Rice Supply and Demand in Thailand:

The Future Outlook

RICE SUPPLY AND DEMAND IN THAILAND : THE FUTURE OUTLOOK

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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 (Table2.1).

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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)

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[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.

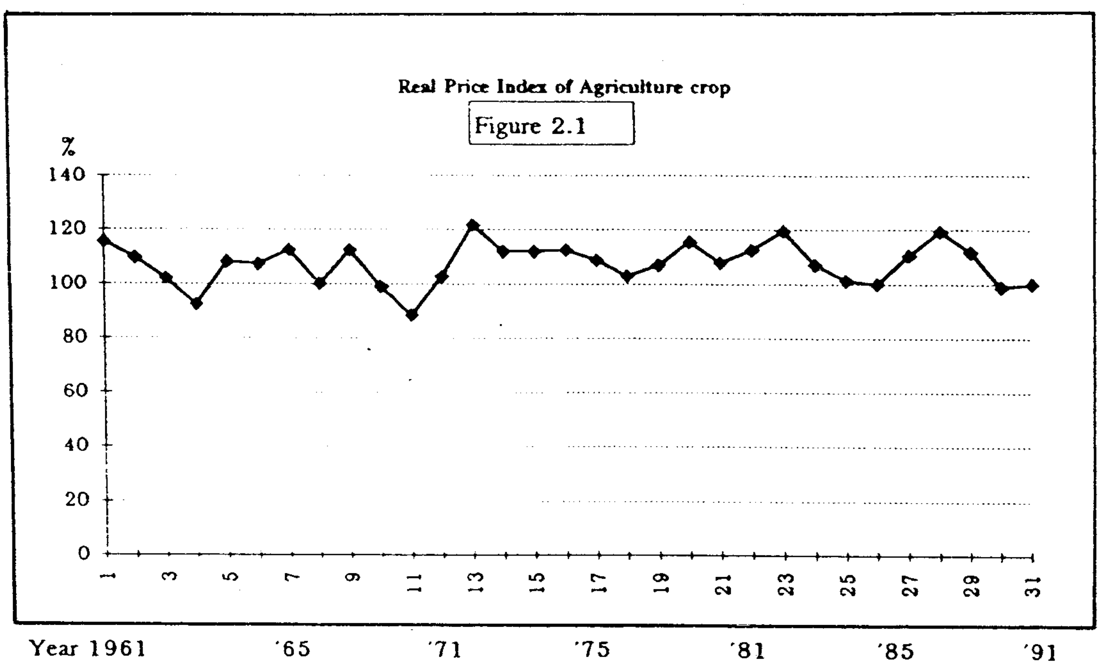
2.4 Government Policies for the Rice Prices

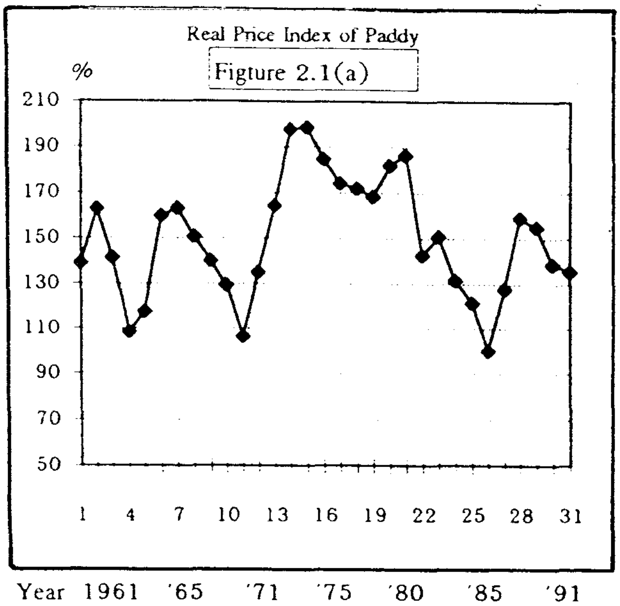
In Thailand, rice is a vital crop and as such has significant political importance. The country's production of rice exceeds domestic demand and the surplus is exported. Over the past few decades, Thailand has played a dominant role in the rice export market. Despite droughts or flooding which had negative 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

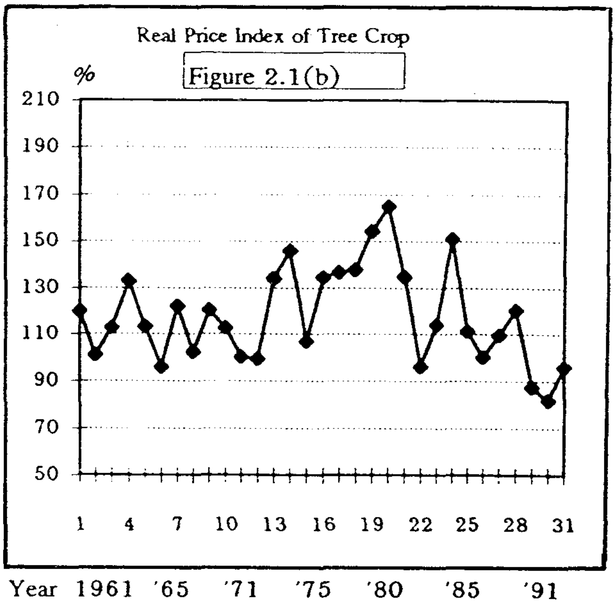
1) Export tax program

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,

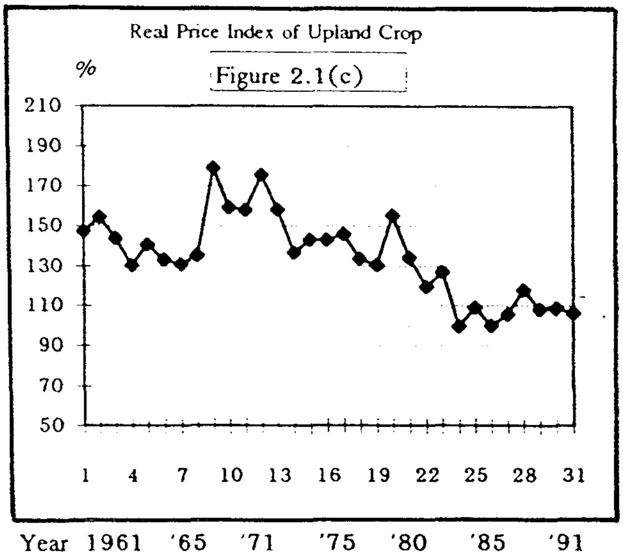

Real Price Index of Agriculture crop
Figure 2.1
%
140
120
100
80
60
40
20
0
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
Year 1961
'65
'71
'75
'81
'85
'91



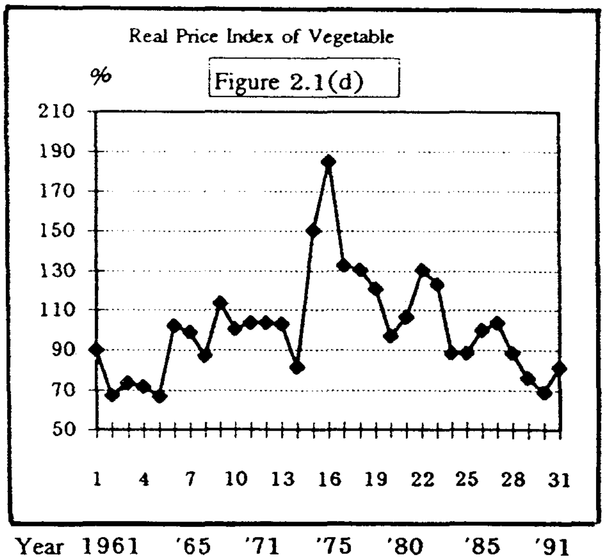
Real Price Index of Paddy
Figure 2.1(a)



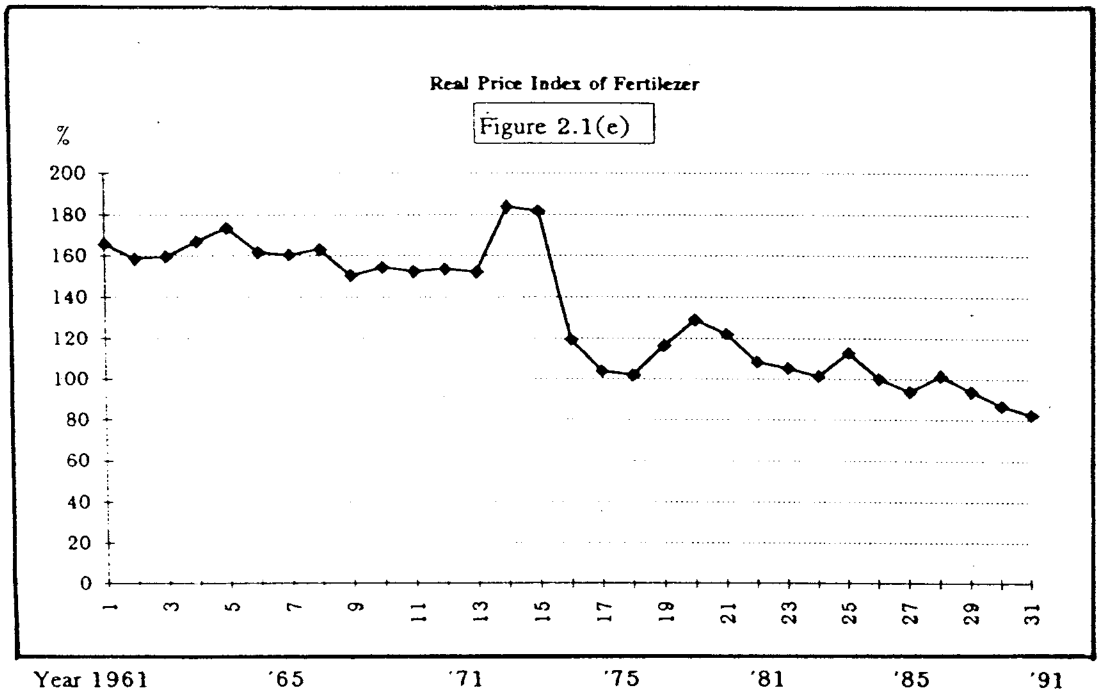
Real Price Index of Tree Crop
Figure 2.1(b)



Real Price Index of Upland Crop
Figure 2.1(c)



Real Price Index of Vegetable
Figure 2.1(d)


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

[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 a1.d 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: Export Premium	(2) Tax Equivalent: Export Duty	(3) Tax Equivalent: Rice Reserve	(4) Tax Equivalent: Quota Rent	(5) Total Tax	(6) c/ Domestic Price	(7) Border Price	(8) Ratio of Tax to Domestic Price	(9) 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

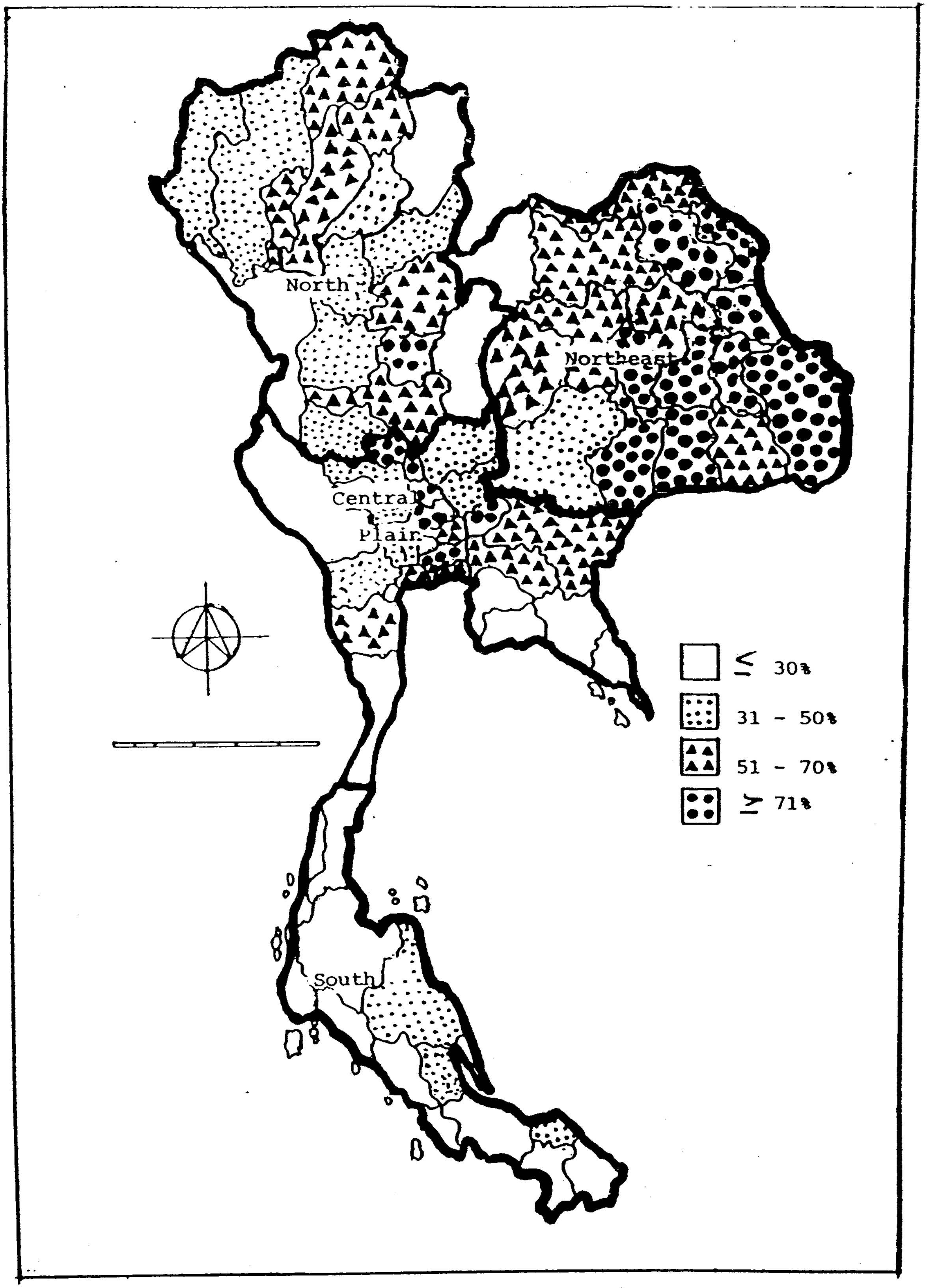

Figure 3.1 Ratio of wet season paddy to provincial cultivated areas (average from 1986 to 1991)

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, Various 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
	Northeast			North			Central Plain	South	Total	Growth
	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	37,02[illegible]
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 per capita per annum1/	4.73	-0.95	3.00	1.63
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:

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

$$(2)\ lnVic = \beta 1 + \beta 2\ lnXic + \beta 3\ lnZic + \beta 4\ ln\ Pc + u2ic,$$

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,

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

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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

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

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

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

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:

$$\Sigma\alpha_j = 1$$

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

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

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

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:

$$(8) \quad Y_t = \Theta_o + \Sigma_i\Theta_{1i}.P_{it-1} + \Sigma_k\Theta_{2k}.W_t + \Sigma_m\Theta_{3m}.Z_{mt} + \Theta_4.A_t + u_{3t}.$$

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:

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

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 mean to represent an unusual rainfall condition. The variable is in a dummy from. Differences in physical attributes across the country are also accounted for by regional dummy variables.

In the model, the dependent variables the in acreage share response equations are acreage shares of rice, upland crops, tree crops, and vegetables. The explanatory variables used in the model consist of lag indices of four crop prices, namely rice $(PDPR)_{t-1}$ upland crop$(UPPR)_{t-1}$, vegetable crop $(VGPR)_{t-1}$, and tree crop $(TRPR)_{t-1}$; index of fertilizer price (FRPR); irrigation ratio (IRRG); education level (EDUC); agricultual extension investment (EXTE; baht/ha) ; agricultural research investment (RESE; baht/ha); road construction investment (ROAD;baht/ha); labor per cultivated area (LABO; head/ha); machine per hectare (CAPI; baht/ha); and under rainfall condition (UNRAIN). In each share equation, these variables, particularly crop output and fertilizer prices, extension, research, education, labor, and private capital are in logarithmic form. Due to the presence of zero values, we were unable to use the logarithmic form for the ROAD and IRRG variables.

The results of the acreage supply estimation for rice are shown in table (5.1). Unsurprisingly, rice price has a positive significant effect on rice acreage in all equations of rice share, implying that price has an effect on the rice acreage expansion. On the other hand, competition from upland and tree crops has a negative and significant effect on rice acreage vegetables appear to complement rice crops, with a positive but insignificant effect of the price variable to the rice share equations. Increasing demand for fertilizer also reduces the acreage supply in equation (1) and (2), but not significantly.

Public investments, particularly in irrigation and roads, are found to support the rise in acreage share of rice, despite increasing crop diversification over the past few years. It may be possible that heavy investment in infrastructural development during the 1960s and 1970s coincided with crop area expansion. Chetamart et al (1991) found that between 1961 and 1988 the national forest reserve area declined from 28.03 million ha to 14.38 million hectare, down to about 50% of the 1961 area. In the same period, agricultural area increased from 10.54 million ha to 23.64 million ha, or more than double the agricultural area in 1961. From equation (1), investments in irrigation, education, agricultural extension, and road construction have positive

Table 5.1

estimated results of acreage response equation

	ACREAGE (SPDA)		
	(1)	(2)	(3)
constant	0.0725	0.0373	0.0224
	(2.736)	(5.429)	(2.435)
Ln PDPR	0.0168	0.0112	0.0153
	(3.094)**	(2.660)*	(2.839)*
Ln UPPR	-0.0085	-0.0044	-0.0085
	(-2.353)*	-(1.349)	-(2.337)*
Ln VGPR	0.0003	0.0012	0.0005
	(0.085)	(0.332)	(0.165)
Ln TRPR	-0.0083	-0.0061	-0.0066
	-(2.691)*	-(2.005)*	-(-2.156)*
Ln FRPR	-0.0003	-0.0018	0.0002
	-(0.076)	-(0.335)	(0.073)
IRRG	0.0067	0.0083	0.0083
	-(0.076)	-(0.335)	(0.073)
Ln EDUC	0.0043	-0.0082	0.0020
	(1.336)	(1.665)	(1.675)
Ln EXTE	0.0118	-	-
	(2.789)*	-	-
Ln RESE	-0.0301	-	-
	-(2.968)*	-	-
ROAD	0.0021	0.0023	
	(1.240)	(1.388)	-
Ln LABO	-0.0029	-02.033	-
	-(1.433)	-(1.676)	-
Ln CAPI	0.0051	-0.0002	-0.0008
	(1.201)	-(0.262)	-(0.923)
UNRAIN	-0.0057	-0.0058	-0.0049
	(-2.124)*	-(2.163)	-(1.826)
LAGSPDA	0.9618	0.9033	0.9636
	(264.076)**	(266.628)**	(268.834)**
NORTH	-0.0143	-0.0146	-0.0110
	(-3.230)**	(-3.708)**	(-2.553)*
CENTRAL	-0.0151	-0.0119	-0.0082
	(-3.135)**	(-2.868)*	(-1.905)*
SOUTH	-0.0226	-0.0245	-0.0200
.	(-4.848)**	(-5.702)**	(-4.365)*
Chi-Square	12.6368	12.2029	8.0114
Log-likelihood	14829.47	14814.76	14825.17
Sample no.	2170	2170	2170

Note : ** and * are significant at 1% and 5% , respectively

In porentheser are the t-value.

Source : From estimation

effect on rice acreage share. However, the effects of these variables are insignificant, with the exception of the extension variable. In contrast, it is found that increased investment in agricultural research reduces the share of the rice area, significantly.

Farm labor and capital inputs affect the acreage of rice supply differently. While a reduction in farm labor per area increases the acreage share, the rise in farm capital per area, on the other hand, improves the share. in equertion (1) but that reduces the share in equation (2) and (3)However, both effects are insignificant. Generally, farm capital, particularly tractors and power tillers, is a substitution for labor. In Thailand, shortage of labor in land expansion and preparation for upland crop has resulted in the adoption of large tractors. Also, the lengthening of crop rotation periods and the high cost of animal rearing and wages has resulted in the wide adoption of powertillers, particularly in irrigated rice areas. In recent years, high growth in the non-agricultual sector has continuously drawn farm labor out of agriculture. This has resulted in the increased accumulation of farm capital.

Because the majority of rice area in Thailand are rainfed, the influence of rainfall condition on rice acreage is important. It is found that low rainfall significantly reduces the rice acreage. The influence of a regional specific factor which is demonstrated by its regional dummy is found to be significant in each region.

The estimated results of the acreage equation by sub-regions are shown in appendix table 5.1.

5.4.2 Yield response equation

The yield per ha is assumed to depend on the same set of price and other supply shifter variable as in the acreage equation. However, the lag acreage share is excluded while the cultivated area is included.The later variable is employed to capture the marginal effect of acreage expansion on rice yield. The yield equation is also assumed to have a linear relationship with those regressors. The weighted least squares method where the weight is the rice value share is used for the analysis. In table (5.2), equation (1) shows the estimation result when the same set of

Table 5.2

Estimated results of yield response equation

	YIELD (Y)					
	(1)	(2)	(3)	(4)	(5)	(6)
constant	1.1026	1.5650	1.3568	1.9221	2.0591	1.9349
	(5.908)	(9.491)	(7.502)	(16.838)	(15.735)	(17.040)
PDPR	-0.0812	0.0441	0.0539	0.0900	0.1064	0.0905
	-(1.565)	(0.951)	(1.118)	(1.760)	(2.196)*	(1.900)*
UPPR	0.0231	-	-	-	-0.0338	-
	(0.677)	-	-	-	-(1.076)	-
VGPR	0.1753	-	-	-	-0.0750	-
	(5.135)**	-	-	-	-(1.035)	-
TRPR	0.0888	-	-	-	-0.0231	-
	(1.895)*	-	-	-	-(0.884)	-
FRPR	0.1005	-0.0570	-0.0563	-0.3453	-0.3788	-0.3450
	(1.291)	-(0.789)	-(0.800)	-(7.018)**	-(6.975)**	-(7.016)**
IRRG	0.2757	0.2951	0.2863	0.5627	0.5451	0.5816
	(5.752)**	(6.193)**	(4.435)**	(10.21)**	(9.721)**	(11.0721)**
PDARE	-0.9780	-1.0561	0.7762	-0.7394	-0.8181	0.7496
	(8.278)**	(-9.227)**	-(9.249)**	-(4.061)**	-(4.365)**	-(4.125)**
UNRAIN	-0.0202	-0.0206	-0.0347	-0.0350	-0.0344	-0.0364
	-(0.800)	-(0.814)	-(1.789)	-(1.772)	-(1.740)	-(1.845)
LABO	-0.0289	-0.0275	-0.0183	0.0089	0.0093	-
	(4.931)**	-(4.665)**	-(2.072)**	(1.135)	(1.185)	-
CAPI	0.00001	0.00000	0.00000	-	-	-
	(4.743)**	(3.999)**	(3.538)**	-	-	-
EXTE	0.0059	0.1450	-	-	-	-
	(1.424)	(3.78)**	-	-	-	-
RESE	0.0031	-0.0013	-	-	-	-
	(1.300)	-(0.563)	-	-	-	-
EDUC	0.0033	-0.0054	0.0677	-	-	-
	(0.142)	-(0.237)	(2.571)*	-	-	-
ROAD	0.0611	0.0672	0.0908	-	-	-
	(3.420)**	(3.745)**	(3.219)**	-	-	-
NORTH	0.8791	0.8489	0.8629	0.8295	0.8202	0.8286
	(23.439)**	(22.897)**	(12.62)**	(12.533)	(12.181)	(12.541)
CENTRAL	0.3910	0.3518	0.2385	0.2465	0.2374	0.2368
	(9.687)**	(8.842)**	(3.518)**	(2.653)**	(3.450)**	(3.542)**
SouTH	0.0983	0.0432	0.0373	0.0646	0.0488	0.0604
	(1.822)	(0.891)	(0.493)	(0.869)	(0.622)	(0.825)
Adj-r2	0.4802	0.4736	0.4656	0.4472	0.4501	0.4428
F-ratio	118.8659	140.4052	158.4520	195.9210	148.9200	220.0101
Sample no.	2170	2170	2170	2170	2170	2170

Note : ** and * are significant at 1% and 5% , respectively

Source : From estimation

regressors as used the acreage share equation is applied. Because of the poor performance of the estimated equation, due to obtaining the wrong sign for the rice price variable, some regressors are dropped . Equations (2), (3),(4), (5), and (6) show the sensitivity of the yield response equation when some regressors are taken away. Since equation (6) performs a better result with the expect signs on each variable and provides a significant effect of rice price on its yield, this equation is chosen for calculating the elasticities of rice supply.

The estimated result of equation (6) demonstrated that rice yield positively responds to price but negatively responds to fertilizer price. Intuitively, the higher the rice price the better the yield per ha. In contrast, the higher the fertilizer price the lower the yield. Irrigation improves the yield performance since this factor induces farmers to widely adopt modern rice varieties and rice cropping intensity.

Increasing rice area contributes to a declining yield. This is due to the fact that marginal and submarginal lands are brought into cultivation. This can be observed by a negative sign and significance of the rice acreage variable $(PDARE)_{t-1}$.

A production risk resulting from unusual wheather condition creates a negative effect on yield. As measurement by the UNRAIN variable, a low level of , rainfall reduces the rice yield. Also the estimated coefficient of regional dummies indicated that rice yield in the North and Central Plain is significantly higher than that of the Northeast .

The estimated results of yield equation by sub-regions are demonstrated in appendix table 5.2.

5.4.3 Estimated rice supply elasticities

Table (5.3) shows the parameters. used in estimation of the production elasticities. A parameter $\beta 11$ is brought from the rice acreage share equation (1). Parameters $\Theta 11$ and $\Theta 4$ are taken from yield equation (6). ϕ represents the adjustment coefficient of the acreage share lag. Other parameters,namely s1, PDPR, YIELD, AREA, demonstrate the mean of acreage share, the rice price index, yield, and area, respectively.

Table 5.3 Estimated parameters and mean valve for supply elasticity caculation

Item	$\alpha 11$	$\beta 11$	Θ_4	$1-\phi$	s1	PDPR	Yield	Area
By Kingdom	0.0168	0.0905	-0.7496	0.0367	0.5950	1.4997	2.0121	0.1224
By Sub-region*	-	-	-	-	-	-	-	-
Upper northeastern	0.0328	-	-	-	0.7766	-	-	-
Lower northeastern	0.0153	-	-	-	0.7776	-	-	-
Upper northern	0.0210	-	-	-	0.6402	-	-	-
Lower northern	0.0209	0.0704	-1.2049	-	0.5618	1.4997	2.1972	0.0757
Middle	0.0127	0.0327	-1.3440	-	0.7304	1.4995	2.2924	0.0977
East	-	-		-	0.5426	-	-	-
West	0.0059	0.0546	-2.7218	-	0.4895	1.0013	2.0272	0.0971
Southern	0.0095	0.0993	-1.0805	-	0.2624	1.4992	1.7294	0.0413

Note : * See the estimated acreage and yield equations in Appendix Table (5.1) and (5.2)

Source : From estimation

Table (5.4) shows the estimated elasticities of production (e_{QP}), acreage (e_{AP}), and yield (e_{YP}) for price and elasticity of yield for acreage ($e_{Y.A}$). For the whole kingdom, it is found that the owned-price elasticity of rice output is relatively inelastic (0.0941) in the short-run but that is higher in the long-run (0.7605). Thus a policy on rice price will certainly affect the production supply.

In terms of sub-regions, the Middle of the Central Plain, a commercial rice area, has the highest price elasticity. In contrast, the Lower Northeast , has the lowest elasticity. The regional price elasticities[2] range from 0.0197 to 0.2312.

Rice acreage in the Upper Northeast, Upper North, Lower North and South respond relatively more to rice price changes than other sub-regions. The price elasticity values are between 0.0029 and 0.0362. For the whole kingdom, the price elasticity of acreage share is 0.0282 and 0.7382 for the short- and long-runs, respectively.

Rice price change also has some effects on yield. For the whole kingdom, the elasticity of yield for price is 0.0527 which is very inelastic. The elasticity varies across the sub- regions. The elasticities of rice yield with respect to price are highest in the Middle of the Central Plain. This may be because farming technology in this sub-region is relatively more advanced. Relatively better access to irrigation water and modern varieties induces a substantial increase in yield in this area (Isvalanonda and Wattanutchariya, 1990). The West Central Plain, Lower North, and South have elasticities equal to 0.0404, 0.0481, and 0.0861, respectively. Due to the negative price effect on yield in the Upper Northeast, Lower Northeast, and Upper North, we drop the yield equations in those regions.

Increase in rice acreage generally creates a reduction in yield. As shown in table (5.4), the elasticity of yield for acreage is negative in most cases. Its elasticity for the whole kingdom is -0.0017. In the West of Central Plain, the yield elasticity for acreage is the highest in absolute

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[2] The price elasticities of production supply in upper north and south are excluded due to negative effect of the rice price variable on acreage and yield equations, respectively.

Table 5.4 Estimated own-price elasticities of quantity rice supply

Item	e_{QP}	e_{AP}	e_{YP}	e_{YA}
By Kingdom				
Short-run	0.0941	0.0282	0.0527	-0.0017
Long-run	0.7605	0.7382	0.0527	-0.0452
By Sub-Region				
Upper northeastern	0.0422*	0.0422	-	-
Lower northeastern	0.0197*	0.0197	-	-
Upper northern	0.0324*	0.0324	-	-
Lower northern	0.0810	0.0358	0.0481	-0.0029
Middle	0.2312	0.0174	0.2140	-0.0002
Eastern	-	-	-	-
Western	0.0437	0.0029	0.0404	-0.1304
Southern	0.1214	0.0362	0.0861	-0.0258

Note : * meuns acreage supply elasticity

Source : From calculation

value which may result from the increase of irrigated area in this region. In the Middle, Lower North, and South, the yield elasticities for acreage are equal to - 0.0002, -0.0029, and -0.0258, respectively.

The cross-price elasticities shown in table (5.5) are calculted from the acreage share equation. Increased upland and tree crops prices, in the long-run, reduce the rice acreage share. Thus a relatively higher net return of upland and tree crops over rice will further reduce the rice acreage area.

In conclusion, this chapter analyzed the production supply response. By using two behavioral process of decision-making, the production elasticities can be derived by taking into account the adjustment of yield and acreage to price change. The effect of dimishing-return on yield due to the expansion of cultivated land is also considered in the estimation. While production levels are less responsive to price changes in the short-run, then in the longer-run rice supply adjusts to some extent. Furthermore, higher upland and tree crops prices reduce the rice supply. These estimated results will be employed in the projection of future rice supply in the next chapter.

Table 5.5

Estimated cross-price elasticities of rice acreage supply

Crop price	cross-price elasticities	
	short-run	long-run
Upland	-0.0143	-0.3743
Tree	-0.0140	-0.3665
Vegetable	+0.0005 1/	+0.0131 1/

Note : Coefficents of cross-price obtain from equation (1), table 5.1.

1/ The coefficients of acreage paddy share with respect to price indices of tree crop and vegetable are insignificant.

Source : From Calculation

CHAPTER VI

PROJECTIONS OF RICE SUPPLY AND DEMAND

The previous chapters have examined the dynamics of rice production and consumption in Thailand. Given the result of this analysis, the present chapter speculates on the future of the rice situation in Thailand to the year 2010, especially in terms of the potential impacts of declining real export prices and water constraints. In order to estimate growth in rice production, the results from fitted acreage and yield response functions in chapter V are used in constructing a growth accounting model. The derived coefficients from previous rice supply analyses are then employed to calculate the physical requirements of this growth in terms of potential crop and fertilizer prices and potential public investments.

Future rice consumption will depend on the nature and pace of economic growth, population growth, and price increases and changing patterns of consumption. In order to forecast consumption growth, past information on household food expenditure levels, quantity and unit value of rice purchases by households, and household characteristics are used in the rice consumption share and unit value response equations. The estimated coefficients from the previous consumption demand analysis in chapter IV are then employed in order to calculate consumption growth.

6.1 Future Rice Supply

The rice supply projection is determined by a simultaneous system of acreage and yield response equations. Since rice is nested in a crop system, the rice acreage response is jointly estimated with other crop shares in order to capture the interaction effect of production resources and crop and input prices in a mixed crop system. A rice yield response function is independently estimated based on other crop yields.

6.1.1 Growth Accounting Model and Policy Variables

Following from the significant effects of particul.r independent variables on rice yield and acreage, the growth model of rice supply in this study can be demonstrated as equation (6.1):

$$(6.1)\quad \hat{Q}/Q = e_{QPi}.\hat{PDPR}/PDPR + e_{QPj}.\hat{UPPR}/UPPR + e_{QPf}.\hat{FRPR}/FRPR + e_{QIR}.\hat{IRRG}/IRRG + e_{QRE}.\hat{RESE}/RESE + e_{QEX}.\hat{EXTE}/EXTE.$$

where

$\hat{Q}/Q$ = growth in quantity of rice supply,

$\hat{PDPR}/PDPR$ = growth in the real paddy price index,

$\hat{UPPR}/UPPR$ = growth in the real upland crop price index,

$\hat{FRPR}/FRPR$ = growth in the real fertilizer price index,

$\hat{IRRG}/IRRG$ = growth in irrigated area per cultivated area,

$\hat{RESE}/RESE$ = growth in real agricultural research investment stock per cultivated area,

$\hat{EXTE}/EXTE$ = growth in real agricultural extension investment stock per cultivated area,

e_{QPi} = elasticity of rice supply for its owned price,

e_{QPj} = elasticity of rice supply for upland price,

e_{QPf} = elasticity of rice supply for fertilizer price,

e_{QIR} = elasticity of rice supply for irrigated area,

e_{QRE} = elasticity of rice supply for agricultural research investment stock,

e_{QEX} = elasticity of rice supply for agricultural extension investment stock,

Table 6.1 shows calculated elasticity coefficients of rice supply quantity for prices and some investment inputs. It appears that a change in crop and fertilizer prices induces an effect on rice supply. A ten percent increase in rice price raises th^ quantity supplied by 9.41 percent the in short-run and by about 76.05 percent in the long-run. On the other hand, a ten percent rise in upland crop prices results a 1.43 percent decline in rice supply in the short-run and a 37.43 percent

Table 6.1

Estimated price and non-price elasticities for projected rice supply

Variables	elasticities	
	Shart-run	Long-run
Paddy price index $(PDPR)_{t-1}$	+ 0.0941	+ 0.7608
Upland crop price index $(UPPR)_{t-1}$	-0.0143	-0.3743
Fertilizer price index (FRPR) 1/	-0.2288	-
Irrigated area per cultivated land (IRRG)2/	+ 0.0794	-
Research investment stock per cultivated area (RESE)3/	-0.0506	-
Extension investment stock per cultivated area (EXTE)4/	+ 0.0198	-

Source : From calculation

Note : 1/ Using the elasticity of yield with respect to fertilizer price

2/ Using the elasticity of acreage share with respect to ratio of irrigated area

3/ Using the elasticity of acreage share with respect to usearch invertiment stock

4/ Using the elasticity of acreage share with respect to extension investment stock.

decline in the long-run. Because rice yield, particularly modern varieties, responds to chemical fertilizer, a ten percent reduction in fertilizer price stimulates a 22.88 percent increase in yield as well as rice supply.

Public investment in irrigation and agricultural research and extension generate different effects on rice supply. Because many rice areas are rainfed, the elasticity of rice supply by irrigated area indicated that a ten percent rise in irrigated areas raises the total rice supply by 7.94 percent. Crop growing in Thailand has undergone considerable technological changes. Governmental efforts to diversify away rice crops has had the side effect of reducing the share of funds apportioned to rice research. Consequently, the effect of research investment on rice supply is in the opposite direction. As shown in table 6.1, a ten percent increase in research investment is associated with a 5.06 percent decrease in rice supply. However, a ten percent increase in extension investment is associated with a 1.98 percent increase in rice supply. These elasticities will be used below in the analysis of supply growth.

Concerning the growth accounting calculation of rice supply from 1992 to 2010, five scenarios are set up based on different assumptions of price and non-price policy variables. The base case (case A) assumes the following: (a) the real rice price will stay the same as base year; (b) the real price of upland crop will rise at the rate of 0.5 percent due to the increased growth of livestock and poultry and due to positive expectations of GATT negotiations; (c) the real fertilizer price will adjust upward by 1.5 percent per annum; (d) the scarcity of forested areas and constraints on water resource development (and associated concerns about environmental degradation) will result in a decline in the growth of irrigated areas at the rate of one percent per annum; (e) real agricultural research and extension investments are assumed to remain at their previous levels of 3.5 and three percent (based on the 1981 to 1991 period). Under the assumptions of base case A, the results indicated that rice supply will decline by .55 percent per annum in the short-run and by .35 percent per annum in long-run (Table 6.2).

Table 6.2

Growth assumptions usec' for projected rice supply

	Scenarios		Scenarios		
	A	B	C	D	E
	percent per annum				
Paddy price $(PDPR)_{t-1}$	0.0	-1.0	1.0	2.0	0.0
Upland price $(UPPR)_{t-1}$	0.5	0.5	1.5	0.5	0.5
Fertilizer price (FRPR)	1.5	1.5	1.5	-1.5	1.5
Irrigated area (IRGR)	-1.0	-1.0	-1.0	-1.0	-1.0
Researc investment (RESE)	3.5	3.5	3.5	3.5	7.0
Extension investment (EXTE)	3.0	3.0	3.0	3.0	6.0
Growth of rice supply (%)					
Short-run	-0.55	-0.64	-0.48	0.33	-0.79
Long-run	0.35	-1.49	-0.34	1.48	-1.61

Scenarios B and C allow for changes in crop prices, but other non-price variables and fertilizer prices are kept the same as in the base case. Case B represents a pessimistic view, assuming the presence of new competitors, particularly Vietnam, Myanmar, and China. In this case, real rice prices are assumed to follow the World Bank's projection (World Bank, 1993). The World Bank has predicted a price decline of approximately one percent per annum. The results under scenario B predict that output growth will decline by .64 percent in short-run and 1.49 percent in the long-run. In contrast, case C assumes that the real rice price in the international market will adjust upwardly, mainly due to the continuous progress of GATT negotiations. Furthermore, this case assumes a deterioration of the world's natural environment which will prevent an upward trend in world rice supply. Under this scenario, rice and up-land crop prices are assumed to rise by one percent and 1.5 percent respectively. The projected rice supply is found to fall by .48 percent in short-run and .34 percent in the long-run.

Scenario D assumes that the government chooses to undertake farm price support programs and allows rice price to grow at two percent per annum and it is also assumed that the government provides a subsidy for fertilizer price. In other terms, the fertilizer price will be reduced by 1.5 percent per annum. The other factors conform with the base case. Under this scenario, the supply is predicted to grow at 0.33 percent in the short-run and 1.48 percent in the long-run. Scenario E assumes that rice and fertilizer price trends are the same as in the base case. However, in aiming to increase crop diversification away from rice, government investments in agricultural research and extension are assumed to be double that of the base case, while the irrigated area is assumed to remain the same as in the base year. Under this scenario, the growth of paddy supply is predicted to decrease by 0.79 percent in the short-run and 1.61 percent in the long-run.

6.1.2 Projection results

Despite the fact that regional variations in landscape and resources play a significant role in paddy production, we will not attempt to disaggregate projected supply results by region, nor crop season mainly to information limitations. According to total wet and dry season paddy production in base year (1991), which was equivalent to 20.40 million tons, the base case projection of paddy supply will substantially decline to 19.96 million tons in 1995. After that the rice supply will fall to 19.42, 18.90, and 18.39 million tons in 2000, 2005, and 2010, respectively (Table 6.3).

Under scenario B, which projected falling prices, the supply will fall from 19.88 million tons in 1995 to 18.06 million tons in 2010. In contrast, under the optimistic-price case scenario C, the supply will slightly decline from 20.01 million tons in 1995 to 18.62 million tons in 2010 (Table 6.3).

To observe the effects of price support programs on paddy supply, case D shows that output will increase substantially, from 20.67 million tons in 1995 to 21.72 million tons in 2010. In contrast, non-price policy, particularly double investments in public research and extension, will considerably reduce the paddy supply from 19.83 million tons in 1995 to 17.85 million tons in 2010 (case E).

6.2 Future Rice Consumption Demand

The estimation of future rice consumption demand is done under several alternative assumptions of income, population, and price growth. Because rural and urban consumers reveal different patterns in rice consumption, this estimation attempts to disaggregate the consumption demand into rural and urban consumption[1/].

Table 6.3

Projection of paddy production under different growth assumptions

Year	Quantity				
	Base Case	Pessimistic price case	Optimistic-price case	Farm price support case	Non-price case
			1,000 tons		
1991*	20,399.42	20,399.42	20,399.42	20,399.42	20,399.42
1995	19,958.34	19,882.19	20,010.56	20,670.03	19,834.21
2000	19,420.04	19,254.05	19,534.90	21,013.34	19,149.65
2005	18,896.90	18,645.76	19,070.54	21,362.36	18,488.74
2010	18,387.54	18,056.68	18,617.22	21,717.17	17,850.63

Note : * indicates base year for projection.

Source : From calculation, see appendlix table (6.1)

6.2.1 Consumption demand growth

The growth in consumption demand is considered to be driven primarily by population growth, income growth, and commodity price growth which can be demonstrated as follows:

$$(6.2)\quad \hat{D}/D = e_{QI}(\hat{INC}/INC - \hat{POP}/POP) + e_{QP}.\hat{PR}/PR + \hat{POP}/POP,$$

where

$\hat{D}/D$ = growth of rice consumption demand,

$\hat{INC}/INC$ = growth of income,

$\hat{POP}/POP$ = growth of population

$\hat{PR}/PR$ = growth of consumer purchased price for milled rice,

e_{QI} = income elasticity of rice consumption demand,

e_{QP} = price elasticity of rice consumption demand.

In calculating the growth of demand, knowledge of income and price elasticities and also the potential growth of a country's income, population and price is necessary. Theoretically, increased[i] income will either positively or negatively affect the quantity demanded depending upon its normality or inferiority. In this analysis, the estimated food expenditure elasticity by community type is used to represent the income variable (table 6.4). Own-price and cross-price also play a significant role in inducing the change in quantity demanded. Generally, an increase in own-price will reduce the quantity demanded but the rise in cross-price will either increase or decrease in the quantity of rice demand depending upon whether the good is a complement or a substitute. Unfortunately, due to the unavailability of information on cross-price elasticity, this analysis will exclude this variable from the growth model. The estimated own-price elasticity is demonstrated in table 6.4.

[i] Urban community includes municipality and sanitary areas.

Table 6.4

Estimated expenditure and price elasticities

of quantity rice demand by rural and urban consumers for

projected demand

Variables	elasticities
Rural consumers	
Expenditure	-0.1359
Own-price	-0.6254
Urban consumers	
Expenditure	-0.2109
Own-price	-0.8166

Source : From calculation

Table 6.5 outlines the growth assumptions of the policy variables in the demand projection. Real agricultural GDP and non-agricultural GDP growth, as forecasted by Thailand Development Institute and Monenco Consultants Limited (1992), is employed to represent the growth of rural and urban income. In that forecast, average rural and urban income growth from 1991-2000 are anticipated to grow by 2.63 percent and 8.47 percent respectively. However, from 2001-2010, rural and urban income growth rates are expected to decrease to 2.19 percent and 7.27 percent respectively.

Over the past few decades, population in Thailand has continuously increased at a considerable rate. From the amount of 28 million in 1961, Thailand's population reached 57 million in 1991. Of this number, about 70 percent of the population is rural. However, successful family planning since the second half of the 1970s has resulted in a decrease in the population growth rate. The growth of urban population is expected to rise faster than that of rural population because of rural to urban migration. According to the NESDB's forecast, average urban and rural population growth rates are predicted at 2.84 and 0.6 percent per annum over the 1991 to 2000 period. The projected population growth rates are expected to decline to 2.75 percent and 0.5 percent, respectively, from 2001 to 2010 (1991) (Table 6.5).

Staple food prices, particularly rice, are generally characterized by inelastic demand. Nonetheless, our estimated own-price elasticities indicated less inelasticity in both rural and urban consumer groups, i.e., indicating greater forecasted sensitivity to price change. In this study, three alternative assumptions for the growth rate of rice price are made. The base case assumes that the rice price will follow the base year price, implying a growth rate of zero. The pessimistic price case assumes a mild reduction in the real rice price at the rate of one percent per annum from 1991 to 2010. The third case anticipates a considerable rise in domestic price due to the favorable outcome of GATT negotiations; the real price is assumed to rise by one percent per annum from 1991 to 2010.

Table 6.5

rowth assumptions used for projected rice consumption deman

	Rural	Urban
	—— % ——	
Period of 1991-2000		
Income	+2.63	+8.47
Poulation	+0.60	+2.84
Real rice price		
Base case	0.00	0.00
Pessimistic-price case	-1.00	-1.00
Optimistic-price cases	+1.00	+1.00
Period of 2001-2010		
Income	+2.19	7.27
Poulation	+0.50	+2.75
Real rice price		
Base case	0.00	0.00
Pessimistic-price case	-1.00	-1.00
Optimistic-price case	+1.00	+1.00
	Growth of Quatity demanded (%)	
Base case		
1991-2000	+0.28	+1.18
2001-2010	+0.23	+0.95
Pesimistic-price case		
1991-2000	+0.91	+1.02
2001-2010	+0.86	+1.77
Optimistic-price case		
1991-2000	-0.35	+0.36
2001-2010	-0.40	+0.13

Under the base case scenario, the quantity demanded by rural and urban communities is projected to grow at the rates of 0.28 percent and 1.18 percent per annum, respectively, from 1991 to 2000. However, from 2001 to 2010, the growth rates of both communities is projected to diminish slightly to 0.23 percent and 0.95 percent per annum, respectively. In the pessimistic price case, a decline in the real rice price will substantially raise the quantity demanded of both rural and urban consumers by 0.91 percent and 1.02 percent per annum, respectively during 1991 to 2000 and by 0.86 percent and 1.77 percent, respectively during 2001 to 2010. This is partly because of a high rate of projected population growth rate in urban communities as a consequence of labor migration.

The optimistic-price case allows rice price to grow by one percent per annum. It is found that rural communities faces negative population growth rates which is should induce a considerable reduction in the growth of quantity demanded in rural areas by .35 percent during the 1991 to 2000 period and by .4 percent during the 2001 to 2010 period (Table 6.5). However, urban areas are expected to have positive growth in rice demand over both periods.

6.2.2 Future Consumption of Rice

In Thailand, rural consumption constitutes a major proportion of the country's rice consumption. From the 1990 SES survey data, it was found that the average rice consumption per head of rural household is 154.2 kg (in term of milled rice); but that of urban consumers is smaller at 97.2 kg. In Aggregate, the estimated amount of rice consumed by rural community is approximately 6.08 tons of milled rice, the equivalent of 9.22 million tons of paddy. On the other hand, the urban community consumes approximately 1.64 million tons of milled rice, or 2.48 million tons of paddy. Furthermore, the consumption of both communities in aggregate is about 7.72 million tons of milled rice or 11.70 million tons of paddy equivalence.

The future consumption of rice by communities for the 1991 to 2010 period is calculated based on the estimated elasticities and variable growth assumptions as shown in tables 6.4 and 6.5. In the base case where price growth is zero, rural rice consumption will rise from 9.35 million tons of paddy in 1995 to 9.70 million tons in 2010, while urban consumption will move from 2.63 million tons in 1995 to 3.06 million tons in 2010. In aggregate, the consumption of rice is found to increase substantially from 11.98 million tons in 1995 to 12.77 million tons in 2010.

In the pessimistic price case, both rural and urban consumption will increase substantially from 9.65 and 2.74 million tons in 1995 to 11.00 and 3.60 million tons in 2010, respectively.

The optimistic price case predicts a reduction in rural consumption. The aggregated consumption will slightly fall from 11.59 million tons in 1995 to 11.16 million tons in 2010 (Table 6.6).

6.3 Projected Rice Supply-Demand Balances

Knowledge of future rice supply and demand will help to predict the domestic rice balance which has policy implications. The projected levels under the base case indicate a 7.98 million ton surplus of rice paddy in 1995, however the surplus is expected to decline considerably to 5.62 million tons by 2010. The pessimistic price case found a paddy surplus of 7.50 million tons in 1995 which was project to fall significantly to 3.46 million tons by 2010. On the other hand, the optimistic price case demonstrated an increase in paddy surplus from 8.42 million tons in 1995 to 7.46 million tons in 2010 (Table 6.7).

The rice price support case calculated the balance using scenario D, the projection of paddy supply and the base case of rice demand. This scenario found an increasing of paddy supply in 1995 (8.69 million tons). Inevitably, the surplus continues to rise substantially and is projected to reach 8.95 million tons by 2010, creating a large surplus for export.

Table 6.6

Projection of consumption demand for rice (in terms of paddy equivalence) under different price growth assumptions

	Quantity Demanded		
	Base Case	Pesimistic price case	Optimistic price case
	---------- 1,000 tons ----------		
	---------- Rural ----------		
1990*	9,222.78	9,222.78	9,222.78
1995	9,352.63	9,650.13	9,062.51
2000	9,484.30	10,097.27	8,905.02
2005	9,593.87	10,538.99	8,555.16
2010	9,704.71	11,000.03	
	---------- Urban ----------		
1990*	2,478.35	2,478.35	2,478.35
1995	2,628.07	2,736.30	2,523.29
2000	2,786.83	3,021.10	2,569.03
2005	2,921.74	3,298.10	2,585.77
2010	3,063.18	3,600.50	2,602.63
	---------- Total ----------		
1990*	11,701.13	11,701.13	11,701.13
1995	11,980.70	12,386.43	11,585.80
2000	12,271.13	13,118.37	11,474.05
2005	12,515.61	13,837.09	11,314.11
2010	12,767.89	14,600.53	11,157.79

Note : * indicates base year for projection.

Source : From calculation, see appenclix table (6.2)

Table 6.7

Projected rice supply-demand balances (in terms of paddy equivalence) under different scenarios of price assumptions

	Rice Supply-Demand Balances				
	Base Case (1)	Pesimistic-price case (2)	Optimistic price case (3)	Farm price support case (4)	High public investment case (5)
			million tons		
1995	7,977.64	7,495.76	8,424.77	8,689.33	7,853.51
2000	7,149.24	6,135.68	8,060.84	8,742.22	6,878.53
2005	6,381.29	4,808.67	7,756.42	8,846.75	5,973.13
2010	5,619.64	3,456.15	7,459.43	8,949.28	5,082.74

Source : From calculation

The high public investment case demonstrates a surplus of paddy supply when the non-price case of projected supply is taken into account by the base case of projected demand. In this case, if the government chooses a non-price policy program through speeding up investments in agricultural research and extension, the investments would induce agricultural diversification away from rice. Evidently, the future surplus of rice supply will considerably decline from 7.85 million tons in 1995 to 5.08 million tons in 2010.

Because rice is a major exportable commodity, an increasing exportable surplus from Thailand and also from other rice export countries would hinder the export price trend. If this phenomenon continues over the longer-run, farmers will surely be worse off.

6.4 Policy implications

For Thailand, rice is an important crop, both economically and politically. The majority of farmers are still dependent on rice production for their livelihoods and, further, a large amount of the country's land and labor resources is allocated to rice production. On the other hand, rice is not only an essential domestic staple, but also a major export. Because Thailand is a major exporter internationally, a large surplus of Thai rice supply will have some affect on the international price. Furthermore, an increase in domestic paddy stock will depress farm price which acts to lower income. In contrast, a lower supply in the international market will raise the export price and thus stimulate exports which will result in the reduction of domestic stock and hence an increase in consumer price, worsening the welfare of the urban poor. Fortunately, the success of the green revolution in most parts of the world in recent years has induced rapid growth in world rice production which has resulted in a long-term trend of surplus and declining real rice prices. According to the World Bank forecast, the international price of rice should continue on its downward trend over the next decade. While increased supply and decreased price is good for consumers, especially the urban poor, it results in a worsening situation for farmers whose livelihood is tied to the strength of international rice prices. How can Thailand help to alleviate the negative impacts of the international fall in prices?

6.4.1 The poverty faced by farmers

While Thailand's economy has continued to grow and diversify, due to the growth of the non-agricultural sector, agriculture has only experienced sluggish improvements in productivity with decelerated growth rates. The sluggish performance of the agricultural sector is certainly one factor driving the growing income gap between rural and urban populations. Because rice is a major export crop, the continuous decline in its price will worsen rural welfare. Under the circumstances, two alternative means are designed to alleviate the reduction of farmers' income: to increase the rice price to help sustain and increase farmers' income or to accelerate crop diversification away from rice, particularly shifts to higher-value horticultural crops, livestock and fish farming since the demand for these products are increasing rapidly due to high economic growth.

Under conditions of price policies, which was the central concern of the Thai government for most of the past decade, it is likely that the rice sector displays a persistent capacity to overproduce which raises the balance and exportable surplus as shown in table 6.7 (column 4). This outcome will be the central constraint to policy-making since it is expensive to support the commodity price above the world price level. Otherwise, the only viable option to sustain and increase the farmers' standard of living is to subsidize rice exports, either implicitly or explicitly, since rice will continue to be produced export surplus levels for the next decade. Inevitably, the effectiveness of rice export subsidization will be undermined if the foreign demand for Thai rice is inelastic.

An alternative policy for sustaining and increasing farmers' income is to accelerate agricultural diversification. In Thailand, the rice sector is a lumpy sector in terms of its resource commands, particularly land and labor. Any induced changes in the sector need time for adjustment. In the past, the adjustment in the crop mix for Thai agriculture have been made through the area expansion. This can be observed in the expansion of cultivated area during 1960s and 1970s as well as in the rising area shares of upland crops, particularly maize, cassava, and sugar cane. Since the late of 1980s, a constraint on land availability has resulted in the competitive use in cultivated area. Farmers who are sensitive to relative price changes and have fewer financial constraints are now taking a leading role in searching for new farming businesses. This can be easily observed in irrigated areas in the central plain where many former rice areas are now used for horticultural farming or fish farming. Moreover, in many rainfed areas, the adoption of new crops and dairy and livestock farming are using mobilized farm resources for a relatively better return. At this point, the government should play an essential role in supporting and searching for new technology and new crop potentials by promoting public research investments. The output from research will provide flexibility to farmers in improving their farm incomes.

Generally farmers are very cautious in shifting their farm business due mainly to limited funds and skills. To accelerate their adoption of new farming technologies, extension works and networks are very important to escalate and disseminate new farming techniques to farmers. The extension investment will also help to reduce farmers' risks generated from undertaking new crops and other farming businesses. In order to transform agriculture, in general, and the rice sector in particular, a provision of medium- term and long-term credits is necessary in order to help the transformation succeed rapidly. Since farmers are generally poor and thus have financial constraints, providing them with some medium- and long-term agricultural credits would increase their opportunities to diversify their farm businesses. At present, the bank for Agricultural and Agricultural Cooperatives (BAAC) has already provided some medium- and long- term credits to the farmers but only the large scale farmers can access the credits. Further government effort is needed toward increasing the effectiveness of the policy.

6.4.2 The need for research priorities in the area of high quality rice improvement

It cannot be denied that rapid economic growth in Thailand in the recent past has induced an increase in rice production costs, particularly labor costs. Productivity improvements in rice production on the other hand has only progressed slowly, has occurred mostly in the irrigated area of the central plain where modern varieties are adopted. Higher costs of production and the possible reduction of world rice prices will make it difficult for Thailand to rely on international rice markets. The main source of rice demand will continue to be domestic consumers. From the demand analysis, we have shown that the income elasticity of quality rice demand was positive, implying increased demand in high quality rice when income rises. Furthermore, the potential demand for high quality Thai rice, particularly jasmine rice, in international markets is loomed to expand due to the fact that markets for high quality rice has a limited supply, resulting a relatively higher price. At present, the production of high quality rice tends to slowly increase. This is a consequence of physical specificities of land because high quality rice can only be successfully produced in some certain rainfed areas of the lower northeast. In response to increasing demand for high quality rice, a research priority for high quality rice variety improvement is necessary. Since this research output would help farmers who choose to stay in rice production, this can help lessen the negative impacts of the declining rice prices.

6.4.3 A need for the restructuring of on-farm irrigation water supply systems

In the past, irrigation systems were largely designed to advantage of rice producers, particularly in irrigated low-land areas of the central plain. It is very difficult for farmers to change their crop production and farming businesses due mainly to public goods characteristic of water supply. Each individual's development costs, specifically for water control, are very enormous. It is impossible for farmers to invest in on-farm irrigation development. Public investment in restructuring of the irrigation water system at the village level is necessary. This would help not only small farmers easily adjust their cropping patterns in response to market conditions, but also in the more efficient use of irrigated water supply.

6.4.4 A Burden faced by the BAAC under the government's rice pledging scheme

Presently, the government has attempted to alleviate the welfare loss among rice farmers which has resulted from the declining rice price, particularly after the harvested season, by introducing the rice pledging scheme. The purpose of the program is to allow farmers to pledge their paddy with the BAAC at a given support price and allow to redeem in a later period. This program helps farmers to acquire urgent cash without the necessity of hurriedly selling out their paddy after the harvest. It also helps to spread the flow of rice supply to the markets. However, we have shown in chapter V that under the support farm price, the supply will face considerable positive growth. This would probably result in a lower market price than the support price. Thus it is likely that the burden born by the BAAC in the future will not be small if the world price trend consistently declines.

CHAPTER VII

SUMMARY

Thailand has continuously performed well economically over the past few decades. In spite of the declining role of agriculture in recent years, rapid economic growth has essentially stemmed from high growth in the manufacturing and service sectors. Differential sectoral growth rates, it has resulted in the shifting of resources away from rural areas. Even within the agricultural sector, resources have shifted away from rice production because of its relatively lower comparative advantage.

Because rice is a traditional staple for the Thais and an important traded good in the international market, the government has been concerned over the instability of domestic rice prices. Before 1986, rice premiums and export quotas were implemented in order to control the export market. On the other hand, a farm price support program and a consumption subsidy program were used to stabilize the domestic price. Whereas the former was considered as a tool to raise the producers' income, the later was meant to support the domestic consumers. These policies were subject to public criticism for their inefficiency and inequity for many decades. Due to the downward trend of rice price in the international market in the recent past, price policies have switched toward an interest in export promotion and also in providing short-term loan for farmers under the rice pledging scheme.

Rice areas in Thailand are mostly in rainfed areas. Despite heavy investments in irrigation development in the 1960s and 1970s, irrigated rice (in the rainy season) constituted about 24 percent of total rice production area in 1991. From the 1961-65 period to the 1986-91 period, rice production nearly doubled, from 10.38 to 19.33 million tons. The growth of rice production was largely generated by area expansion, particularly in the 1960s and the early 1970s. Production expansion later tapered off due mainly to the scarcity of additional land. Moreover, both area and production declined since the second half of the 1980s due to environmental degradation and a shortage of irrigated water.

Government efforts to improve rice productivity were made through irrigation development and also research investment. Modern rice varieties were extensively adopted but mostly concentrated in irrigated environments. The adoption of modern rice varieties induced increased rice cropping intensity and the increased use of chemical fertilizers. As a result, rice yields in irrigated areas was almost double that of yields in rainfed environments. The average yield growth in the past three decades was approximately .4 percent per annum.

Rice productivity per unit of labor improved considerably during the past two decades, from 1.36 tons per unit of labor over the 1971-75 period, to 1.65 tons per unit of labor over the 1986-91 period. In estimating labor productivity, it was found that between 1971-73 and 1977-79, productivity growth was about 4.75 percent per annum. In this period, the major sources of productivity growth stemmed from cultivated area expansion, rice research, and irrigation development. Over the 1977-79 and 1983-85 periods, growth rates were negative at around -.95 percent per annum. The source of negative growth was in lack of availability of cultivated land for increased rice production, thus negative growth occurred despite the positive contributions of research, irrigation, and road factors. This trend continued through 1991, although the positive contributions from research, road, and irrigation factors outweighed the negative effects of limited land availability, resulted in an average growth rate of around three percent per annum.

In an attempt to quantify the price and non-price effects on the quantity of rice supply, the acreage and yield response functions were estimated by using crop panel data at the provincial level from 1961 to 1991. Besides rice, other crops consisted of upland crops, tree crops, and vegetables. The acreage share equations were estimated by using a seemingly unrelated technique in order to take into account resource availability in the crop mix system. However, the yield response function was instead estimated by a weighted least squares technique where rice yield is determined by price and non-price factors. The analysis showed that own-price elasticity of the quantity of rice supply was 0.09 in short run but that it was 0.76 in the long-run. Intuitively, the quantity supplied slowed to adjust to the rice price change in the short- run but that adjustment was rather high in the long-run. The upland and tree crops seemed to be competitive with rice but their effects were rather small. Furthermore, the quantity of rice supplied was negatively related to fertilizer price, such that a ten percent subsidy on fertilizer cost result in a 23 percent increase in rice supply. Other non-price factors in the model, particularly irrigation development and extension investment were found to raise the rice supply. In contrast, research investment was negatively correlated with rice supply.

Based on different assumptions of price and non-price policy variables, five scenarios were set up, namely a base case (case A); a pessimistic price case (case B); an optimistic price case (case C); a high price support case (case D); and a non-price case (case E). The base case assumed real rice price stayed the same as in the base year, that is, it experienced zero growth. The result showed a .55 percent decline in the growth rate per annum in the short-run and .35 percent per annum decline in the long-run. It was projected that rice supply will decrease from 20.40 million tons in 1991 (base year) to 18.39 million tons in 2010. In the pessimistic case, the real rice price was assumed to decline at the rate of one percent per annum due to the success in agricultural development in importing countries and also due to the increased number of rice exporting countries. Other policy variables were kept the same as in the base case. Consequently, the rice supply will decline at the rate of .64 percent per annum in the short-run and 1.49 percent in the long-run. Under the short-run growth path, the quantity supplied will decline to 18.06 million tons in 2010. Even in the optimistic case where real rice price was assumed to rise at one percent per annum, the growth of the rice supply still declined at the rate of 0.48 percent per annum in the short-run and .34 percent per annum in the long-run. As a result, the supply will stay around 18.65 million tons given the short-run growth path. Under the price support program case by assuming the real rice price growth at the rate of two percent per annum and by assuming that fertilizer price will decline at the rate of 1.5 percent, the supply will rise at the rate of 0.33 percent per annum, resulting in an increase in quantity supplied to 21.72 million tons in 2010. On the other hand, if the government chooses to use non-price policies by promoting research and extension, the non-price policy case showed a decline in supply at the rate of .79 percent in the short-run. Under this path, the supply will fall to 17.85 million tons in 2010.

In spite of a traditional staple of rice, the food consumption patterns for the Thais have gradually changed toward a preference of more luxury items, resulting from the country's economic development. By using information from the socio-economic survey in 1990, the food consumption patterns were found to vary across both communities and income classes. Between municipality and village households, the average rice consumption per head for those municipalities was 83.20 kgs (of milled rice) while that of village households was almost double. Furthermore, within the same location, the rich consume less rice than the poor. In this study, the rice consumption demand analysis was based on the fitted equations of rice expenditure share and unit rice value. This technique provided information to derive income and price elasticities of quantity demanded as well as income elasticity of quality demanded. The analysis indicated that in aggregated rice (both non-glutinous and glutinous), the income elasticity is negative (or -0.1641), implying that rice is an inferior good for Thais. However between glutinous and non-glutinous rice, the non-glutinous rice reflects an inferiority while glutinous does not. Across expenditure classes, the poor faced a positive income elasticity but the rich consume less rice when incomes rise. Between community types, the analysis found that rice was an inferior good in both urban and village areas. Considering the effect of price on quantity demanded, consumer behavior in each group conformed according to the law of demand, reflecting a declining quantity demanded when price increased. Nonetheless, the price elasticities found in this analysis are relatively less inelastic. Moreover, the income effect on quality demanded was positively observed, particularly in urban areas and in the highest income class.

The future demand for rice in Thailand was projected by using community type information from the demand analysis, including community income levels and population growth. Three different price scenarios were assumed, namely, a base case, a pessimistic price case, and an optimistic price case. The base case allowed the real price to follow the base year price, implying zero price growth. Under this case the growth of consumption demand depended importantly on population and income growth. Higher population growth in urban communities over rural areas resulted in a higher growth in quantity of rice demanded. In fact, urban and rural demand were found to grow at the rates of 1.18 percent and .28 percent per annum, respectively, during the 1991-2000 period. However, over the 2001-2010 period, growth diminished slightly to

.95 percent and .23 percent per annum, respectively. As a consequence, aggregated rice consumption rose from 11.70 million tons of paddy (or 7.72 million tons of milled rice) in 1990 to 12.77 million tons of paddy (or 8.43 million tons of milled rice) in 2010. In the pessimistic price case, the real rice price assumed to decline at the rate of one percent per annum over the 1991 to 2010 period, resulting in a higher growth in quantity demanded in both rural and urban communities. Under this scenario, the aggregated consumption demand will reach 14.60 million tons of paddy (or 9.64 million tons of milled rice) in 2010. In contrast, by allowing the rice price to increase by one percent per annum, the aggregated consumption demand will fall to 11.16 million tons of paddy (or 7.36 million tons of milled rice) in 2010.

This analysis predicts a declining trend in export surplus by 2010, except under the scenarios of increased subsidization for farm price and input price. Thus in order to accelerate a reduction in surplus, increasing investments in research and extension were found to be essential.

This study further recommends that despite the potential for increased poverty for rice farmers under unfavorable rice price trends in the near future, the government should not choose a farm price support policy to maintain the domestic price higher than the world price level since it will be difficult and financially expensive to manage the policy and it will also raise the amount of export surplus. Instead, the government could subsidize exports, either implicitly or explicitly, in order to maintain the farmers' standard of living. In the long-run, the alternative policy is to accelerate agricultural diversification by promoting public research and extension. For the rice sector, research should be directed toward the promotion of rice quality improvements.

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APPENDIX

Appendix Table 2.1 Real price indices of agricultural crop, paddy, upland crop, tree crop, vegetable, and fertilizer 1/

Year	Indices of					
	Agricul- 1/3/ ture crop	Paddy 1/	Upland 1/ crop	Tree 1/ crop	Vege - 1/ table	Fertilizer 2/
	(1)	(2)	(3)	(4)	(5)	(6)
	percent					
1961	115.62	80.48	147.05	119.93	90.16	165.57
1962	109.82	80.77	154.33	100.87	67.39	158.55
1963	102.15	72.07	143.65	112.64	73.59	159.59
1964	92.46	60.34	130.17	132.97	71.65	166.92
1965	108.22	81.63	140.56	113.43	66.82	173.44
1966	107.46	82.47	133.07	95.92	102.02	161.71
1967	112.60	92.26	130.72	122.19	98.76	160.19
1968	100.08	78.39	135.23	102.21	87.31	163.24
1969	112.52	79.54	179.01	120.52	113.50	150.10
1970	99.01	69.35	159.26	112.66	100.39	154.33
1971	88.51	57.23	157.82	99.99	103.75	152.33
1972	102.76	76.65	175.74	99.41	103.80	153.53
1973	121.53	100.06	158.28	134.04	103.15	152.02
1974	112.04	98.49	136.67	145.98	81.48	183.81
1975	112.16	93.06	143.13	106.88	150.28	181.73
1976	112.65	87.43	143.20	134.65	185.06	119.44
1977	108.78	85.44	145.86	136.73	132.77	103.75
1978	103.15	83.56	133.69	137.89	130.49	101.88
1979	107.12	83.23	130.52	154.26	120.72	116.09
1980	115.68	93.63	155.31	165.02	97.07	129.10
1981	108.04	98.13	134.11	134.77	106.43	121.89
1985	122.61	127.12	119.45	96.03	130.51	108.22
1983	119.48	119.69	127.05	114.18	123.11	105.35
1984	107.26	109.14	99.70	115.04	88.36	101.26
1985	101.49	100.81	109.00	111.30	88.59	112.86
1986	100.00	100.00	100.00	100.00	100.00	100.00
1987	110.51	113.30	105.68	109.46	103.68	93.55
1988	119.34	127.61	117.70	120.45	88.45	101.09
1989	111.92	132.68	107.91	87.37	76.25	93.97
1990	99.99	112.77	108.70	81.89	69.04	86.72
1991	100.58	115.55	106.30	95.75	81.42	82.56

Note: 1/ Except for fertilizer index, other indices are calculated by employing Divisia price index technique. To construct the index, the Bangkok wholesale price is deflated by index of non-agricultural price (1986 as a base case) to reflect a relative price.

2/ Using the average wholesale prices of 16-20-0, 15-15-15, and 21-0-0 to construct the simple index. Before construct the index, the fertilizer price is deflated by index of non-agricultural price (1986 as a base case).

Appendix Table 3.1

Average predicted output value and its atrributes in logarithmic

Year	Predicted output per capita	Atrributes				
		Area	Irigation	Research	Road	Other
1971-73	0.3439	-0.2758	-0.0675	-0.8398	0.0287	0.8105
1977-79	0.4415	-0.2174	-0.0455	-0.8343	0.0362	0.6195
1983-85	0.4163	-0.2607	-0.0254	-0.8321	0.0405	0.6614
1989-91	0.4912	-0.2751	-0.0181	-0.7973	0.0752	0.5242
1971-75	0.3719	-0.2565	-0.0652	-0.8363	0.0304	0.7557
1986-91	0.4626	-0.2698	-0.0201	-0.8089	0.0599	0.5764

Source From estimation

Appendix Table 3.2

Rice production supply, export, and domestic dissappearance (in terms of paddy)

by calendar year, 1962-91

Year	Production1/ (1)	export2/ (2)	Domestic3/ (3)	Seed Use (4)	Domestic Available After Seed Deduction (5)	Domestic4/ Disappea. (6)	Per Capita Disappea.
	1,000 metric tons						
1962	9,508.13	1,931.49	7,577.64	458.73	7,120.91	-	-
1963	9,882.76	2,152.49	7,730.27	452.09	7,278.18	7,245.10	248.39
1964	10,654.34	2,870.09	7,784.25	448.03	7,336.22	7,420.84	244.78
1965	10,975.98	2,878.75	8,097.23	449.09	7,648.14	7,715.60	248.79
1966	10,958.58	2,284.17	8,674.41	511.96	8,162.45	8,998.32	278.58
1967	13,899.67	2,254.78	11,641.89	460.51	11,184.38	9,394.84	283.32
1968	11,195.90	1,861.22	9,334.68	497.00	8,837.68	9,998.64	293.21
1969	12,034.00	1,560.87	10,473.13	529.28	9,943.87	10,098.82	288.72
1970	13,661.42	1,619.41	12,042.01	527.10	11,514.91	10,798.03	301.41
1971	13,857.13	2,394.07	11,463.06	524.73	10,938.32	10,983.14	298.46
1972	14,244.61	3,212.36	11,032.25	506.07	10,526.18	10,674.30	278.59
1973	12,434.99	1,301.20	11,133.79	575.40	10,558.39	11,303.75	283.01
1974	14,976.56	1,587.94	13,388.62	561.96	12,826.67	11,891.49	283.45
1975	13,794.59	1,479.15	13,794.59	626.02	11,689.42	12,164.93	287.75
1976	15,571.47	2,989.99	12,581.48	602.78	11,978.70	11,350.48	282.49
1977	15,478.99	4,464.29	11,014.70	631.39	10,383.31	11,073.18	250.61
1978	13,996.05	2,434.47	11,561.58	704.04	10,857.54	11,222.61	248.04
1979	17,325.59	4,237.68	13,087.91	660.93	12,426.98	11,440.70	248.21
1980	15,950.85	4,242.01	11,708.84	671.27	11,037.57	11,869.44	252.52
1981	17,378.54	4,593.61	12,484.93	671.17	12,113.76	11,513.68	240.41
1982	17,797.78	5,733.55	12,064.23	674.51	11,389.72	474.12	236.57
1983	16,889.86	5,267.39	11,622.47	703.58	10,918.89	11,392.45	229.44
1984	19,562.76	8,993.64	12,569.12	700.39	11,868.73	11,937.39	236.54
1985	19,890.06	6,154.91	13,736.15	710.61	13,024.54	12,512.68	241.61
1986	20,187.60	6,853.94	13,333.66	688.90	12,644.76	12,372.14	234.41
1987	18,868.16	6,735.27	12,135.89	658.78	11,477.11	10,930.82	203.18
1988	18,039.05	8,638.57	9,400.48	729.90	8,670.58	10,231.86	188.51
1989	21,262.90	9,979.67	11,283.23	735.38	10,547.85	10,872.03	194.81
1990	20,177.07	6,086.50	14,090.57	692.92	13,397.65	11,300.65	200.49
1991	17,193.22	6,565.17	10,628.05	671.80	9,956.45	-	-

Note : 1/ Converting supply by crop year to be that of calender year by using one year lag.

2/ Converting miled rice to be paddy by dividing the export by 0.66

3/ Minus production supply by amounts of export.

4/ Using three-year moving average.

Source : (1) and (3) from office of agricultural Economics

(2) from department of custom

Appendix Talbe 5.1

Estimated results of rice acreage share

equation (SPDA) by sub-region

Item	ACREAGE (SPDA)			
	UPNE	LONE	UPN	LON
Constant	0.0199	0.2480	0.2716	0.1892
	(0.245)	(8.299)	(2.310)	(1.956)
Ln $PDPR_{t-1}$	0.0328	0.0153	0.0209	0.0201
	(2.573)**	(0.881)	(0.836)	(0.958)
Ln $UPPR_{t-1}$	-0.0339	-0.0177	-0.0282	-0.0206
	-(2.698)**	-(1.058)	-(1.397)	-(1.008)
Ln $VGPR_{t-1}$	0.0166	-0.0220	0.0048	-0.0158
	(1.852)	(1.911)	(0.310)	-(1.509)
LN $TRPR_{t-1}$	0.0004	-0.0002	-0.0075	0.0005
	(0.674)	-(0.208)	-(2.482)*	(0.486)
Ln FRPR	-0.0160	-0.0193	0.0900	0.0158
	-(1.756)	-(1.682)	(0.506)	(1.495)
IRRG	0.0361	-0.1922	-0.0023	0.0452
	(0.585)	(1.429)	-(0.099)	(1.045)
Ln EDUC	0.1446	-0.2076	-0.0571	0.0602
	(2.79)**	-(0.147)	-(2.144)*	(1.025)
Ln EXTE	-0.0095	-0.0194	0.0189	0.0241
	-(0.670)	-(1.926)	(0.997)	(1.463)
Ln RESE	-0.0023	0.0105	-0.0461	-0.0815
	-(0.062)	(0.442)	-(0.942)	-(1.836)
ROAD	0.0391	0.2015	0.0467	0.0618
	(0.931)	(3.996)**	(1.020)	(1.240)
Ln LABO	0.0175	0.0500	-0.0040	0.0006
	(1.537)	(3.234)	-(0.583)	(0.100)
Ln CAPI	-0.0224	-0.0148	0.0039	-0.0001
	-(4.644)**	-(4.472)**	(0.811)	-(0.019)
UNRAIN	0.0037	-0.0182	-0.0096	-0.0124
	-(0.464)	(1.966)*	-(1.006)	-(1.599)
LAGSPDA	0.8332	0.7382	0.8047	0.8978
	(36.987)**	(25.956)**	(26.9)**	(52.316)**
Chi-Square	9.4461	7.2915	3.1206	6.7320
Log-like lihood	2,876.980	2,013.245	1,610.421	2,694.306
Sample no	279	187	216	279

Note : ** and * are significant at 1% and 5% respectively

UPNE = upper northeast, ULONE = lower northeast, UPN = upper north

Lon = lwer north

Source . From estimation

Appendix Talbe 5.1 (Continued)

Item	ACREAGE (SPDA)			
	MIDDLE	EAST	WEST	SOUTH
Constant	0.0643	0.0780	0.1113	0.3391
	(1.544)	(1.459)	(1.049)	(5.001)
Ln PDPR $_{t-1}$	0.0127	-0.0036	0.0059	0.0095
	(1.117)	-(0.310)	(0.331)	(0.690)
Ln UPPR $_{t-1}$	0.0027	0.0008	0.0144	-0.0026
	(0.441)	(0.094)	(1.032)	-(0.481)
Ln VGPR $_{t-1}$	-0.0027	-0.0046	-0.0050	-0.0001
	-(0.484)	-(0.552)	-(0.345)	-(0.018)
LN TRPR $_{t-1}$	-0.0133	0.0028	-0.0164	-0.0074
	-(2.026)*	(0.286)	-(1.745)	-(0.585)
Ln FRPR	0.0006	0.0045	0.0011	0.0006
	(0.102)	(0.548)	(0.075)	(0.077)
IRRG	-0.0061	0.0624	0.0481	0.1410
	-(0.999)	(3.564)**	(1.201)	(3.531)**
Ln EDUC	0.0218	0.0027	-0.0824	-0.0024
	(1.067)	(0.060)	-(1.488)	-(0.189)
Ln EXTE	0.0087	0.0169	-0.0004	0.0476
	(1.171)	(1.537)	-(0.021)	(4.933)**
Ln RESE	-0.0359	-0.0370	-0.0161	-0.1244
	-(1.909)*	-(1.220)	-(0.315)	-(4.734)**
ROAD	0.0011	-0.0014	-0.0173	0.0063
	(0.506)	-(0.062)	-(0.321)	(0.611)
Ln LABO	-0.0020	0.0038	-0.0004	-0.0153
	-(0.601)	(0.609)	-(0.059)	-(2.653)**
Ln CAPI	0.0047	0.2049	0.0126	0.0067
	(1.556)	(0.400)	(1.639)	(2.041)*
UNRAIN	-0.0071	-0.0130	-0.0027	-0.0080
	-(1.654)	-(1.637)	-(0.287)	-(0.927)
LAGSPDA	0.9705	0.9544	0.917	0.0094
	(143.861)**	(88.74)**	(49.877)**	(2.388)*
Chi-Square	4.2517	12.2354	7.4030	11.3131
Log-like lihood	4104.314	2088.012	1061.99	3324.097
Sample no	591	156	218	434

Note ** and * are significant at 1% and 5% respectively

In parenthesis are the t-valve.

Source : From estimation

Appendix Talbe 5.2

Estimated results of yield response equations

by sub-region

Item	YIELD (Y)			
	UPNE	LONE	UPN	LON
Constant	1 8702	2 1500	2.6571	2.5918
	(7 735)	(8 221)	(8 495)	(7 509)
$PDPR_{t-1}$	-0 1473	-0 2469	-0 2290	0.0704
	-(1 565)	-(2 192)*	-(1 568)	(0.460)
FRPR	-0 2374	-0 1726	0.1731	-0 1874
	-(2 143)*	-(1 454)	(1 122)	-(1 110)
IRRG	0 4090	-0 9065	0 6258	-0 4061
	(0 751)	-(0 956)	(3.407)**	-(0 742)
PDARE	-0 1602	-0 4178	1 4403	-1 2049
	-(0 451)	-(1 923)*	(2.463)*	-(2 30)*
UNRAIN	-0 0509	0.0344	-0 0024	-0 1051
	-(1 195)	(0 717)	-(0 034)	-(2.799)**
Adj-R2	0 1600	0 1695	0 0819	0.0434
F-ratio	7 7811	8 5962	4 8533	3.5222
Sample no	179	187	216	278

Appendix Talbe 5.2 (Continued)

Item	YIED (Y)			
	MIDDLE	EAST	WEST	SOUTH
Constant	2 5466	2 3501	2 1937	1 6398
	(11 678)	(9 287)	(7 391)	(9 182)
PDPR $_{t-1}$	0 3271	0 0372	0 0546	0 0993
	(3 348)**	(0 285)	(0 382)	(1 123)
FRPR	-0 9285	-0 5001	-0 7262	-0 0955
	-(9 182)**	-(3 951)**	-(4 949)**	-(1 054)
IRRG	0 5216	0 2343	0 9213	0 7856
	(7 611)**	(1 258)	(4 514)**	(2 55)**
PDARE	-1 3440	0 0868	-2 7218	-1 0805
	-(0 227)	(0 144)	-(4 567)**	-(1 716)
UNRAIN	-0 0078	-0 1009	-0 0758	0 0339
	-(0 227)	-(1 418)	-(1 344)	(0 528)
Adj-R2	0 3870	0 1687	0 6015	0 0576
F-ratio	75 3639	9 8069	46 2851	6 3253
Sample no	591	218	151	434

Note ** and * are significant at 1% and 5% respectively

In porentheses are the t-value

UPNE = upper northeast,. ULONE = lower northeast, UPN = upper north

Lon = lower north

Source From estimation

Appendix table 6.1

Projection of paddy production under different

growth assumptions, 1992-2010

Year	Case (A)	Case (B)	Case (C)	Case (D)	Case (E)
	1,000 tons				
1991**	20,399.42	20,399.42	20,399.42	20,399.42	20,399.42
1992	20,288.24	20,268.86	20,301.50	20,466.74	20,238.26
1993	20,177.67	20,139.14	20,204.06	20,534.28	20,078.38
1994	20,067.70	20,010.25	20,107.08	20,602.04	19,919.76
1995	19,958.33	19,882.19	20,010.56	20,670.03	19,762.40
1996	19,849.56	19,754.94	19,914.51	20,738.24	19,606.27
1997	19,741.38	19,628.51	19,818.92	20,806.68	19,451.38
1998	19,633.79	19,502.89	19,723.79	20,875.34	19,297.72
1999	19,526.79	19,378.07	19,629.12	20,944.23	19,145.27
2000	19,420.37	19,254.05	19,534.90	21,013.34	18,994.02
2001	19,314.53	19,130.82	19,441.13	21,082.69	18,843.97
2002	19,209.26	19,008.39	19,347.81	21,152.26	18,695.10
2003	19,104.57	18,886.67	19,254.94	21,222.06	18,547.41
2004	19,000.45	18,765.86	19,162.52	21,292.09	18,400.88
2005	18,896.90	18,645.76	19,090.54	21,362.36	18,255.52
2006	18,793.91	18,526.42	18,979.00	21,432.85	18,111.30
2007	18,691.48	18,407.85	18,887.90	21,503.58	17,968.22
2008	18,589.61	18,290.04	18,797.24	21,574.54	17,826.69
2009	18,488.30	18,172.99	18,707.01	21,645.74	17,685.44
2010	18,387.54	18;056.68	18,617.22	21,717.17	17,545.73

Note : ** is a base year

Appendix table 6.2

Projection of consumption demand for rice (in terms of paddy equivalence) under different price growth assumption, 1992-2010

Year	Base case			Pessimistic case			Optimistic case		
Year	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
	1,000 tons								
1990**	2,478.35	9,222.78	11,701.13	2,478.35	9,222.78	11,701.13	2,478.35	9,222.78	11,701.13
1991	2,507.60	9,248.61	11,756.21	2,527.92	9,306.71	11,834.63	2,487.28	9,190.50	11,677.78
1992	2,537.19	9,274.50	11,811.69	2,578.48	9,391.40	11,969.88	2,496.23	9,158.34	11,654.57
1993	2,576.13	9,300.47	11,867.60	2,630.05	9,476.86	12,106.91	2,505.21	9,126.28	11,631.49
1994	2,597.42	9,326.51	11,923.93	2,682.65	9,563.10	12,245.75	2,514.23	9,094.34	11,608.57
1995	2,628.07	9,352.63	11,980.70	2,736.30	9,650.13	12,386.43	2,523.29	9,062.51	11,585.80
1996	2,659.08	9,378.81	12,037.89	2,791.03	9,737.94	12,528.97	2,532.37	9,030.79	11,563.16
1997	2,690.46	9,405.08	12,095.53	2,848.85	9,826.56	12,673.41	2,541.49	8,999.18	11,540.67
1998	2,722.20	9434.41	12,153.61	2,903.79	9,915.98	12,819.77	2,550.63	8,967.69	11,518.32
1999	2,754.33	9,457.82	1,212.15	2,961.86	10,006.22	1,268.08	2,559.82	8,936.30	11,496.12
2000	2,786.83	9,482.30	12,271.13	3,021.10	10,097.27	13,118.37	2,569.03	8,905.02	11,474.05
2001	2,813.30	9,506.11	12,319.41	3,074.57	10,184.11	13,258.68	2,572.37	8,869.40	11,441.77
2002	2,840.03	9,527.98	12,368.01	3,128.99	10,271.69	13,400.68	2,575.72	8,833.92	11,409.64
2003	2,867.01	9,549.89	12,416.90	3,184.37	10,360.03	13,544.40	2,579.07	8,798.59	11,377.66
2004	2,894.24	9,571.86	12,466.91	3,240.74	10,449.12	13,689.86	2,582.42	8,763.39	11,345.81
2005	2,921.74	9,593.87	12,515.61	3,298.10	10,568.98	13,837.08	2,585.78	8,728.34	11,314.12
2006	2,949.50	9,615.94	12,565.43	3,356.48	10,629.62	13,986.10	2,589.13	8,693.43	11,282.56
2007	2,977.52	9,368.05	12,615.57	3,415.89	10,721.04	14,136.92	2,592.50	8,658.65	11,251.15
2008	3,005.80	9,660.22	12,666.02	3,476.35	10,813.24	14,289.58	2,595.87	8,624.02	11,219.89
2009	3,034.36	9,682.44	12,716.80	3,537.88	10,906.23	14,444.11	2,599.25	8,589.52	11,188.77
2010	3,063.18	9,704.71	1,276.89	3,600.50	11,000.03	14,600.52	2,602.63	8,555.16	11,157.79

Note : ** is a base year