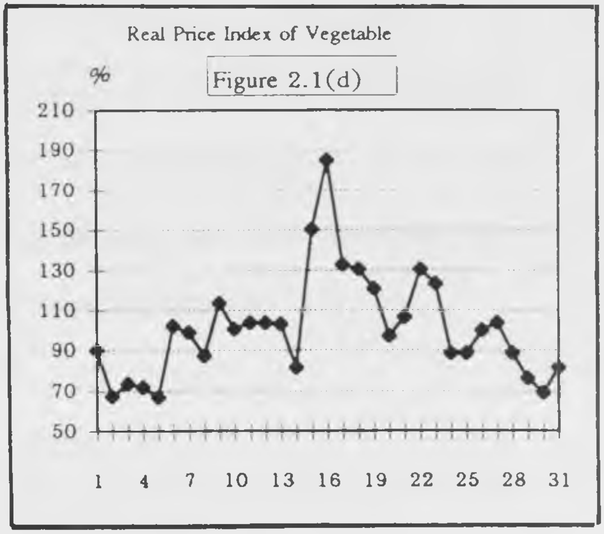
Year 1961 '65 '71 '75 '80 '85 '91



Real Price Index of Upland Crop

Figure 2.1(c)

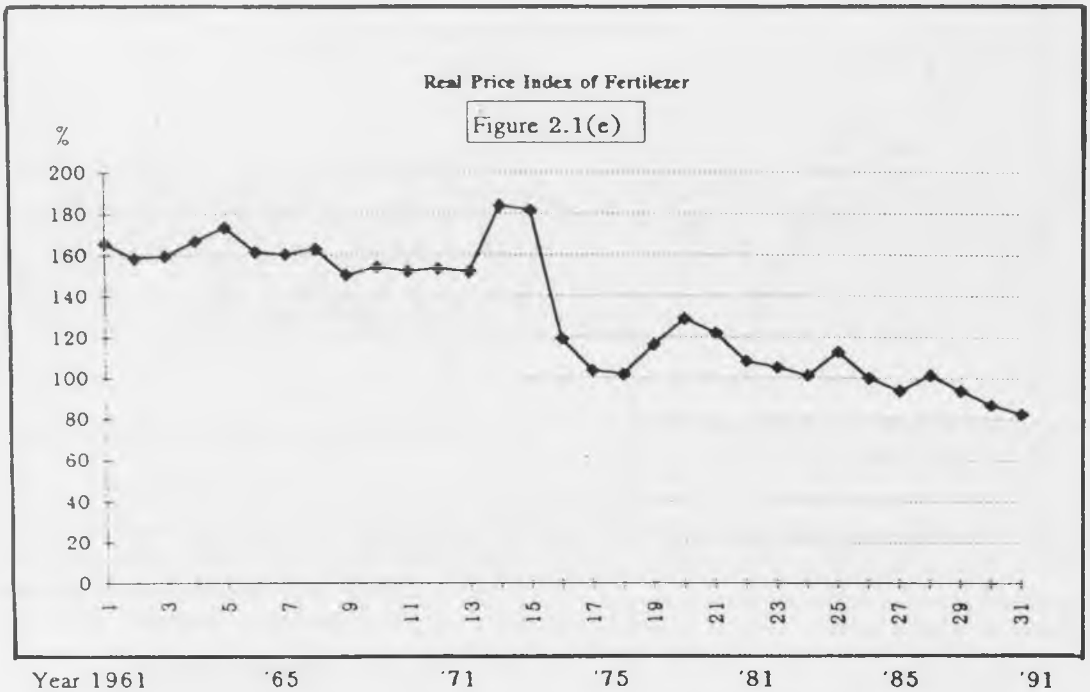
Year 1961 '65 '71 '75 '80 '85 '91



Real Price Index of Vegetable

Figure 2.1(d)

Year 1961 '65 '71 '75 '80 '85 '91


Real Price Index of Fertilezer
Figure 2.1(e)
%
200
180
160
140
120
100
80
60
40
20
0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
Year 1961
'65
'71
'75
'81
'85
'91

control on rice exports was used to prevent domestic rice shortage and to generate the government revenue[5] (Sanittanont, 1967). In 1960s and 1970s the premium rate was varied to stabilize the domestic rice prices in response to fluctuations of the world price. Moreover, quotas were often set to control the export supply (Siamwalla,1975). This binding policy generated significant quota rents to exporters. As the crisis in the world rice market subsided in the early 1980s, the rice premium rate decreased. The rice premium was eventually abolished in 1986.

2) Export subsidy program

The government started to subsidize rice exports in 1975 by providing discounted credit rates to exporters. Despite this credit program which was aimed to reduce exporter's costs, it benefited only some exporters due to a limited amount of available funds. In 1975, the available amount of credit was 775 million baht or 13% of total rice export value. In 1988, the amount had reached 20,091 million baht (or 58%). It declined gradually since its peak in 1988 to 12,379.4 million baht (or 40.57%) in 1991 (Table 2.7). The advantage of this policy is that it is not create a distortion between domestic and international prices.

2.4.2 Domestic price policies

1) Price support program

This policy is aimed to combat decreases in the paddy price during the beginning of each rice season. An important program was to buy paddy and to keep in storage until market prices were favorable. This rice support program has been in effect since 1965, but since the

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[5] Normally, all premium revenue before 1974 were handed over to Ministry of Finance. With the passage of the Farmers' Aid Fund Act in 1974, the revenue was placed into the Farmers' Aid Fund that would be administered by a Farmers' Aid Committee.

Table 2.7

Amount of packing credit made available for rice exporters and ratio of the credit to total rice export value, 1975-91

Year	Amount of Packing Credit (Million Baht) 1/ (1)	Ratio of the Credit to Total Export Value (%) 2/ (2)
1975	775	12.97
1976	2,087	24.26
1977	3,310	24.73
1978	1,999	19.18
1979	5,872	37.66
1980	6,341	32.51
1981	5,677	21.53
1982	11,843	52.61
1983	12,780	63.40
1984	14,640	56.46
1985	11,224	49.83
1986	11,330	55.77
1987	10,928	48.13
1988	20,091	57.94
1989	13,577	29.86
1990	9,986	35.96
1991	12,379	40.57

Source : 1/ Bank of Thailand

2/ Divided (1) by total rice export value.

declared support price was below the market price in the earlier year, the program plays no significant role (Siamwalla and Setboonsang, 1989). The program was also less effective even when the market price dropped below the support price. This is because the money available was never sufficient to buy a huge amount of marketed paddy after it was harvested. After the Farmer's Aid Fund was set up in 1975, the main operation fund for this program was allocated from this source. Moreover, to support the policy program, the Marketing Organization for Farmers (MOF) was established and made responsible for paddy price intervention. The PWO was sometimes involved in the support program through buying the milled rice and keeping it in stock for few months before it was resold under a government-to-government (G-to-G) agreement. Due to high transaction costs and lack of continuity either in method or organization, the program operation faced heavy losses to both the MOF and PWO. The program has also created a substantial economic rents for sellers who can sell to government. In a careful study of the distribution of benefit and burden of the 1983 rice market intervention by MOF, Pinthong (1984) found that of the economic rent thus generated, the distribution was 54% for millers and exporters, 27% for government officials and political parties, 6% for farm leaders, and 13% for farmers.

Currently, the operation of the rice support program is limited. Instead, the paddy pledging scheme was promoted since 1986. Under this program, farmers can acquire a short-term loan from the Bank of Agriculture and Agricultural Cooperatives (BAAC) by pledging their paddy with the Bank .[6] The loan amounts were about 80% of the market price. However, the BAAC has to bear the risk if the paddy price did not increase enough to cover the redeemable cost and the farmers did not redeem.

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[6] Initially, the pledged paddy was kept at the PWO. After 1986, the pledged paddy was kept at each farmer storage for saving a transportation cost. The BAAC paid a storage rent to farmer at very low rate or 1 baht per ton.

2) A consumption subsidy program

From 1962 to 1982, the "rice reserve requirement" was imposed on exporters to insure stable domestic rice quantities and prices. For every ton exported, the exporters were required to sell the government a certain portion of rice at below market prices. The rice was later resold to selected retail markets by the Public Warehouse Organization (PWO). Originally, the policy was aimed to subsidize consumers during periods of high domestic rice prices. This program was a price-stabilizing factor for two reasons. First, it created a stock of rice to buffer against sudden surges in demand. Second, the implicit export tax was collected in a way that made it function as a sort of variable levy. As the domestic price markedly increased, the equivalent export tax rate rose up. This, in turn, stabilized the domestic market, even though it destabilized the export market (Siamwalla and Setboonsang, 1989). As a result of its pressure on domestic paddy prices, the rice reserve program was eliminated in the early 1982.

2.4.3 Domestic input price policy: a fertilizer subsidy

In Thailand, input markets are mostly free of government intervention. Public policies on chemical fertilizers mainly involve distribution of fertilizers at market price or at reduced costs. The government has used the MOF as a network to distribute the fertilizer. This in effect amounts to a subsidy as it reduces transportation costs. During 1987-1990, the average quantity of fertilizer sold by MOF per annum was about 18% of the total quantity of fertilizer used in paddy production (Table 2.8). During 1987-90, the MOF supplied fertilizer below market prices. A comparision of the MOF and market wholesale prices is shown in table (2.9). The net price differences were in many cases more than 200 baht per ton. This practice was made possible by inexpensive loans provided by Farmers' Aid Fund and fertilizer grants from the government of

Table 2.8

Average quantity of fertilizer distributed by MOF by

region, 1978-1991. 1/

	Regions									Total Quantity of Distributed Fertilizer (Million Ton)
	Northeast		North		Central Plain			South	Total	
	UPNE	LONE	UPN	LON	WT	MD	ET			
	%									
1978-80	6.83	12.99	4.21	6.73	11.04	34.18	17.38	6.64	100	120.96
1981-85	9.59	18.38	4.88	4.20	6.06	37.38	12.00	7.51	100	158 77
1986-91	20.28	24.57	7.84	7.55	4.54	14.47	9.11	11.64	100	149.52

Source : MOF

1/ Percentage value is calculated from the MOF data

Table 2.9

The MOF's selling prices and the market wholesale

prices of some fertilizers

Year	Prices	Fertilizer (Baht/Ton)		
		21-0-0	16-20-0	15-15-15
1987	MOF	2,000	3,800	4,400
	Market	2,342	4,088	5,217
	Price difference 1/	15	7	16
1988	MOF	2,000	4,400	5,450
	Market	2,892	4,742	5,538
	Price difference 1/	31	7	2
1989	MOF	3,000	5,000	5,450
	Market	3,078	5,046	5,596
	Price difference 1/	3	1	3
1990	MOF	2,400	4,400	5,500
	Market	2,825	4,950	5,617
	Price difference 1/	15	11	2

Sources : Adopted from (TDRI, 1992)

Note : 1/ is shown price differences as % of market prices

Japan. TDRI (1992) reported that from 1987 to 1990 the government provided 650.7 million baht for fertilizer subsidies.

Since domestic market prices closely follow international prices and there are no import duties for agriculturally used fertilizers, the price difference plus transportation costs equals the economic subsidy. TDRI (1992) reported that MOF operation succeeded in creating a two price system but failed to affect the marginal price of fertilizers to farmers. Instead economic rents are accrured by those who sell subsidized fertilizers at market prices. Thus, the MOF operation has no impact on resource allocation with regards to fertilizer utilization. Another government organization to intervene in the fertilizer distribution policy was the BAAC. However, its role for fertilizer distribution was involved only for insuring that its approved loan to farmers was used for investment purposes. The margin that the BAAC charges to its customers is 2% of the actual cost. Transportation is provided at cost.

2.5 Direct Price Effects of Government Measures

The export market played an essential role in determining the domestic rice prices and rice export generated a significant amount of foreign exchange, thus any crisis on world rice market often has repercussions on the domestic market. Past governments had utilized various policies and measures to intervene on the export market with the aim to stabilize the domestic price. Except for packing credit, the other measures, particularly, export premium, rice reserve requirement and export quota, generated substantial impacts on lowering the domestic price and also increasing the export burden. These measures previously created not only a price distortion between domestic and export prices, but were also a source of tax revenue to the government. The tax was mostly borne largely by farmers.

Including export duty at the ad valorem of 5% from 1952 to 1985[7], table (2.10) shows that before 1986, export premium was the major component of the total export tax per ton of " standard paddy".[8] The rice reserve and export quota had a substantial role in the 1970s. In the early 1980s, the rice export moved towards free trade and was free of export tax since 1986. The ratios of total tax rate to domestic price[9] was higher than 71% in the 1960s. It declined in the early 1970s. However, during the crisis in world rice market in 1973 and 1974, the ratio was very high and reached a peak of about 170.5% in 1974. Since 1975, the ratio has tended to decline rapidly until it was abolished in 1986.

The previous interventions in rice exports created some distortions between domestic and border prices. The imposed tax resulted in depressed domestic prices that were lower than the border price. Table (2.10) shows a proportionate difference between the domestic and border prices. The price distortion ratio was relatively high in the 1960S or more than 41%. Except for the period of 1973-75, the rate fluctuated around 29% to 40% in 1970s. In the first half of 1980s, the rate declined rapidly until it was free from distortion since the late of 1986.

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[7] The export duty on rice was abolished in 1986.

[8] One ton of "paddy" is defined as 450 kgs. of white rice 5%, plus 150 kgs. of broken rice A1-extra, plus 30 kgs. of broken rice C1-extra, plus 30kgs of broken rice C3.

[9] The domestic price here refers to the weighted wholesale domestic prices of rices for "standard paddy".

Table 2.10

Export tax equivalents of various intervention measures on rice, domestic and border prices, 1960-92 (in terms of paddy) a/b/

Year	(1) Tax Equivalent	(2)	(3)	(4)	(5)	(6) c/	(7)	(8)	(9)
	Export Premium	Export Duty	Rice Reserve	Quota Rent	Total Tax	Domestic Price	Border Price	Ratio of Tax to Domestic Price	Rate of Price Distortion [(6) / (7)]-1
	(Baht/Ton of paddy in Nominal)								
1960-64	530.80	75.84	5.02	100.12	711.88	973.98	1,685.86	83.94	-0.43
1965-69	704.16	103.71	9.54	67.15	884.56	1,241.15	2,125.69	98.52	-0.42
1970	527.31	88.22	0.00	0.00	615.53	1,133.86	1,609.93	54.29	-0.30
1971	356.25	75.51	0.00	85.10	516.86	952.00	1,468.86	54.29	-0.35
1972	337.50	77.93	4.90	173.45	593.78	1,145.30	1,739.08	58.85	-0.34
1973	530.00	115.69	825.15	827.45	2,298.29	1,770.84	4,069.13	129.79	-0.57
1974	2,410.36	197.40	606.57	781.03	3,995.36	2,342.87	6,338.23	170.53	-0.63
1975	88,395.00	162.15	576.95	331.69	1,954.74	2,261.75	4,216.49	86.43	-0.46
1976	368.83	148.50	21.08	62.76	601.02	2,233.20	2,834.22	26.91	-0.21
1977	357.63	153.99	118.64	200.26	830.51	2,313.96	3,144.47	35.89	-0.26
1978	510.00	207.83	493.10	481.96	1,692.88	2,509.05	4,201.93	67.47	-0.40
1979	510.00	178.85	311.50	94.21	1,094.57	2,675.09	3,769.65	40.92	-0.29
1980	482.50	241.98	527.13	273.67	1,525.27	3,403.93	4,929.20	44.81	-0.31
1981	347.52	297.68	877.31	219.37	1,741.87	3,951.39	5,693.25	44.06	-0.31
1982	201.00	222.03	87.31	15.13	525.47	3,303.78	3,829.25	15.91	-0.14

Table 2.10 (cont)

Year	(1)	(2)	(3)	(4)	(5)	(6) c/	(7)	(8)	(9)
	Tax Equivalent				Total Tax	Domestic Price	Border Price	Ratio of Tax to Domestic Price	Rate of Price Distortion [(6) / (7)]-1
	Export Premium	Export Duty	Rice Reserve	Quota Rent					
	(Baht/Ton of paddy in Nominal)								
1983	176.71	178.03	0.00	0.00	354.75	3,303.52	3,658.26	10.74	-0.10
1984	100.50	103.58	0.00	52.97	257.05	3,309.02	3,566.07	7.77	-0.07
1985	121.96	31.60	0.00	0.00	153.56	2,866.27	3,019.83	5.36	-0.05
1986	39.79	0.00	0.00	0.00	8.38	2,532.09	2,571.88	0.33	-0.02
1987	0.00	0.00	0.00	0.00	0.00	3,107.19	3,107.19	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	4,063.47	4,063.47	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	4,464.95	4,464.95	0.00	0.00
1990	0.00	0.00	0.00	0.00	0.00	3,864.05	3,864.05	0.00	0.00
1991	0.00	0.00	0.00	0.00	0.00	4,247.34	4,247.34	0.00	0.00
1992	0.00	0.00	0.00	0.00	0.00	3,906.32	3,906.32	0.00	0.00

Note : a/ One ton of "paddy" is defined as 450 Kgs. of white rice 5%, plus 150 Kgs. of broketn rice A1 extra, plus 30 Kgs. of broken rice C1 extra, plus 30 Kgs of broketn rice C3.

Source: b/ Adopted from Siamwalla and Setboonsagn (1989) from period 1960-1984. The update data were calculated by authors using the same technique employed by Siamwalla and Setboonsang.

c/ Using Banngkok wholesale price, Department of Internal Trade.

CHAPTER III

TRENDS IN RICE PRODUCTION AND UTILIZATION

This chapter highlights the structure and development of rice production in Thailand. Differences in agro-ecological conditions across the regions that have differing effects on resource allocations and on production performance are presented. Historical trends in production, yield, and inputs, including public investment in irrigation and rice research are discussed. The source of rice productivity growth is quantified. Furthermore, trends in rice utilization are discussed.

3.1 Rice production in Thai agriculture

Before World War II, rice was Thailand's sole important crop. As a result of the forced rice exports, as war reparations, an increase in production was encouraged through the expansion of cultivated land. Agricultural development in Thailand started with the inception of the First National Economic Development Plan, in the early 1960s. Significant investments in agricultural infrastructure and the increasing influence of international trade induced the diversification of agriculture towards upland and other various crops. From 1961-65 to 1986-91, the share of rice to the total cultivated area declined from 68.72% to 53.20%. Despite this declining trend of cultivated area devoted to rice, it remains a major share of total crop revenue (Table 3.1)

The major rice areas in Thailand are rainfed. Water resource constraints in this environment have resulted in lesser developments of farming techniques. A single rice crop is prevalent. Generally, rice yields in rainfed areas are very low. Commercial rice production is mostly concentrated in the irrigated areas. Good water control induces the dissemination of modern varieties (MVs). Rice yields in irrigated areas are relatively high. Due to the rapid expansion of rice cropping intensity, from one crop to two or three crops a year, in irrigated areas, mechanization and chemical inputs have been widely adopted in recent years.

Table 3.1

Average share of crop values (at 1986 price)

and their average growth, 1961-91

Period	Rice	upland	Tree	Vegetable	Total
		cultivated area share (%)			
1961-65	68.72	11.98	17.74	1.55	100.00
1966-70	63.96	15.48	18.76	1.79	100.00
1971-75	60.12	19.01	18.95	1.92	100.00
1976-80	57.77	21.46	19.06	1.71	100.00
1981-85	54.52	24.25	19.76	1.47	100.00
1985-91	53.20	24.56	21.22	1.02	100.00
1961-70	66.34	13.73	18.25	1.67	100.00
1971-80	58.95	20.23	19.00	1.82	100.00
1981-91	53.80	24.42	20.58	1.23	100.00
			crop revenue share (%)		
1961-70	58.29	17.46	19.42	4.84	100.00
1966-70	57.49	20.80	15.22	6.49	100.00
1971-75	51.96	26.12	13.36	8.56	100.00
1976-80	47.88	28.52	14.70	8.89	100.00
1981-85	51.85	24.77	15.96	7.42	100.00
1986-91	50.10	23.56	21.64	4.70	100.00
1961-70	57.89	19.13	17.32	5.66	100.00
1971-80	49.92	27.32	14.03	8.75	100.00
1981-91	50.90	24.11	19.06	5.94	100.00

Source : Office of Agricultural Economics

3.1.1 Geographical variations and rice area by region.

Thailand is traditionally divided into four main regions, Northeast, North, Central Plain and South (Figure 3.1). These regions are further subdivided in this study. The Northeast is the poorest endowed in terms of soil fertility and water control. It generally has thin and sandy soils with limited capacities to retain water. Moreover, rainfall is erratic with high annual variability. This region is an undulating plateau where low-lying areas are used for rice cultivation. In upland areas, maize, cassava and sugar cane are grown. Glutinous rice is generally found in the Upper Northeast. In contrast, a specific characteristic of the soils in the Lower Northeast has specifically made the area suitable for auspicious or 'jasmine' rice which is a high quality rice. In the 1986-91 period, the Northeast accounted for 48% and 36.5% of Thailand's total rice area and production, (Table 3.2). Normally, the Northeast's per ha yields and marketable surplus are very low.

The Northern region is generally much better off in terms of soil fertility and water control, however large differences exist within region. Most of the land towards the North is mountainous. The Lower North is an extension of the Central Plain and generally has fertile soils. Due to the terrain, the Upper North has smaller farm holdings than average for Thailand. A large number of old irrigation schemes are found in the valley which allow for some double cropping. Glutinous rice crop is mostly found in the wet season but non-glutinous crop is commonly grown in the dry season. Paddy yields in the North are rather high. The shares of rice cultivated area and production in this region are about 22.70 and 28.20%, respectively, during 1986-91.

The Central Region is the most developed rice area. Again, large differences exist within the region. In the West and the East, upland crop and horticulture have expanded enormously. The Middle area, which in endowed with fertile soils, is still the rice bowl of Thailand. Double rice cropping is the norm with extensive adoption of modern rice varieties and fertilizer. Even though large portions of the rice area in this region have good water control and can grow two to three rice crops a year, many flat areas are flooded for several months in the wet season. Broadcasting or floating rice cultivation is possible and no more than one crop per year can be obtained. During 1986-91, the share of rice area and production in Central Plain were

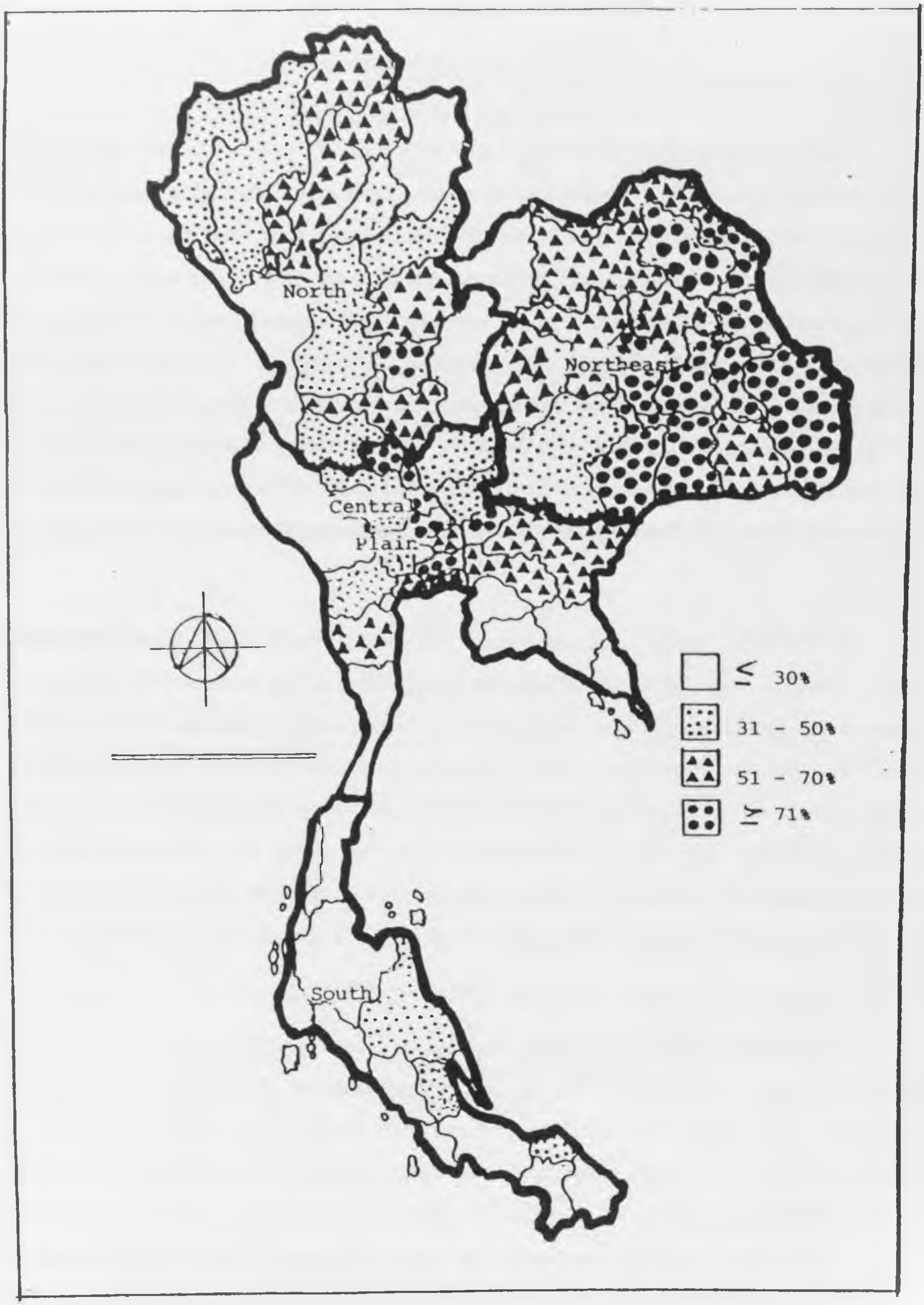

Figure 3.1 Ratio of wet season paddy to provincial cultivated areas (average from 1986 to 1991)

Table 3.2

Average rice area, production, and yield by region, 1961-91

	Regions									Annual Growth (%)
	Northeast		North		Central Plain			South	Total	
	UPNE	LONE	UPN	LON	WT	MD	ET			
production (million ton)										
1961-65	1.62	1.59	1.13	1.84	0.68	2.00	0.77	0.75	10.38	3.11
1966-70	2.06	2.25	1.47	2.28	0.79	2.15	0.93	0.94	12.87	3.90
1971-75	2.37	2.35	1.44	2.29	1.04	2.68	1.12	0.94	14.23	1.68
1976-80	2.69	2.44	1.79	2.64	0.95	3.21	1.21	1.16	16.09	1.70
1981-85	3.11	3.41	1.80	3.45	1.33	3.41	1.31	1.06	18.88	2.84
1986-91	3.42	3.64	1.72	3.73	1.38	3.17	1.32	0.95	19.33	-0.64
% share during										
1986-91	17.69	18.83	8.90	19.30	7.14	16.40	6.83	4.91	100.00	-
cultivated rice area (million ha)										
1961-65	1.26	1.33	0.42	0.87	0.43	1.14	0.54	0.51	6.50	1.36
1966-70	1.45	1.56	0.47	1.08	0.46	1.18	0.59	0.57	7.36	2.74
1971-75	1.77	1.74	0.50	1.19	0.50	1.23	0.65	0.56	8.14	3.06
1976-80	2.12	2.20	0.62	1.34	0.49	1.30	0.64	0.64	9.35	1.26
1981-85	2.17	2.45	0.60	1.57	0.51	1.26	0.67	0.64	9.87	1.02
1986-91	2.26	2.50	0.56	1.69	0.52	1.18	0.64	0 56	9.91	-1.16
% share during										
1986-91	22.81	25.23	5.65	17.05	5.25	11.91	6.45	5.65	100.00	-
annual yield (ton/ha)										
1961-65	1.29	1.19	2.68	2.12	1.57	1.85	1.42	1.47	1.61	1.94
1966-70	1.41	1.44	3.13	2.11	1.73	1.92	1.59	1.65	1.77	2.22
1971-75	1.34	1.35	2.90	1.91	2.08	2.17	1.66	1.68	1.77	-0.82
1976-80	1.27	1.11	2.87	1.96	1.91	2.32	1.76	1.80	1.74	1.17
1981-85	1.43	1.39	3.00	2.20	2.63	2.46	1.83	1.65	1.93	2.20
1986-91	1.51	1.45	3.05	2.21	2.68	2.57	1.87	1.64	1.97	1.69
wet season yield (ton/ha)										
1961-65	1.29	1.19	2.68	2.11	1.75	1.42	1.57	1.47	1.60	1.98
1966-70	1.41	1.42	3.18	2.11	1.71	1.59	1.71	1.65	1.75	2.06
1971-75	1.34	1.37	2.92	1.89	1.95	1.66	1.95	1.64	1.70	-1.46
1976-80	1.25	1.09	2.87	1.93	1.65	1.76	1.66	1.78	1.61	0.70
1981-85	1.41	1.38	3.00	2.15	2.27	1.83	2.27	1.62	1.79	1.88
1986-91	1.47	1.44	3.04	2.05	2.35	1.79	2.28	1.6	1.79	1.55

Source : OAE, Agricultural Statistics of Thailand, Various Issues.

about 23.61 and 30.37%, respectively. Approximately 12% of the rice area in the Central region is suitable for floating rice cultivation. These areas have the lowest rice yields (Isvilanonda and Wattanutchariya, 1990).

The South is suited for plantation due to long periods of high rainfall. As the rice area is the smallest, the rice supply in this region is largely imported from other regions.

3.1.2 Growth in production and cultivated area

Rice production, during the past three decades, rose at the rate of 2.78% per annum or from 10.38 million tons during 1961-65 to 19.33 million tons during 1986-91 (Table 3.2). However, in the 1960s and the early 1970s, the growth was largely generated by an expansion of the cultivated area. Cultivated rice area rose from 6.50 million ha during 1961-65 to 9.35 million ha in 1976-80 or about 2.92% per annum; whereas production increased by about 3.30% per annum. The dry season production accounted for a relatively negligible amount even though the growth in area adoption was rapidly increased. The production expansion tapered off due to a slow rate of area growth in the late 1970s and early 1980s resulting from a scarcity of the additional land and the country's economic recession from oil price shocks. However, an increase in rice cropping intensity and adoption of MVs in the late 1970s substantially regenerated the production growth. Both area and production declined in the second half of 1980 s, largely due to rising environmental degradation and shortages of irrigation water, particularly in the dry season. It is expected that the growth of rice supply will continue to decline in the following decade.

3.1.3 Production of non-glutinous and glutinous rice

Non-glutinous and glutinous rice are two major types of rice grown in Thailand. Non-glutinous rice is an important export commodity and a vital domestic food crop. During 1976-80, the average share of cultivated area allocated for this crop was 62 percent (or 5.79 million ha) of the total rice area. During the 1986-91 period, the share increased to 69 percent (or 6.79 million ha). Non-glutinous rice is grown in all regions, but the major area for non-glutinous rice is the Central Plain. The Lower Northeast, Lower North, and South contribute sizable shares to the production area. Most of the recently developed rice varieties are non-glutinous, thus the average production share of non-glutinous rice is greater than its share of cultivated rice fields, reflecting the productivity improvement. The production of non-glutinous rice rose from 10.97 to 13.96 million tons from the 1976-80 to the 1986-91 period. Moreover, the average yield improved, from 1.92 ton per ha during 1976-80 to 2.08 ton per ha during 1986-91 (Table 3.3).

While the rice economy of Thailand is dominated by non- glutinous rice, glutinous or sticky rice, on the other hand, is a traditional and subsistence crop of Northeastern and Northern farmers. The major production area is in the Upper Northeast. Other sub-regions, particularly, the Lower Northeast and the Upper North, contribute considerable shares of both area and quantity. Due to mild climate and good water control in the North, the glutinous yield is more than double of that in the Northeast. Unlike non-glutinous rice, which is utilized for both domestic consumption and export, the production supply of glutinous rice is mostly used for domestic consumption, particularly in the North and Northeast regions.

3.1.4 Land productivity and chemical fertilizer use

Overall, rice yield in Thailand is relatively low, however, the average dry season yield was double that of the wet season yield during the 1086-91 period. The lower yield of wet season crop results from a significant share of rainfed and floating rice area. During 1961- 75, the annual yield performance improved slightly and that yield was almost the same as that of the dry season. Increased adoption of rice cropping intensity and MVs significantly raised the dry season production and fairly improved the annual yield performance in the late 1970s and 1980s. In general, the average yield growth over the three decades was about 0.4% per annum. A shortage of irrigation water, particularly in the dry season, in the late 1980s negatively impacted the growth of rice yield (Table 3.4).

Since the introduction of modern varieties in 1969 (Jackson et al, 1969), the area adoption of MVs has rapidly increased, particularly in Central region (Isvilanonda and Wattanutchariya, 1990). During 1989-91, the average area adoption of MVs in wet season rice was 39.75% (CFAS, 1993). Because MVs respond to chemical fertilizer, fertilizer use rose from 27.7 kg/ha during 1971-75 to 85 kg/ha during 1986-91. The average dry season application rate per ha was almost five times of that of wet season (Table 3.5). Most chemical fertilizers are

Table 3.3

Average cultivated area, production, and yields of non-glutinous

'and glutinous rices by regions, 1976-91

	Regions						Share to	
	Northeast		North		Central Plain	South	Total	Total Rice
	UPNE	LONE	UPN	LON				
	non-glutinous rice							
	cultivated area (million ha)							(%)
1976-80	0.16	1.21	0.09	1.27	2.42	0.64	5.79	62.03
1981-85	0.32	1.55	0.08	1.50	2.43	0.64	6.52	66.06
1986-91	0.50	1.69	0.11	1.61	2.32	0.56	6.79	68.85
% share during								
1986-91	7.36	24.89	1.62	23.71	34.17	8.25	100.00	-
	production (million tons)							(%)
1976-80	0.28	1.48	0.25	2.46	5.35	1.15	10.97	68.22
1981-85	0.47	2.29	0.27	3.2[illegible]	6.01	1.07	13.39	70.92
1986-91	0.79	2.52	0.32	3.54	5.84	0.95	13.96	72.31
% share during								
1986-91	5.66	18.05	2.29	25.36	41.83	6.81	100.00	-
	annual yield (ton/ha)							
1976-80	1.75	1.22	2.80	1.93	2.14	-	1.92	-
1981-85	1.46	1.47	2.98	2.18	2.47	-	2.08	-
1986-91	1.59	1.49	2.89	2.19	2.52	-	2.08	-
	glutinous rice							
	cultivated area (million ha)							(%)
1976-80	1.95	0.99	0.53	0.07	0.01	ng	3.55	37.97
1981-85	1.85	0.90	0.51	0.07	0.02	ng	3.35	33.94
1986-91	1.76	0.81	0.45	0.01	0.01	ng	3.11	31.48
% share during								
1986-91	56.59	26.04	14.47	0.33	0.33	-	100.00	-
	production (million tons)							(%)
1976-80	2.41	0.96	1.54	0.01	0.01	ng	5.10	31.78
1981-85	2.64	1.12	1.53	0.03	0.03	ng	5.49	29.09
1986-91	2.63	1.11	1.40	0.02	0.02	ng	5.36	27.69
% share during								
1986-91	49.07	20.71	26.12	3.73	0.37	-	100.00	-
	annual yield (ton/ha)							
1972-75	1.34	1.30	2.80	2.59	1.50	-	1.59	-
1976-80	1.23	0.98	2.89	2.41	1.86	-	1.44	-
1981-85	1.42	1.25	2.96	2.52	2.00	-	1.64	-
1986-91	1.49	1.37	3.12	2.48	1.73	-	1.72	-

Source : Center for Agricultura Statistics, OAE.

Table 3.4

Average quantity and growth of production, area, and yield

of rice classified by wet and dry season crops, 1961-91

	Quantity			Growth		
	Wet Season Rice	Dry Season Rice	Annual Rice	Wet Season Rice	Dry Season Rice	Annual Rice
			area			
	——average area (1000 ha)———			—average growth (%)——		
1961-65	6,494.96	15.58	6,510.54	1.32	15.32	1.36
1966-70	7,284.07	76.76	7,360.83	2.55	23.66	2.74
1971-75	7,827.32	316.54	8,143.86	2.29	25.35	3.06
1976-80	8,845.11	509.57	9,354.86	1.23	-1.32	1.26
1981-85	9,126.93	653.51	9,870.44	0.82	3.76	1.02
1986-91	9,189.30	718.43	9,907.73	-1.40	-0.08	-1.16
			production			
	—average area (1000 ha)——			—average growth (%)——		
1961-65	10,360.15	28.45	10,388.60	3.06	18.93	3.11
1966-70	12,688.47	183.52	12,871.99	3.56	29.17	3.90
1971-75	13,201.52	1,019.15	14,220.69	-0.01	27.23	1.68
1976-80	14,314.73	1,769.62	16,084.35	1.21	0.58	1.70
1981-85	16,535.88	2,338.21	18,874.09	2.02	2.86	2.84
1986-91	16,741.73	2,581.58	19,323.31	-1.08	-0.22	-0.64
			yield			
	—average area (1000 ha)——			—average growth (%)——		
1961-65	1.60	1.79	1.60	1.93	5.32	1.94
1966-70	1.75	2.30	1.75	2.09	8.46	2.22
1971-75	1.69	3.20	1.75	-1.53	3.28	-0.82
1976-80	1.62	3.47	1.72	0.78	4.03	1.17
1981-85	1.79	3.52	1.91	2.35	-0.57	2.20
1986-91	1.82	3.62	1.95	1.53	5.76	1.69

Source : OAE, Agricultural Statistics of Thailand, Var'ous Issues.

Table 3.5

Average application rate of chemical fertilizer for rice, 1971- 91.

Year	Wet Season Rice (Kg/ha)	Dry Season Rice (Kg/ha)	Annual Rice (Kg/ha)
1971-75	23.2	169.4	27.7
1976-80	32.8	236.1	43.6
1991-85	44.2	295.2	60.1
1986-91	69.6	296.2	86.0

Source : Office of Agricultural Economics imported. A high ratio of fertilizer to rice prices has previously discouraged farmers from adopting the practice.

3.2 Labor Use for Rice Crop and Rice Area Per Unit Worker

The insignificant role of the non-agricultural sector in the past was reflected in the high rate of labor participation in the agricultural sector (82 percent in the 1961-65 period). The development of Thailand economy towards the increasing importance of non-agricultural sector in the 1970s and 1980s has consequently generated alternative employment opportunities for labor, with widening income disparities between the sectors (Watanabe, 1987). Not surprisingly, the ratio of agricultural labor force continuously declined to nearly 60 percent during the average of 1986-91 (Table 3.6).

During the 1971-75 period, approximately 71 percent of agricultural laborers were rice cultivators. With agricultural diversification in the late 1970s, the ratio slightly declined. The share further declined to 61.48 percent in the late 1980s as a result of urbanization and industrial development. The reduction of worker supply in rice production has, in turn, promoted the rapid adoption of mechanization in recent years.

The distribution of rice labor across regions and sub-regions is shown in Table 3.7. Among sub-regions, the Upper Northeast contributed the biggest share of rice labor; whereas the Lower Northeast was the second. By region, about half of the rice labor force (or 50.94 percent) in 1986-91 came from the Northeast, while one-forth ; whereas the percentage share of rice labor in the North was about one-fourth (25.89 percent) came from the North. On the other hand, a small percentage share of rice labor with a large share of production in the Central Plain implies that this is the primarily site of commercial rice production.

Table 3.6

Total and agricultural labor forces, rice labor and its shares,1961-91

Period	Total Labor Force (million) (1)	Agr. Labor Force (million) (2)	Rice Labor Force /1 (million) (3)	Share of Agr. Labor to Total Labor (%) (2)/(1)	Share of Rice Labor to Total Labor (%) (3)/(1)	Share of Rice Labor to Agr. Labor (%) (3)/(2)
1961-65	14.74	12.01	-	81.48	-	-
1966-70	16.23	12.98	-	79.98	-	-
1971-75	20.13	14.42	10.26	71.63	50.97	71.15
1976-80	25.27	16.44	11.39	65.06	45.07	69.28
1981-85	28.95	18.05	12.05	62.35	41.62	66.76
1986-91	31.43	19.03	11.70	60.55	37.23	61.48

Source : OAE

Note : /1 Calculated by multiplying provincial agricultural labor force by provincial ratios of rice farm to farm households.

Table 3.7

Average rice labor and ratio of rice cultivated area to rice labor by region, 1971-91.

	Regions									Annual Growth (%)
	Northeast			North			Central Plain	South	Total	
	UPNE	LONE	TOTAL	UPN	LON	TOTAL				
	rice labor (million head)									
1971-75	2.54	2.42	4.96	1.32	1.30	2.62	1.65	1.03	10.26	-
	(24.76)	(23.59)	(48.38)	(12.86)	(12.67)	(25.53)	(16.08)	(10.04)	(100.00)	-
1976-80	3.14	2.57	5.71	1.50	1.43	2.93	1.62	1.13	11.39	2.20
	(27.57)	(22.56)	(50.13)	(13.18)	(12.55)	(25.73)	(14.22)	(9.92)	(100.00)	
1981-85	3.44	2.66	6.10	1.65	1.50	3.15	1.59	1.21	12.05	1.16
	(28.55)	(28.55)	(50.62)	(13.69)	(12.45)	(26.14)	(13.20)	(10.04)	(100.00)	
1986-91	3.42	2.54	5.89	1.58	1.45	3.03	1.51	1.20	11.70	-0.58
	(29.23)	(23.21)	(50.94)	(13.50)	(12.39)	(25.89)	(12.91)	(10.26)	(100.00)	
	ratio of total rice cultivated area to labor									
1971-75	0.63	0.72	0.78	0.38	0.92	0.67	1.45	0.55	0.78	
1976-80	0.67	0.85	0.82	0.42	0.94	0.75	1.49	0.57	0.82	
1981-85	0.63	0.92	0.82	0.36	1.05	0.76	1.53	0.53	0.82	
1986-91	0.66	1.09	0.85	0.36	1.15	0.8	1.54	0.47	0.85	

Note : In parentheses demonstrate share values

3.2.1 Rice area per unit worker

Land and labor were previously the main factors contributing to agricultural output growth in Thailand, particularly rice. A large land resource endowment with a small population enabled the government to encourage people to cultivate land for export crops toward increasing Thailand`s foreign exchange earnings (Ingram, 1954). This resulted in a rising ratio of cultivated area to agricultural labor despite a rapid growth in population during the 1960s and 1970s (Isvilanonda, 1992).

Table (3.7) shows the ratio of total rice cultivated area to rice labor. The expansion of the dry season rice crop since the green revolution in early 1970s substantially raised the rice-area-labor ratios. Despite a constraint on land availability and a lower comparative advantage of rice compared to other crops, farm-labor out-migration in the second half of 1980s has substantially enhanced the rice-area-labor ratio.

3.3 The Development of Mechanization

In Thailand, farm mechanization first occurred in the 1950s and 1960s when acreage expansion occurred at a high rate in response to the favorable relative price changes due to increased foreign demand of field crops, especially corn, cassava, and kenaf (TDRI, 1992). Improvements in rural infrastructure, particularly roads have also led to an expansion in the planted area of field crops. Labor shortages are also responsible for the adoption of tractors (Siamwalla, 1987: Rijk, 1989). The increased tractor supply in that period reduced the rental rate which also made it relatively more advantageous over the use of animals and human labors in land preparation. Tractor use has been later spreading into rice areas for land preparations, particularly in the flood-prone and rain- fed areas (Wattanutchariya, 1983). At first, big tractors could not be used in irrigated areas. The improvements in farm machinery for land preparations in irrigated areas was made after the establishment of the Engineering Division in 1957 (Rijk, 1989). Since 1969, power tillers have been commercially produced in Thailand. It quickly gained popularity in the irrigated areas with high intensity cropping. In fact, the increase in crop rotation periods and the high cost of animal rearing and in wages are the important factors in contributing to this success. In effect, using animals in land preparation has virtually been ceased in most parts of Central Plain and Northern regions.

Table (3.8) shows numbers of power tillers, tractors, water pumps, and threshers. The numbers of these machines increased dramatically from 1977 to 1991. In this period, the increased mechanization was associated with the intensity of crop land use. Kaosa-ard (1988) found that the used of machinery is concentrated in irrigated areas. The Central Plain, the most extensively irrigated regions, has the highest intensity of machine use with 52% of paddy threshed by machine. In contrast the Northeast, where only 5% of cultivated area is irrigated, less than 5% of paddy threshing is done by machine.

Even though, the data here did not presented the adoption of combined-harvester. Since 1990, the custom service of combined- harvester has been easily discerned in the Central Plain and Lower North.

3.4. Labor productivity in rice production and sources of productivity growth

Rural infrastructure development and rapid growth of the non-agricultural sector generates a change in rural resource allocation in the crop sectors and between the agricultural and non-agricultural sectors. The increasing importance of field crops and horticulture has changed the competitive use of the country's resources, particularly land and labor, away from rice. Moreover, the country's limited resource supply, coupled with the influential role of the industrial sector in a later period, have accelerated the rise in wage rates and land prices which, in turn, upsurged the withdrawal of resources out of agriculture. The decline of labor in rice production[1] and the increased adoption of modern rice technologies have improved labor productivity. As shown in table (3.9), the average labor productivity in rice production substantially increased from 1.36 ton/labor during 1971-75 to 1.65 ton/labor during 1986- 91 or about 21.32 percent.

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[1] To estimate the rice labor force, we use the provincial ratios of rice to agricultural households and multiply this value by the agricultural labor force. We assume that all households have the same proportion of the agricultural labor force.

Table 3.8

Machinery and equipment used in agriculture,1977- 91

(units)

Year	Power Tiller	Large Tractor	Water Pump	Threshing Equipment
1977	151,504	22,826	317,328	4,962
1978	192,004	28,987	359,308	5,557
1979	230,591	33,285	473,975	6,224
1980	280,591	37,177	517,975	18,394
1981	284,351	50,044	603,548	20,601
1982	323,846	61,840	780,610	30,091
1983	364,948	45,092	858,671	33,100
1984	360,243	28,340	564,915	28,243
1985	402,082	31,415	614,791	29,735
1986	450,033	34,823	669,095	33,352
1987	515,075	40,750	768,328	34,884
1988	582,753	45,544	851,349	37,020
1989	660,685	51,279	943,387	39,352
1990	750,542	57,737	1,101,850	41,876
1991	854,279	65,010	1,220,816	44,626

Source : Agricultural Statistics of Thailand, Crop Year 1991-92, Office of Agricultural Economics.

Table 3.9

Labor productivity (ton/worker) in rice production by region, 1971-91

	Northeast		North		Central Plain			South	Total
	UPNE	LONE	UPNE	LON	WT	MD	ET		
1971-75	0.85	0.97	1.09	1.76	2.86	3.28	2.45	0.91	1.36
1976-80	0.86	0.95	1.19	1.85	2.68	4.10	2.48	1.03	1.41
1981-85	0.90	1.28	1.09	2.30	3.91	4.65	2.51	0.89	1.57
1986-91	1.01	1.44	1.09	2.58	4.31	4.54	2.68	0.79	1.65

Source : From calculation

3.4.1 Labor productivity estimation

The labor productivity (PROLA; ton) function in this analysis is hypothesized to be determined by the following factors: 1) rice cultivation area per unit of labor (CPDLA; ha); 2) irrigated area per unit of labor (IRGLA; ha); 3) stock of rice research investment per unit of labor (RES; baht)[2]; 4) farm capital per unit of labor (CAPLA; baht); 5) a dummy variable for rainfall conditions (UNRAIN)[3]; and 6) rice- ecological variation (in terms of regional dummies). The rice cultivated area is used to measure the important effect of land resource to productivity since it is a basic resource in crop production. Intuitively, the larger the area the greater the productivity will be, given the same amount of labor. On the other hand, holding the same ratio of land to labor, the lower the land quality, the lower productivity will be. To demonstrate the importance of public investment in rice production, three additional variables are included in the analysis: accumulated irrigated area per capita, rice research investment per capita, and public road investment per capita. The value of power tillers and water pumps per capita is also included in order to reflect the accumulation of capital by farmers.

Since the data are desegregated at the provincial level from 1971-1991, a total of 1470 samples are used in the analysis. The Cobb-Douglas production form is chosen and the equation is specified in the log-linear form. The farm variable is in absolute numbers due to some missing data points.

The results from using the ordinary least squares (OLS) and the weighted least squares (WLS) estimation techniques are shown in Table 3.10. The WLS technique provides a better result because the samples are weighted by the shares of cultivated rice area by province. The equation has a very good fit with a high value of adjusted R-square (0.8092). Except for rainfall variables which are significant at the five percent level, all variables are significant at the one percent level. A positive relationship between farm land and labor productivity implies that an abundance of farm land and increased rice cropping intensity generate increased labor

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[2] The accumulated stock of research investment is estimated by following the Evenson and Setboonsarng study technique.

[3] A lower amount of rainfall, compared to the provincial mean, indicates lower productivity since many large rice areas are rainfed.

Table 3.10

Estimated results of production function, 1971-91.

	Ln PROLA			
	OLS		WLS	
Constant	1.9282	(8.141)	1.2661	(6.8650)
Ln CPDLA	0.9032	(35.903)**	0.8185	(45.668)**
Ln IRGLA	-0.0376	(-4.622)**	0.0232	(2.724)**
Ln RESLA	0.1816	(7.717)**	0.1001	(5.234)**
CAPLA	- 0.0000	(-1.649)**	0.0000	(3.014)**
Ln ROADLA	0.0391	(3.133)**	0.0207	(2.649)**
UNRAIN	0.0133	(0.329)**	-0.0554	(-2.171)**
NORTH	0.3140	(6.548)**	0.4127	(16.474)**
CENTRAL PLAIN	-0.0810	(-1.356)	0.1417	(3.831)**
SOUTH	0.6060	(10.686)**	0.3514	(8.430)**
Adj R2	0.5416		0.8092	
F-ratio	193.8242		693.0738	
Sample no.	1470		1470	

Note : In parentheses are t-value, ** and * are significant at 1 and 5%, respectively.

productivity. Furthermore, public investment in irrigation, rice research, and road development create productivity improvements. Despite its positive significant effect, the magnitude of farm capital on productivity is very small.

Weather conditions, particularly droughts, reduce productivity due to declined yield per unit area. The positive significance of the NORTH, CENTRAL PLAIN, and SOUTH dummy variables indicate that the North, Central Plain, and South have a relatively higher productivity than the Northeast.

Except for farm capital, rainfall, and regional dummies variables, the coefficients obtained from the estimated equation represent the production elasticities of those inputs. Judging from the elasticity, the rice area has the largest magnitude since extensive farming is still commonly practiced among farmers. Other factors, particularly research and public capital investments contribute substantially.

3.4.2 Sources of productivity growth

Toward determining the sources of productivity growth, first, we decomposed labor by its factor uses. Then, the three year average is used to smooth the irregularity of the obtained values. The sources of productivity growth from 1971-73 to 1977-79, from 1977-79 to 1983-85, and from 1983-85 to 19881-91 can be derived. As shown in Table (3.11), it is found that from 1971-73 to 1977-79 productivity growth was 4.73% per annum. The growth largely stemmed from cultivated area expansion (2.65% per annum). Rapid adoption of modern rice varieties in this period stimulated rice cropping intensity, which in turn led to increased cultivated areas, particularly in irrigated areas. Further, accelerated deforestation continuously resulted in increased farm lands.

Research and irrigation investments induce modern rice technology adoption, particularly modern varieties (MVs). Since MVs are responsive to chemical fertilizer, the adoption of MVs, particularly in irrigated areas, has contributed to higher yields. This can be observed by the attribute of research and irrigation variables on productivity growth which are equal to 2.49 and 0.27% per annum, respectively.

Table 3.11

Sources of labor productivity growth in rice production

Soure	Rice output growth and its sources (%)			
	1971-73 to 1977-79	1977-79 to 1983-85	1983-85 to 1989-91	1971-75 to 1986-91
Rice output growth	4.73	-0.95	3.00	1.63
per capita per annum1/				
Attributable to				
Cultivated area per capita	2.65	-1.63	-0.58	-0.24
Irrigated area per capita	1.07	0.76	0.29	0.81
Rice research per capita	0.27	0.08	1.39	0.49
Farm capital per capita	2/	2/	2/	2/
Road investment per capita	0.37	0.16	1.39	0.53
Unexplain residual	0.37	0.63	0.51	0.04

Note : 1/ Only rice labor force

2/ very small amount

Source : Calculated from Appendix Table (3.1)

From 1977-79 to 1983-85, the growth of labor productivity is negative, or 0.95% per annum. It is possible that the decrease stemmed from the oil price shock and drought during this period. Despite the fact that research, irrigation, and road variables contributed to increased productivity, the negative effects of decreasing cultivated area per capita off-set the overall growth performance.

From 1983-85 to 1989-91, the productivity growth is positive despite negative growth attribute in cultivated area. Rice research investment and infrastructure development helps generate growth. It is found that the growth attribute from research is highest (1.39% per annum), followed by the growth attribute from road development at 1.38 percent per annum.

Based on the average value, productivity growth from the 1971-75 period to the 1986-1991 period was 1.63 percent per annum on average. A major contribution to growth was irrigation investment (.81 percent per annum). Rice research and road investment contribute .68 percent and .75 percent, respectively. On the other hand, the lack of new frontier land available for cultivation has reduced productivity growth despite a strong presence of rural to city migration.

Generally, the sources of labor productivity growth between the two decades stem from public investment in rice research, irrigation and road development.

3.5 Trends in Rice Utilization

3.5.1 Rice export

Thai rice exports can be traced back to the Bowring Treaty which was signed in 1855[4]. Prior to World War II, exports constituted about 40% of total production. After the War, a shortage of rice supply throughout the world led Thailand to exercise a monopoly power over its rice trade during the 1950s and 1960s. As a consequence of the Green Revolution, which took place in the early 1970s, the export rice market was gradually transformed toward the increasing competitiveness of world rice trade.

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[4] The treaty was purposively established a free trade between Thailand and England. It was signed during the King Rama IV period.

Table 3.12 shows the fluctuation trend of rice exports. The average amount of exports during 1962-65 was 2.46 million tons of paddy equivalent (or 1.62 tons of milled rice) per annum or about 23.97% of total supply. Exports declined considerably to 1.92 and 1.99 million tons of paddy equivalence per annum during 1966-70 and 1971-75, respectively. Since then the average amount of exports increased markedly from 3.67 million tons (of paddy equivalence) per annum during 1976-80 to 7.48 million tons (of paddy equivalence) per annum during 1986-91. Concomitantly, the share of rice exports to the total supply continuously rose from 14.39% during 1971-75 to 38.76% during 1986-91 despite the continuous increase in total rice supply. A heavy export tax rate during the late of 1960s and the early of 1970s, geared toward stabilizing the domestic price, resulted in decreased exports. However, a gradual adjustment toward free trade in the 1980s led to increased rice exports. Currently, Thailand is the largest exporter in the world market. There is no data available on high quality rice exports, however, there appears to be room for expansion.

3.5.2 Domestic rice available and disappearance

The domestic availability of rice each calendar year is obtained by deducting exports from the total produced which also includes annual changes in rice stock. In contrast, the domestic disappearance consists of industrial and domestic consumption but here excludes seed use.

The utilization of rice for seed varied with the cultivated area. The average share in the total output supply was rather small at about four percent per annum and stable over the entire period under study (1962 to 1991). Even with a change of planting technique from transplanting to pregerminated direct seeding in many areas of Central Plain, which required a higher amount of seed use per unit area per annum, total output supply increased as a result of the adoption of high yielding varieties and improved rice cropping intensity, particularly in irrigated environments. This resulted in increased seed demand during 1980s.

The use of rice as a raw material in agro-industry and feed mills is not widespread. The data from NESDB indicated that the average amount of rice for intermediate consumption was about 0.648 million tons in 1991, however, timeseries data on intermediate rice consumption is not available.

Rice production has seasonal patterns. The majority of rice supply or 84% of total output, is obtained from the wet season crop. After the harvest, the marketable surplus first flows through local and regional rice markets before it is processed and distributed to domestic consumers and to wholesale markets in Bangkok for export. The stocking activity for rice is mostly done by some large middlemen, millers, and exporters. In Thailand, reliable time-series data on rice stock is very difficult to find. The per capita disappearance per annum in table (3.12) is calculated by using the three-year moving average (in order to reduce the effect of annual change in rice stock from domestic availability) divided by population. It was found that after the first half of 1960s, the average per capita domestic disappearance of rice per annum (in terms of paddy) showed a continuously declining trend from 289.05 kgs (or 190.74 kgs in milled rice) during 1976-80 to 203.88 kgs (or 134.56 kgs in milleo rice) during 1986-91. Given negligible growth for other uses, the declining trend of rice disappearance per capita implies a reduction of domestic rice consumption per capita over the past few decades.

In the next chapter, we will investigate household consumption of food and rice. By estimating rice expenditure and rice value per unit, income and price elasticities of quantity rice demand can be indirectly estimated.

Table 3.12

Average rice export and domestic utilization, 1962-91.

Year	Average per Annual				
	Total Rice Utilization	Seed Use Export	Domestic Avai. After Seed Use 2/	Per Capita Domestic Disapear.	
	1,000 Tons of Paddy Equivalence				kgs
1962-65	10,255.56	2,458.21	451.49	7,345.86	245.99
	(100.00)	(23.97)	(4.40)	(71.63)	
1966-70	12,349.90	1,916.08	505.17	9,928.65	289.05
	(100.00)	(15.51)	(4.09)	(80.40)	
1971-75	13,861.58	1,994.95	558.83	11,307.80	286.25
	(100.00)	(14.39)	(4.03)	(81.58)	
1976-80	15,664.59	3,673.69	654.08	11,336.82	252.35
	(100.00)	(23.45)	(4.18)	(72.37)	
1981-85	18,303.80	5,748.62	692.05	11,863.13	236.51
	(100.00)	(31.41)	(3.78)	(64.81)	
1986-91	19,288.00	7,476.02	696.25	11,115.73	203.88
	(100.00)	(38.76)	(3.61)	(57.63)	

Note : 1/ Assuming stock at the end of 1961 is equal to zero

2/ Including changes in annual stock

Source : Appendix Table (3.2)

CHAPTER IV

HOUSEHOLD FOOD EXPENDITURE AND RICE CONSUMPTION DEMAND

Traditionally, Thai dietary habits were based on rice and curried or chillied fish. In addition to rice and fish, other important foods are pork, chicken, and beef. Even though Thailand is a food surplus country, the distribution of food among consumers is uneven with some population groups experiencing malnutrition, particularly the rural poor and slum dwellers in Bangkok. Income disparity is an important factor explaining this problem (Triratvorakul, 1984; Konjing and Konjing, 1991).

Food consumption patterns in Thailand have gradually changed over the past few decades. There has been an increasing trend in per capita consumption of nutritious foods, such as meats, fruits, vegetables, and fat and oils and a declining trend in per capita rice consumption (Konjing and Veerakitpanich, 1985; SEP, 1992). Rapid economic growth, urbanization and improvements in marketing networks and education induce a change in consumers' habits as well as their food consumption expenditures.

Household food consumption patterns depend mainly on socio-economic and cultural factors. High income consumers spend a smaller proportion of their income on food. They also spend less on rice and cereals. On the other hand, low income consumers must allocate a higher proportion of their budget to food, particularly rice and cereals (Patmasiriwat and Poldee, 1990). In this chapter, the household socio-economic survey (SES) data from 1990 will be employed to examine factors that contribute to changing household consumption patterns.

4.1 Household Expenditures and Food Expenditure Shares

Table 4.1 shows that the total average consumption expenditure of households is 5,896.68 Baht per month. Of this expenditure, on average, 37.26 percent is spent on food. Municipal households tend to spend a relatively lower proportion on food expenses than village households.

Table 4.1

Number of household samples, household size, household food expenditure, and monthly household income by community,1990

Items	Community			Total
	Municicality	Sanitary	Rural	Average
No. of samples	5,074	2,654	5,458	13,186
Household size	3.79	3.99	4.25	4.02
Food expenditue				
(Baht/month)	2,611.72	1,941.87	1,954.25	2,197.05
Household consumption expenditure				
(Baht/month)	8,299.48	5,194.54	4,004.36	5,896.68
Ratio of food to				
total expenditure (%)	31.47	37.38	48.80	37.26
Food expenditure shares (%)				
- Rice & cereal	13.61	20.14	20.71	17.09
- Meat, beaf, and poultry	11.85	16.46	15.47	14.05
- Fish	7.96	13.85	13.04	10.90
- Milks	5.71	5.50	5.99	5.79
- Oils	1.89	1.85	2.17	1.99
- Fruits & vegetables	11.87	15.04	15.43	13.79
- Sugar	1.86	1.60	1.91	1.84
- Others	45.25	25.56	25.28	34.55
Total	100.00	100.00	100.00	100.00

Source : Calculated from the Socio-Economic survey Data 1990.

Rice and cereal expenses constituted the biggest share, or 17.09 percent, of the household food budget. In municipalities, the share of rice and cereal expenditures is lower than in sanitaries and villages. Meat, beef and poultry, and fruits and vegetables are other important food expenses.

Patterns of household food expenditure differ across economic classes. In terms of the extremes, the food budget of the poor is 1,776.56 Baht per month, compared to 1,990.22 and 3,030.91 Baht per month respectively for middle-income and rich households. However, a larger proportion of household expenditure of the poor is spent on food (97.28 percent); whereas that ratio is smaller for middle-income and rich households (47.58 and 22.63 percent respectively). Rice and cereal are still major expenses for the poor. In contrast, the rich allocate nearly equal proportions for rice and cereal, meat (including beef, and poultry), and fruits and vegetables (Table 4.2).

4.2 Household and Per Capita Rice Consumption

Rice consumption varies across regions, communities, and expenditure classes. Table 4.3 shows quantities and values of rice consumed both per household and per capita. Among regions, the average amount of rice consumed per household in Bangkok (including adjacent provinces) is 274.77 kgs (in terms of milled rice) per annum but that in Northeast, North, Central Plain, and South are 2.5, 1.9 1.55, and 1.65 times of that in Bangkok, respectively. Furthermore, cultural differences among regions are reflected in rice preferences. Northeastern and Northern households normally prefer glutinous over non-glutinous rices. Shares of glutinous rice to the total rice consumption of households in Northeast and North are 69.85% and 55.19%, respectively. Households in other regions consume an insignificant share of glutinous rice since non-glutinous rice is prefered by households in the Central Plain, South, and Bangkok.

To reduce the family size effect, per capita rice consumption is calculated. Since there was not much difference in family size across regions, per capita rice consumption was almost the same as household consumption patterns. In Bangkok, per capita rice consumption per annum was the lowest (72.31 kgs) it was the highest in Northeast (160.98 kgs). In Northern, Central, and

Table 4.2

Number of household samples, household size,

and household food expenditure by monthly household expense,1990

Items	Monthly household Expense		
	Bottom 25%	Middle 50%	Top 25%
No. of samples	3,249	6,595	3,297
Household size	3.22	4.03	4.79
Food expenditue			
(Baht/month)	1,776.56	1,990.22	3,030.91
Household consumption expenditure			
(Baht/month)	1,826.28	4,182.84	13,391.60
Ratio of food expenditure to			
total expenditure (%)	97.28	47.58	22.63
Food expenditure shares (%)			
- Rice & cereal	21.29	18.56	12.69
- Meat, beaf, and poultry	15.97	14.38	12.48
- Fish	12.86	11.57	8.89
- Milks	5.59	5.59	6.19
- Oils	2.02	2.08	1.86
- Fruits & vegetables	14.82	14.26	12.55
- Sugar	1.67	2.03	1.68
- Others	25.78	31.53	43.66
Total	100.00	100.00	100.00

Source : Calculated from the Socio-Economic survey Data 1990.

Southern Regions, the per capita rice consumptions are 140.86, 107.30, and 106.11 kgs, respectively. By overall average, the per capita rice consumtion per annum is 118.89 kgs.

Figures on rice consumption value of the average household and by per capita are shown in table (4.3). Because rice consumption value consists of quantity, price, and quality,a unit value of rice can be derived by dividing value by quantity. The unit value obtained contains price and quality components. Given the quality, price can be varied due to different transaction costs. The average unit value of rice (per kg) paid by households in Bangkok is the highest (10.36 Baht per kg) and that in the Northeast is the lowest (6.72 Baht per kg). Between the regions, the ratio of average unit value of rice in Bangkok, Central Plain, South, and North are 1.54, 1.32, 1.31, and 1.08 times that in the Northeast. The differences in unit value of rice across regions imply effects of unequal tranportation costs and rice qualities.

Urbanization may affect household rice consumption patterns. Urban households tend to consume less rice than village households. Better access to food services outside the home in urban areas is one of the factors explaining this behavior. In table (4.3), an average municipal household consumes 315.33 kgs of rice per annum which is half of the amount reported by the average village household . In terms of per capita rice consumption, the average consumer in a municipality consumes 83.20 kgs of rice per annum, whereas per capita consumption in sanitary and village was 124.53 and 154.20 kgs of rice per annum, respectively. It is also found that the unit rice value in municipalities (9.52 Baht per kg) is higher than that in sanitaries and villages (7.88 and 7.29 Baht per kg, respectively). This implies that high quality rice was consumed by urban households. Among high quality rice, Khao Dawk Mali 105 which has aromatic smell, is the most prefered, particularly for high income classes.

Levels of household expenditure affects per capita amount of rice consumption. The higher the household expenditure class, the lower the annual quantity of rice consumption per capita will be. Furthermore, the higher the expenditure class, the higher the unit rice value. Reflecting a higher quality of rice purchased (Table 4.3).

Table 4.3

Household and per caita annual rice consumption,1990

	No. of	Household	Quantity 1/ (Kgs)			Value (Baht)			Average4/ Value of
	Cases	size	Household	Per	Capita	Household	Per	Capita	Milled Rice Baht (Kg)
					By Region				
North	2,697	3.76	529 62	(55 19)	140.86	3,829 49	(48.50)	1,018.48	7.23
Northeast	2,915	4.35	700.28	(69.85)	160 98	4,703.24	(64.93)	1,081.21	6 72
Central Pkaub2/	2,538	3 96	424 89	(1 99)	107.30	3,763.55	(1.74)	950 39	8.86
South	2,081	4 27	452 66	(1.40)	106.01	3,984 55	(1.38)	933 15	8 80
Bangkok and Surrounding									
Provinces3/	2,955	3 80	274 77	(3.18)	72.31	2,845.80	(2.60)	748 90	10.36
				By Community and Household's Income					
Muicipality	5,074	3 79	315.33	(14.76)	83.20	3,001.24	(10.70)	791 88	9.52
Bottom 25%	487	1 99	192.30	(14.76)	96 63	1,622.25		815 20	8 44
Middle 50%	2,371	3 28	290 99		88 72	2,686 08		818 93	9 23
Top 25%	2,216	4 73	368.39		77 88	3,641 50		769.87	9 89
Sanitary	2,654	3 99	496.86	(37.58)	124 53	3,913.31	(30.65)	980.78	7 88
Bottom 25%	710	3.10	412.70		133 12	2,938.95		948 05	7.12
Middle 50%	1,444	4.14	518.67		125.28	4,090 75		988 10	7 89
Top 25%	500	4.80	553 49		115 31	4,784 52		996.78	8.64
Village	5,458	4 25	619 89	(45.60)	154.20	4,521.24	(38 89)	1,063.82	7 29
Bottom 25%	2,097	3 55	537 36		151.37	3,642 80		1,026.14	6 78
Middle 50%	2,780	4 61	671.02		145.56	5,001.58		1,084 94	7.45
Top 25%	581	5 02	673.23		134.11	2,393 50		1,074.40	8 01
Total Ave	13,186	4.02	477 93	(36.09)	118 89	3,813 99		948 75	7.98

Source Calculated from the household's socio-economic survey data in 1990

1/ In terms of milled rice

2/ Excluding Bangkok and other surrounding provinces.

3/ Including Samuth Prakarn, Pathum Thani, and Nonthaburi

4/ Dividing value by quantity The figures may be slightly under estimated because zero rice consumption samples were included.

4.3 Per Capita Rice Demand Analysis

In Thailand, domestic consumption of rice generally consists of two types: glutinous and nonglutinous rices. Except for households in the Upper North and the Upper Northeast, the majority of Thai households consume non-glutinous rice. Non-glutinous rice has a less homogenous grain quality for a number of reasons[1]. In this demand analysis, the income effect of quality rice demand was separated from quantity demand.

4.3.1 Model formulation

The framework for the analysis was a model of consumer behavior in which households choose how much of rice to buy and in what quality or grade. Rice is considered as a collection of heterogeneous goods within which consumers can choose more or less expensive items, so that the unit value of rice is a matter of choice. Both quantity and quality choices are functions of household income, price, and household characteristics.

Houschold income affects consumer choice because better-off houscholds tend to consume not only the better and more expensive quality rice, but also different proportions. It was expected that there was a positive relationship between a unit value of rice purchases and household income. On the other hand, richer households spend a smaller propoition of income on rice, which implys a negative correlation between houschold income and expenditure share on rice.

The market price was treated as an unobservable variable in this model. It directly determines quantity purchased and indicate unit value. However, since unit value was a dependent variable in the model, two problems had to be accounted for. First, unit value reflects quality choice and quality choice is affected by price. If the market price rises, consumers can

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[1] The important components for grain quality characteristics are cooking quality, amylose content, gelatinization temperature, gel consistency, grain elongation, and aroma (Kaosa-ard, 1989).

alter both the quantity and the quality of rice purchases. As a result, they will switch to buy a poorer quality rice. It is likely that the unit value is varied less than proportionally with its price. Second, the observed data on expenditure and quantity of rice purchased are subject to measurement errors resulting from the interviewing process. A unit value, or the ratio of expenditure to quantity, is affected by measurement errors, possibly generating a spurious correlation between quantity and unit value. Spurious correlation must be corrected in the estimation process.

4.3.2 Econometric estimation

The basic assumption for the econometric model was that normal households in each village or cluster will purchase rice which equals in its quality and price. This assumption is necessary because it implies that each household in the same village is faced with the same transportation cost and market price. However, due to varying quality of rice purchases between villages, the market prices will differ over space or location. Since the market price is unobservable but reflected in quantities purchased and in their unit values which, on the other hand, are observed. Denoting the household by i and cluster by c, the two basic equations are:

$$(1)\ Wic = \alpha 1 + \alpha 2 \ln Xic + \alpha 3 \ln Zic + \alpha 4 \ln Pc + fc + u1ci,$$

$$(2)\ \ln Vic = \beta 1 + \beta 2 \ln Xic + \beta 3 \ln Zic + \beta 4 \ln Pc + u2ic,$$

where Wic is the share of the budget to rice purchased (including both actual purchases and imputed expenditures), lnXic is the per capita total budget and is in the logarithmic form, lnVic is the calculated unit rice value and is also in logarithmic forms, and Zic is a household characteristic variable, all of which are observed. The logarithm of the cluster price (lnPic), the cluster fixed-effect fc, and the two error terms u1ic and u2ic are unobserved.

The demand equation (1) is simply the regression function of budget share conditional on the right-hand side variables. Because the budget share included both purchasers and non-purchasers, this equation is a standard Engel curve specification, linking expenditure to total spending, price, and household characteristics. The unit value equation (2), which is observed only for households that record positive market purchases represents the quality choice analysis. It relates unit value to total budget, to household characteristics, and to price.

The share equation (1) contains a set of cluster fixed- effects fc that represent unobservable taste variations from cluster to cluster. They can be thought of as "residuals" in a cross-cluster explaination of purchased (Deaton 1988).

(1) Estimation of income elasticity

For estimation of income elasticity of quantity demand, we firstly applied the Ordinary Least Squares (OLS) technique to the data with cluster means removed in equations (1) and (2). Intuitively, the parameters $\alpha 2$ in (1) and $\beta 2$ in (2) determine the total expenditure elasticities of quantity and quality. Since $\beta 2$ = dlnV/dlnX and since unit value is price time quality, the parameter is simply the expenditure elasticity of quality. If (1) is differentiated with respect to lnX and e_{qx} is the expenditure elasticity of quantity demand, thus we have

$$(4)\ d\ln W/d\ln X = \alpha 2/W = e_{qx} + \beta 2 - 1,$$

since the logarithm of the share is the sum of logarithms of quantity and unit value less the logarithm of expenditure. Rearranging (4),

$$(5)\quad e_{qx} = (1 - \beta 2) + (\alpha 2/W).$$

This equation is used to estimate the income elasticity of quantity rice demand.

(2) Estimation of price elasticities

In equations (1) and (2), we assume that a price variable exists in the equations. By differentiating equation (1) with respect to lnPc and making use of the price elasticity of unit value from (2), it can be shown that

$$(6)\quad d\ln W/\, d\ln P = \beta 4 + e_{qp} = \alpha 4/W,$$

where e_{qp} is the price elasticity of quantity demand. The parameters $\alpha 4$ and $\beta 4$ that appear in (6) cannot be directly estimated from the equations (1) and (2). However, from the relationship between unit value, price and quality, it can be shown in terms of elasticity that price elasticity of unit value (e_{vp}) is equivalent to (7) (Deaton, 1988),

$$(7)\quad e_{vp} = 1+ \beta 2\, e_{qp}/e_{qx} = \beta 4.$$

By Substituting (5) into (7), we obtain :

$$(8)\quad \beta 4 = 1 + \beta 2\, e_{qp}/(1 + \alpha 2/W - \beta 2).$$

For indirect estimation of the price elasticity of unit value, Deaton (1988) employed the following technigue :

Step I, use the predicted and actual values of equation (1) and (2) to calculate the variances and covariances of the error terms. That is, the estimated error term u1 has variance $\sigma 11$ and the estimated error term u2 has variance $\sigma 22$ and covariances $\sigma 12$ with u1. These variances and covariances allow the model to capture the spurious relationships between quality and price that do not come from genuine price responses. Furthermore, $\sigma 12$ would be zero if there is independent of measurement error between expenditures and unit values [2]

Step II, the estimated parameters of $\hat{\alpha} 2$, $\hat{\alpha} 3$, $\hat{\beta} 2$, and $\hat{\beta} 3$ are used with the regressors in the equation (1) and (2) to correct shares and unit values by calculating the two variables,

$$(9)\quad y1ic = Wic - \bar{\hat{\alpha}} 2 \ln Xic - \hat{\alpha} 3\, Zic,$$

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[2] Because $\ln Ei = \ln Ei^{*} + e1i$ and $\ln Qi = \ln Qi^{*} + e2i$, where Ei is the expenditure, Qi is the quantity, e1i and e2i are the errors of Ei and Qi, respectively. The asterisks demonstrate the true value of that variable. Thus, we have $\ln Vi = \ln Vi^{*} + e1i - e2i$

$$(10)\quad y2ic = \ln Vic - \hat{\beta}2 \ln Xic - \hat{\beta}3\ Zic.$$

Since we are interested in the between cluster variation in these magnitudes, the cluster mean of y1ic and y2ic are calculated and they are indicated by y1c and y2c which satisfy

$$(11)\quad y1c = \alpha 1 + \alpha 4 \ln Pc + fc + u1c,$$

$$(12)\quad y2c = \beta 1 + \beta 4 \ln Pc + u2c.$$

By estimating the variance of y2c and covariance of y1c and y2c, Deaton (1988) shows that these variance and covariance values are equivalent to (13) and (14), respectively,

$$(13)\quad \text{cov}\ (y1c, y2c) = \alpha 2 \beta 2\ m_p + \sigma 12/n1$$

$$(14)\quad \text{var}\ (y2c) = \beta 2^2 m_p + \sigma 22/n2$$

where n1 is the number of households in cluster c and n2 is the number of households which make a positive consumption. The m_p is the intercluster variance of lnPc. After corrected, the effect of spurious correlation between quantity and price, the ratio of this covariance to variance (ϕ) is equivalent to (15),

$$(15)\quad \phi = \alpha 4/\beta 4.$$

By substitute (15) into (8), we can derived $\alpha 4$ as:

$$(16)\quad \alpha 4 = \phi[\alpha 2 + W(1 - \beta 2)]/[\alpha 2 + W - \phi\beta 2).$$

The value of $\alpha 4$ and $\beta 4$ will further be employed to calculate the price elasticity of quantity demand in the next section.

4.3.3 Estimation results

Following the variables specified in equations (1) and (2), household size is used to represent the variable (Z) in the models. This variable is also in logarithmic form. We also added dummy variables on household head's eduction (EDU; it equals zero if less than college level) and household head's occupation (OCU; it equals zero for farm households) in both share and unit value equations. For expense variable, X, in the models, the per capita food expense per annum of household is used to represent the total expense due to limited information.

The estimations of nonglutinous, glutinous, and aggregated rice demands is shown in table (4.4). The estimation of glutinous rice demand is confined to Northeastern and Northern regions. It is found that the variable lnX is significant at 1% in all share equations (1A, 2A, 3A), implying that the higher the household expense, the smaller the share of rice expenditure. Furthermore, the positively significant effect of expenditure variable (X) on unit value equation of nonglutinous and aggregated rices (1B and 3B, respectively), suggests that as the expenditure increases, the quality rice demand will increase. Household size is negatively correlated and significant with the share equations (1A, 2A, 3A), implying that when family size is bigger, the share of rice expenditure will decline. Occupation variable (OCU) is positively significant in the share equations of nonglutineous and aggregated rices, suggesting a greater share of rice expenditure for farm households than non-farm households. On the contrary, the OCU variable is negatively significant for unit value equations of glutinous and aggregated rices, suggesting that farm households spend less on unit value of glutinous and aggregated rices. The EDU variable does not show significant effect on both share and unit value equations. However, it is likely that higher education households tend to spend less on rice due to negative sign of this variable in the share equation but they spend more on quality, due to its positive sign in all unit value equations.

By estimating of the share and unit value equations by communities (Table 4.5), it was found that the food expenditure variable (X) had a negatively significant effect on the share equations of urban communities (4A) and of rural communities (5A), suggesting that as the expenditures of both urban and rural households increase, the proportion spent on rice decrcases.In contrast, increased expenditures (X) tends to increase the quality of rice demanded by the urban community. This can be observed from the positively significant effect of this variable in the unit value equation. In both urban and rural communities, household size is negatively significant in the share equations, suggesting that households with more members tend to have a smaller share of rice spending. However, household size does not significantly effect the unit value equation of rural community households (5B). The dummy variable of household head's occupation is significant in all equations. It implies that farm households have greater share on rice expenditure but they have lower unit value of rice. In contrast, heads of household with a higher-than-secondary school level of education tend to have a lower expenditure share on rice

Table 4.4

Estimation results of share and unit value equations

by types of rice Consumers

Variable	Non-glutineous rice consumers		Glutineous rice1/ consumers		Aggregated rice consumers	
	W (1A)	ln (1B)	W (2A)	ln (2B)	W (3A)	ln (3B)
Constant	-0.0206	-0.0105	-0.0201	-0.0021	-0.0441	-0.0110
	-(11.978)	-(4.093)	-(4.441)	-(0.419)	-(24.857)	-(4.944)
Lnx	-0.1601	0.0065	-0.2044	-0.0014	-0.2041	0.0064
	(-69.598)**	(-1.989)*	(-36.426)**	(-0.261)**	(–87.429)**	(-2.202)*
Lnz	-0.0401	-0.0001	-0.0420	-0.0013	-0.0292	-0.0012
	(-14.487)**	(-1.015)	(–5.267)**	(-0.161)	(–9.846)**	(-0.292)
OCU	0.0051	-0.0053	0.0080	-0.0126	0.0112	-0.0066
	(1.953)*	(-1.379)*	(1.449)	(–2.442)*	(4.465)**	(-2.151)*
EDU	-0.0004	0.0090	-0.0142	0.0083	-0.0053	0.0210
	(-0.137)	(1.766)	(-1.343)	(0.600)	(–1.492)	(4.558)**
Adj.R	0.368	0.002	0.368	0.003	0.450	0.003
F-ratio	1527.015	3.199	502.787	1.631	2695.748	10.887
No. of cases	10,496	8,805	3,461	2,635	13,186	12,370
No. of clusters	1,289		351		1,640	

Note : In parentheses are the t-values. ** and * are significant at 1% and 5% respectively.

1/ Consider only households in the North and Northeast

Table 4.5

Estimation results of share and unit value equations

by community

Variable	Urban commnity		Rural community	
	W (4A)	ln (4B)	W (5A)	ln (5B)
Constant	-0.0257	-0.0334	-0.0541	-0.0027
	-(13.188)	-(8.003)	-(14.652)	-(0.524)
Lnx	-0.1713	0.0205	-0.2566	0.0017
	-(13.681)**	(6.491)**	-(60.237)**	(0.404)
Lnz	-0.0167	0.0253	-0.0533	-0.0117
	-(5.211)**	(2.259)*	-(8.770)**	-(1.869)
OCU	0.0123	-0.0156	0.0096	-0.0121
	(3.182)**	-(2.7371)*	-(2.283)*	-(2.69)*
EDU	-0.0073	0.0253	-0.0101	0.0168
	-(2.090)*	(1.039)	-(0.491)	(1.623)
Adj.R	0.430	0.006	0.494	0.004
F-ratio	1463.222	16.332	1335.187	5.184
No. of cases	7,728	6,977	5,458	5,393
No. of clusters	800		847	

Note : In parentheses are the t-values. ** and * are significant at 1% and 5% respectively.

but a higher unit rice value. These can be observed from the negative effect of the EDU variable on the share equations.

Arranging households into three different expenditure groups (bottom 25%, middle 50%, and top 25%), the estimations of share and unit value equations by expenditure classes are shown in table (4.6). It is found that the expenditure variable is negatively significant in all share equations (6A, 7A, and 8A), suggesting the negative effect of expenditure on the rice share. For the unit value equation of the Top 25% (8B), the positive significance of the expenditure variable demonstrates the positive expenditure effect on quality demand. It is interesting to note that whereas the family size is positively significant in the share equation of poor households (Bottom 25%), the variable is negatively significant in the share equations of middle and rich households (middle 50% and top 25%, respectively). This implies that the larger the family size of poor households, the higher the expenditure share on rice. In contrast, the larger the household size of medium and rich households, the smaller the expenditure share on rice. The effect of household size on unit value by expenditure class, is insignificant in each equation. For other variables, the OCU variable has a significant, positive affect on the share equations by expenditure class. However, the effect of the OCU variable on unit value is insignificant in all equations. In contrast, the EDU variable negatively affects the share in all equations, except for the medium expenditure class. Furthermore, only in rich households does education tend to significantly affect unit value positively.

(1) Estimated income elasticities

Table (4.7) shows the parameters employed in estimation of the demand elasticities. The parameter $\beta 2$ directly demonstrates the expenditure elasticity of quality demand. In calculation of income elasticity of quantity demand, the parameters $\alpha 2$, $\beta 2$, and W are involved. On the other hand, a calculation of price elasticity of quantity demand needs all parameters in table (4.7). These parameters are demonstrated by types of rice, expenditure classes, and communities.

Table (4.8) shows the calculated income elasticity of quality and quantity demand. In terms of type of rice consumption, it was found that for non-glutinous rice consumers, the income

Table 4.6

Estimation results of share and unit value equations

by expenditure classes

Variable	Bottom 25%		Middle 50%		Top 25%	
	W (6A)	IN (6B)	W (7A)	IN (7B)	W (8A)	IN (8B)
Constant	0.3978	-0.0289	-0.0566	-0.0081	-0.0971	-0.0034
	(50.654)	-(5.438)	-(21.280)	-(2.508)	-(5.671)	-(0.774)
LnX	-0.1559	0.0048	-0.2252	0.0043	-0.1732	0.0111
	(-18.404)**	(0.800)	(-65.019)**	(1.011)	(-37.542)**	(1.933)**
LnZ	0.0320	-0.0036	-0.0527	-0.0099	-0.0205	-0.0108
	(3.027)**	-(0.428)	(-10.835)**	-(1.539)	-(3.077)	-(1.226)
OCU	0.1124	0.0046	0.0294	-0.0071	0.0188	-0.0008
	(13.303)**	(0.794)	(8.127)**	-(1.636)	(2.588)*	-(0.092)
EDU	-0.0907	0.0177	-0.0114	0.0109	-0.0193	0.0175
	(3.732)**	(0.919)	-(1.913)	(1.394)	(-3.488)**	(2.513)*
Agj.R	0.244	0.000	0.467	0.002	0.363	0.005
F-ratio	255.394	0.883	1447.803	4.453	470.992	5.051
No. of cases	3,294	3,067	6,687	6,162	3,305	3,147
No. of clusters	1,262		1,582		1,013	

Note : In parentheses are the t-values. ** and * are significant at 1% and 5% respectively.

Table 4.7

Estimated parameters for elasticity calculation

Item						
Types of rice						
Non-Glutionous	-0.1601	+0.0064	+0.0860	+0.0807	+1.0088	+0.1383
glutinous	-0.2044	0.0000	+0.1524	+0.1524	0.0000	+0.1871
Agrregated	-0.2041	+0.0065	+0.0632	+0.0710	+1.1234	+0.1761
Expenditure classes						
Bottom 25%	-0.1559	0.0000	+0.0394	+0.0394	0.0000	+1.1741
Middle 50%	-0.2252	0.0000	0.0649	+0.0649	0.0000	+0.1956
Top 25%	-0.1732	+0.01111	+0.0928	+0.0950	+1.0675	+0.1158
Community types						
Urban	-0.1713	0.0205	+0.0308	+0.0320	+1.0389	+0.1439
Rural	-0.2566	0.0000	+0.0846	+0.0846	0.0000	+0.2590

Source : From Estimation

Table 4.8

Estimated expenditure and price elasticity

	Expenditure Elasticities of		Price Elasticities of
	Quantity demanded	Quantity demanded	Quatity demanded
Types of rice			
Non-Glutionous	+0.0065	-0.1858	-0.4303
glutinous	0.0000	+0.0925	-0.1855
Agrregated	+0.0065	-0.1641	-0.6100
Expenditure classes			
Bottom 25%	0.0000	+0.1045	-0.7337
Middle 50%	0.0000	-0.1513	-0.6682
Top 25%	+0.0111	-0.1845	-0.3801
Community types			
Urban	+0.0205	-0.2109	-0.8166
Rural	0.0000	-0.1359	-0.6254

Source : From Estimation

elasticity of quality demand is positive (+0.0065) but that of the quantity demand is negative (-0.1858), implying that the non-glutinous rice is an inferior good. In other words, as income inereases consumption of non- glutinous rice declines . On the other hand, less variation in varieties of glutinous rice results in quality demand which is indifferent from zero. Moreover, positive income elasticity of glutinous rice suggests that it is a normal good. By aggregating the two types of rices, we observe the positive effect on income elasticity on quality demand (+0.0065),while a negative effect is found for the income easticity of quantity demanded (-0.1641). This result is consistent with a previous study by Ito et al. (1985). In that study, the time series data were employed and the income elasticity was found to be -0.131. In contrast, by using the SES data from 1975, Trairatvorakul (1984) found positive income elasticities for non-glutinous and glutinous rice consumers which equivalent to 0.126 and 0.286, respectively.

Different expenditure classes of households hove different income effects on quality and quantity demands. By classifying households into three groups: bottom 25%, middle 50%, and top 25%, we found that only the top 25% grouping had a positive income elasticity of quality demand. For the poorer groups, there is no significant effect of income on quality demanded.

Between the poor and the rich groups, the income elasticity of the rich is negative (-0.1845) while that of the poor is positive (+0.1045). Even for the middle class (Middle 50%), the income elasticity is found to be negative (-0.1513).

Households in different communities differ in terms of quality and quantity demanded. By disaggregating households into urban and rural communities[3], we found that the income elasticity of quality demand is positive (+ 0.0205) for urban communities but that for rural community it is indifferent from zero. Furthermore, both urban and rural communities have negative income elasticities of quantity demanded (-0.2109 and -0.1359, respectively).

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[3] Households in municipality and sanitary areas are classified as urban community and households in sanitary and village are classified as rural community.

(2) Estimated price elasticities

Non-glutinous and glutinous rices consumers differ in price elasticities of quantity demanded. The price elasticity of nonglutinous consumers (-0.4303) is greater in absolute amount than that of glutinous consumers (-0.1855)(Table 4.8). This implies that consumers of non-glutineous rice are more responsive to price changes than those of glutinous rice. Our findings in owned-price elasticies are less inelastic than the findings found by Trairatvnakul (1984) By uning the SES data in 1975, he found the price elasticies of non-glutinous and glutinous consumers are-0.636 and -0.431, respeetively. If the two rices are aggregated, the price elasticity of demand is -0.610 which is inelastic.

It is also observed that the price elasticity of the low income class is -0.7337 which is greater in absolute value than that of the medium and high income classes (-0.6682 and-0.3801, respectively). Furthermore, by urban and rural communities, the price elasticity of the urban community is -0.8166 which is greater than that of the rural community (-0.6259).

This chapter analyzed the effect of some economic factors on the domestic rice demand by treating rice as a heterogeneous good. Because of the rapid economic development in Thailand over the past few decades, the households ' consumption behaviors for rice have changed. Rice in general, and non-glutinous rice in particular, was found to be an inferior good among Thai people. On the other hand, glutinous rice which largely consumed by households in the North and Northeast, is still a neccessary good. Income class and community type also influenced the changes in consumption behavior of households toward generally decrease rice demand. This information is necessary for the projection of domestic consumption which will be analyzed in the chapter VI.

CHAPTER V

ESTIMATION OF RICE SUPPLY RESPONSE

The importance of rice for the Thai economy was noted in earlier chapters. In this chapter, we quantify the relationship between rice production and prices and other factors, including public investment in agriculture. A system of simultaneous equations is constructed and the hypotheses of acreage and yield responses with respect to some predetermined variables is tested.

5.1 Review of Previous Rice supply Studies

The pioneering work on rice supply analysis in Thailand was done by Behrman (1968). He used a modified Nerlove model together with a nonlinear estimation technique to estimate the structural parameters for both acreage and yield response of rice, corn, cassava, and kenaf. Provincial time series data covering 1937 to 1963 were used in that analysis. The study concluded that Thai farmers were rational decision makers, responding positively to price while responding negatively to risk. Also, the government policy on malaria eradication induces a positive acreage response. His estimated price elasticities of marketed surplus ranged from 0.42 to 0.45 for the kingdom. Furthermore, the price elasticities of acreage are 0.18 for the short-run and 0.32 for the long-run.

By using a nerlovian-type model to estimate the acreage response function during the 1967 to 1977 period, Pongsrihadulchai (1981) found that the acreage elasticities with respect to price are inelastic (or between 0.07-0.12). Trairatvnakul (1984) employed time-series data covering 1955-80 in order to estimate the area and yield response functions. He found the shortrun and long-run elasticities of quantity of paddy supply to be 0.37 and 0.65, respectively. As an alternative to independent estimation of crop supply , TDRI (1987) jointly analyzed the revenue share equation for rice, upland crops, tree crops, and vegetables. Pooled cross- sectional and time series data at the provincial level covering 1961 to 1985 were used in the analysis. Price and crops price elasticites, with respect to the rice revenue share, were calculated. The short coming of the study was that the price elasticity of quantity supplied could not be either directly or indirectly estimated.

By applying the duality approach with farm survey data in ten major rice production provinces in 1982, Puapanichaya and Panayotou (1985) estimated the output supply and input demands of rice and some major crops. They found that the estimated price elasticities of IRRI-rice and NON-IRRI-rice supplies are 0.65 and 0.50, respectively.

5.2. A Theoretical Framework

In the crop supply model used in this analysis, it is assumed that the primary factors employed in the agricultural sector, land, labor and private capital, are fixed in the short run, or at least in each year included in our data set. These factors are then combined with purchased variable inputs . Relative prices between crops and non-agricultural goods determine the level and mix of output. In addition, the capital provided by the public sector also plays a vital role in altering crop supply.

The farmers decision-making behavior is to maximize their profits, net of variable costs from cash input items (such as fertilizers). That is they maximize profits :

$$(1) \qquad \Pi = P'Q - W'V,$$

by varying X and V, subject to the production function:

$$(2) \qquad Q = f(V,Z),$$

where

Q is the vector of all the crop outputs,

V is the vector of all the variable inputs

Z is the vector of other undefined varaibles that affect the shift in crop supply,

P is the vector of output prices, and

W is the vector of variable input prices.

The maximization process then yields the following supply equation system:

$$(3) \qquad Q = g(P,W,Z).$$

In this framework, the crop supply system consists of four broad subgroups of crops, namely rice, upland crops, tree crops, and vegetables. Since the rice supply is nested in the crop supplies system, the estimation of rice supply involves a joint estimation of the share of four subgroups. It is also further assumed that the output supply in this analysis is evolved by two behavioral functions, namely acreage and yield response functions.

The acreage share function of each crop subgroup can be written as a function of its own price, price of other three subgroups, and shifter variables.

A yield per hectare function can be derived from (3):

$$(4) \qquad Y = Q/A0 = h(P, W, Z, A0),$$

where Y is a yield of crop concern (rice), A0 is the area allocated to crop concern. We expect the relation between Y and its own price to be positive. Yet we also expect a negative relationship between Y and A0 since increases in rice acreage involve bringing marginal land into production. Decrease in rice acreage will lead to a higher average yield because marginal land moves out of rice production.

5.3 Econometric Estimation

In studying the supply analysis of any crop, one of the main objectives is the empirical estimation of elasticity of supply or output with respect to price. The choice of dependent variable lies between the production or output and the planting or harvesting acreage. Behrman (1968) criticized that the realized agricultural ouput often differs considerably from the planned output because of important environmental factors which remain beyond farmers' control. The frequent large discrepencies between planned and actual agricultural production have led most econometric investigators of agricultural supply response to approximate planned output not by actual output, but by area. The area actually planted in a particular crop is, to a much greater degree, under the farmers' control than output is, and thus, presumably a much better index of planned production. On the other hand, the actual output is dependent on the harvested, not the planted, area which in turn depends on the harvesting cost relative to the price of output and the actual yield which, to some extent, depends on weather conditions. These factors are not under the control of farmers. The farmer may be able to adjust, to some extent, his ouput by shifting his land from low to high fertility by increasing the utilization of fertilizer, water, and so fourth, or by incorporating greater land area into production. Thus the response of yield with respect to price should be taken into account.

In formulating the behavioral equation of the acreage share, the partial adjustment model is employed. It is hypothesized that the planned acreage crop shares (s*) are dependent on the set of relative output and relative input prices, and other supply shifters, particularly public investment in irrigation , research and extension, road, and education. That is

$$(5)\ sjt^* = aj + \Sigma_i aij.lnPit\text{-}1 + \Sigma_k akj.\ ln\ Wkt + \Sigma_m amj.lnZmt + u1jt,$$

where u1jt = error term.

It is further assumed that the process of acreage adjustment is taken as equation (6).

$$(6)\quad sjt - sjt\text{-}1 = \phi(sj^*t - sjt\text{-}1)),\ 0 < \phi < 1\ .$$

Intuitivcly, the equation (6) explains that farmers are able to change the acreage share of a crop (sj) in any year by only a fraction of the difference between the acreage share they would like to plant and the acreage share actually planted in the preceding year ($0 < \phi < 1$) . By solving the equation (5) and (6), we get

$$(7)\ sjt = \alpha j + \Sigma\beta ij.lnPit\text{-}1 + \Sigma\Upsilon kj.ln\ Wkt + \Sigma wmj.lnZmt + \Upsilon j.sjt\text{-}1 + u2jt,$$

where j = 1..4, and t =year.

To estimate the rice acreage share equation, we estimate the system of acreage share equations with a seemingly unrelated technique. A few cross-equation restrictions. must be imposed, namely:

$$\Sigma\alpha j = 1$$

$$\Sigma\beta ij + \Sigma\Upsilon kj = 0 \text{ for all i and k,}$$

$$\Sigma wmj = 0 \text{ for all m,}$$

$$\beta ij = \beta ji \text{ for all i and j.}$$

The first three restrictions ensure that the shares (sj) always sum up to one. The last symmetry requirement comes ultimately from the symmetry of the bordered Hessian matrix which is obtained at step one of the derivation of the optimal supply function. Note the requirement that $\Sigma\beta ij + \Sigma\Upsilon kj = 0$ and the symmetry conditions imply that the share of each acreage supply is homogeneous degree zero in the prices of the variables.

A yield response function of a crop concern (rice) is assumed to be a linear function and can be specified as follows:

$$(8) \quad Yt = \Theta o + \Sigma_i \Theta 1i.Pit\text{-}1 + \Sigma_k \Theta 2k.Wt + \Sigma_m \Theta 3_m.Zmt + \Theta 4.At + u3t.$$

To estimate the output elasticity of rice supply, the identity equation (9) is used to link the relationship between the acreage share and yield equations. That is:

$$(9) \quad Q = A.Y = s.\bar{A}.Y,$$

where Q represents production of the crop concern and s and Y are acreage share and yield of the crop concern. The equation (9) stated that the crop output is equal to the product of its acreage and yield per unit area. Also, the acreage is a product of its acreage share and average area (A).

This formulation of acreage supply and yield equations allows one to estimate the owner's price elasticity of production (e_{QP}) from the following formula:

$$(10) \qquad e_{QP} = e_{YP} + e_{AP}(1 + e_{YA})$$

The e_{YP} and e_{AP} terms are the elasticities of rice yield and acreage for crop price. e_{YA} is the elasticity of yield with respect to acreage.

5.3.1 Data

Provincial pooled cross-sectional and time series data for 22 crops[1] for the period 1961-1991 were used in the analysis. Provincial area, production, fertilizer price, agricultural labor force, numbers of tractors and water pumps, irrigated area, research and extension data were obtained from the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives. Bangkok wholesale prices were obtained from the Department of Domestic Trade, Ministry of Commerce. Wholesale prices are used in the analysis instead of farm price because the data are more accurate and longer - term data are available. The assumption made here is that the international marketing systems for most agricultural commodities are near perfect, so that Bangkok prices are transmitted completely to the farm-level. Even though Bangkok prices are used, the price indices for various provinces move differently because each province's weight is specific to its output mix.

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[1] In the analysis, these crops are divided into four sub-groups, namely rice, upland crops, tree crops, and vegetables. Rice consists of wet and dry season rice. Upland crop consists of cassava, cotton, groundnut, kenaf, mungbean, maize, soybean, sugarcane, sorghum, and pineapple. Tree crops are rubber, oilpalm, coconut, coffee, and logan. Vegetables are chili, shallot, garlic, and cabbage.

The road budget is obtained from the Department of Highway, Ministry of Communication. The average educational level of labor force in each province is manipulated from the labor force survey data.

5.4 Estimation Results

5.4.1 Rice acreage response equation

The estimation of rice supply elasticities in this study follows a simultaneous equation approach, with reflecting the farmer's decisions in the acreage share and yield equations. The model assumed that the supplies of rice and other crops are influenzed by: (i) resource availability in the province, i.e., land, labor, and capital; (ii) crop prices; (iii) government investment in irrigation and extension; and (iv) weather condition.

The Divisia price index is used to generate the provincial crop price index, taking into account the provincial crop mixture. The crop price index is weighted by a price index of non-agricultural goods at 1986 price to reflect a relative crop value. To capture the importance of public capital accumulation in crop supply analysis, accumulated irrigated area, index of educational level of labor force, stock of agriculural research and extension budgets, and accumulated road construction budget are employed in the model. Private capital accumulation in this study is generated from combining the value of power tillers, four-wheel tractors, and water pumps. Because time series data on these factor prices are not available, the imported value per unit of machine is used in calculating the private capital value . The agricultural labor force is also used in the model to capture the basic factor of farm production.

Physical factors may affect the crop supply, however, it is assumed that a provincial rainfall does not have any affect on crop supply for that province. Since farmers adjust cropping pattens to water availability. What does affect crop supply in any given year is the deviation of rainfall from the provincial mean. We use the lower one-half of negative deviation value from its