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# Choice of rice production technique in Thailand, 1890–1940

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# CHOICE OF RICE PRODUCTION TECHNIQUE IN THAILAND, 1890-1940

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Dedicated to Pym

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## ABSTRACT

This study analyzes the choice of rice production technique in Thailand during 1890-1940. It focuses on two techniques: transplanting and broadcasting. Although transplanting has been the traditional rice growing method in Thailand at least since the seventeenth century, most cultivators in the newly developed areas of the commercialized Central Plain during the period adopted broadcasting. The two conventional explanations for choice of rice production technique--local water conditions and factor prices--cannot consistently explain this choice. The water conditions necessary for transplanting rice did exist in the area, and factor prices during the period moved in favor of transplanting.

Because the two techniques differ both in terms of variable input per unit of land and fixed capital input, a choice of technique model is formulated using the theory of production and the theory of investment to explain the choice of broadcasting. The model is a neoclassical production relation modified to incorporate fixed capital input and the firm's planning horizon. In this regard, the model allows a simultaneous analysis of the firm's short-run production decision and long-run capital investment. Empirical evidence regarding rice farming during the period is consistent with theoretical constructs.

The main findings reveal that the choice of broadcasting during the period is a rational decision. The outcome was caused by uncertainty in land ownership and prices, which were consequences of increased external demand for rice and economic changes in Thailand at the time. Under uncertainty in land ownership, a short planning horizon and consequently a

technique such as broadcasting which requires less fixed capital input minimizes expected losses. Under price uncertainty, broadcasting provides greater production flexibility and, consequently, higher profits for large-landholding firms.

This study contributes to conventional knowledge regarding factors affecting choice of rice production technique and, thus, improves the understanding of a firm's choice of technique. Although the model is simple and empirically oriented, it is adequate to analyze a firm's decision making process. The findings also illuminate relationships between external trade, internal institutions, and agricultural development. While the empirical results presented are specific to Thailand, the process employed here can be applied elsewhere.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ..... v

ABSTRACT ..... vii

LIST OF TABLES ..... xi

LIST OF FIGURES ..... xiv

CHAPTER I INTRODUCTION ..... 1

1.1 Transplanting and Broadcasting ..... 2
1.2 Rice Cultivation Techniques Used on the Central Plain ..... 7
1.3 The Change in Rice Cultivation Technique on the Central Plain in 1890 ..... 13
1.3.1 The Dominant Rice Cultivation Technique on the Central Plain Prior to 1890 ..... 13
1.3.2 The Dominant Rice Cultivation Technique on the Central Plain, 1890-1940 ..... 15
1.4 Objective of the Study ..... 22
1.5 Organization of the Dissertation ..... 26

CHAPTER II ECONOMIC ANALYSIS OF CHOICE OF TECHNIQUE ..... 27

2.1 Inputs in Traditional Thai Rice Production ..... 29
2.2 A Simple Choice of Technique Model ..... 30
2.2.1 Perfect Certainty and Choice of Technique ..... 34
2.2.2 Uncertainty and Choice of Technique ..... 35
2.3 Summary ..... 50

CHAPTER III TRENDS IN FACTOR PRICES AND CHOICE OF TECHNIQUE ..... 52

3.1 The Importance of Rice in Thailand, 1856-1941 ..... 53
3.2 Trends in Factor Prices, 1850-1941 ..... 56
3.2.1 Trend in Wages, 1850-1941 ..... 56
3.2.2 Trend in Land Prices and Land Rents ..... 64
3.2.3 Trends in Relative Factor Prices, 1850-1941 ..... 75
3.3 Summary ..... 81

CHAPTER IV LAND OWNERSHIP AND CHOICE OF TECHNIQUE ..... 84

4.1 Land Development, Land Acquisition, and Land Disputes, 1890s ..... 85
4.2 Land Disputes and Land Tenure in Rangsit, 1890-1910 ..... 92

4.2.1 Land Disputes in Rangsit, 1890-1910 ..... 92
4.2.2 Land Tenure in Rangsit, 1890-1910 ..... 98
4.3 Land Disputes and Land Tenure in Rangsit after 1910 ..... 105
4.4 Summary ..... 106

CHAPTER V PRICE UNIVERSITY, LARGE LANDHOLDING, AND CHOICE OF TECHNIQUE ..... 107

5.1 Uncertainty in Rice Prices, 1864-1941 ..... 108
5.2 Large Landowners, Tenancy, and Large Tenants, 1890-1940 123
5.3 Price Uncertainty, Large Landholding, and Production Flexibility ..... 133
5.3.1 Short-term Leases ..... 133
5.3.2 Fluctuation in Demand for Rented Land and Wage Labor ..... 140
5.4 Summary ..... 144

CHAPTER VI SUMMARY ..... 145
6.1 Restatement of the Problem ..... 145
6.2 Justification of the Study ..... 146
6.3 Summary ..... 147

APPENDIX ..... 151

ENDNOTES ..... 175

BIBLIOGRAPHY ..... 182

## LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1.1 | Comparison of Labor Requirements for Rice Production between Transplanting and Broadcasting Techniques | 4 |
| 1.2 | Comparison of Yields between Transplanting and Broadcasting Techniques | 5 |
| 1.3 | Differences between Transplanting and Broadcasting Techniques | 6 |
| 1.4 | Paddy Output by Cultivation Technique for the Central Plain of Thailand, 1922-1924 | 18 |
| 1.5 | Dominant Rice Cultivation Technique in Various Parts of Thailand, 1930 | 20 |
| 1.6 | Dominant Rice Cultivation Technique in Various Parts of Thailand, 1856-1940 | 22 |
| 2.1 | Possible Values for Capital with Respect to Planning Horizon. | 36 |
| 3.1 | Quantity and Value of Rice Exports, 1857-1941 | 54 |
| 3.2 | Average Annual Rates of Change in Rice Prices, 1864-1941 | 55 |
| 3.3 | Nominal and Real Wages in Terms of Rice for Unskilled Laborers in Bangkok, 1850-1941 | 58 |
| 3.4 | Average Annual Rates of Change in Real Wages, 1850-1941 | 62 |
| 3.5 | Comparisons of Urban Unskilled and Rural Wages, 1889-1931 | 64 |
| 3.6 | Land Prices and Land Rents for Central Plain Paddy Land, 1880-1942 | 66 |
| 3.7 | Land Prices for Rangsit Paddy Land, 1880-1925 | 68 |
| 3.8 | The Siam Canals, Land and Irrigation Company's Sale Prices for Rangsit Land, 1892-1904 | 69 |
| 3.9 | Mortgage Land Values for the Central Plain of Thailand, 1915-1941 | 71 |

| Table | | Page |
|---|---|---|
| 3.10 | Average Annual Rates of Change in Real Land Prices, 1915-1941 | 73 |
| 3.11 | Ratios of Land Prices to Wages, 1880-1915 | 76 |
| 3.12 | Ratios of Land Prices to Wages, 1915-1941 | 77 |
| 3.13 | Average Annual Rates of Change in Ratios of Land Prices to Wages, 1915-1938 | 80 |
| 3.14 | Average Annual Rates of Change in Rice Prices and Factor Prices, 1850-1941 | 82 |
| 4.1 | Area of Paddy Land on Canal Banks on the Young Delta, 1861-1914 | 86 |
| 4.2 | Land Disputes in Rangsit, 1900-1907 | 97 |
| 4.3 | The Siam Canals, Land and Irrigation Company's Land Sales in Rangsit by Plot Size, 1892-1901 | 99 |
| 4.4 | Area Farmed by Different Types of Cultivators in Rangsit, 1892-1901 | 101 |
| 5.1 | Means, Standard Deviations, and Coefficients of Variation of Average Prices of Rice Exports, 1864-1941 | 110 |
| 5.2 | Indicators of the Degree of Tenancy in Thailand, 1930-1935.. | 125 |
| 5.3 | Areas Owned by Different Types of Landowners in Thanyaburi, 1914 | 128 |
| 5.4 | The Siam, Canals, Land and Irrigation Company's Rangsit Land Sales, 1892-1901 | 129 |
| 5.5 | Estimates of Area Owned by Different Types of Landowners for Rangsit, 1910s | 131 |
| Appendix Tables | | |
| 1 | Quantity, Price, and Value of Rice Exports, 1857-1941 | 151 |
| 2 | Urban Unskilled and Rural Wages, 1820 to 1938 | 154 |
| 3 | Observations on Paddy Land Prices and Rents for the Central Plain of Thailand, 1880-1948 | 157 |
| 4 | Ratios of Land Prices to Wages, 1880-1915 | 160 |

| Table | | Page |
|---|---|---|
| 5 | Canal Construction and Area of Newly Opened Rice Lands on the Young Delta, 1861-1914 | 161 |
| 6 | Rangsit Land Sales, Plot Size 10-1,000 Rai | 162 |
| 7 | Rangsit Land Sales, Plot Size 1,050-25,325 Rai | 165 |
| 8 | Canal Construction and Land Development in Rangsit | 167 |
| 9 | Location and Area of Royal Rice Lands, 1900s | 168 |
| 10 | Location and Area of Royal Rice Lands Granted to the Thai Government, 1975 | 170 |
| 11 | Autocorrelation of Rice Prices (Yt), 1864-1941 | 171 |
| 12 | Autocorrelation of the Differenced Rice Prices, 1864-1941 | 173 |

## LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1.1 | A Physiographical Model of Chaophraya Delta | 8 |
| 1.2 | Canal System and Farm Alignment in Rangsit | 11 |
| 2.1 | Flexibility of Technique Measured by the Flatness of the Bottom of Average Cost Curve | 41 |
| 2.2 | Relative Profitability of Transplanting and Broadcasting Techniques under Competition and $AC_T = AC_B$ | 43 |
| 2.3 | Relative Profitability of Transplanting and Broadcasting Techniques under Competition and $AC_B > AC_T$ | 44 |
| 3.1 | Real Wages in Terms of Rice for Unskilled Laborers in Bangkok, 1850-1941 | 60 |
| 3.2 | Nominal and Real Mortgage Land Values for the Central Plain of Thailand, 1915-1941 | 74 |
| 3.3 | Ratios of Land Prices to Wages, 1915-1941 | 79 |
| 5.1 | Average Prices of Rice Exports, 1864-1941 | 109 |
| 5.2 | Rice Export Prices: Autocorrelation Function of Yt, 1864-1941 | 116 |
| 5.3 | Rice Export Prices: Autocorrelation Function of Yt, 1864-1890 | 116 |
| 5.4 | Rice Export Prices: Autocorrelation Function of Yt, 1890-1941 | 117 |
| 5.5 | Rice Export Prices: Autocorrelation Function of $\Delta Yt$, 1864-1890 | 118 |
| 5.6 | Rice Export Prices: Autocorrelation Function of $\Delta Yt$, 1864-1890 | 119 |
| 5.7 | Rice Export Prices: Autocorrelation Function of $\Delta Yt$, 1890-1941 | 120 |

Figure Page

5.8 Rice Export Prices: Autocorrelation Function of $\Delta^2 Yt$, 1864-1941 ..... 120

5.9 Rice Export Prices: Autocorrelation Function of $\Delta^2 Yt$, 1890-1941 ..... 121

5.10 Rice Export Prices: Autocorrelation Function of $\Delta^3 Yt$, 1864-1941 ..... 121

5.11 Rice Export Prices: Autocorrelation Function of $\Delta^3 Yt$, 1890-1941 ..... 122

# CHAPTER I

# INTRODUCTION

This study analyzes the choice of rice production technique in Thailand for the period from 1890 to 1940. It focuses on two rice production techniques: transplanting and broadcasting. Transplanting is generally recognized as a better technique, and it has long been the traditional rice growing method used in Thailand, as well as in other rice producing Asian country. During the period under study, however, most rice cultivators who migrated into the peripheral areas of the commercialized Central Plain adopted broadcasting. In the older commercial rice producing areas of the Central Plain and other regions, cultivators continued to use the transplanting technique. It took more than four decades for these cultivators to start reverting back to transplanting. The causes of this reversion during 1890-1940 is the focus of this study.

This chapter provides the background information needed in subsequent chapters. Section 1.1 describes the two major rice cultivation techniques used in Thailand during 1890-1940 and identifies their main differences. Section 1.2 describes the physiography and hydrology of the Central Plain and the role that they played in determining the use of rice cultivation techniques. Section 1.3 documents the change in rice production technique on the Central Plain of Thailand during 1890-1940. Section 1.4 discusses the research problem and states the objective of the study. An outline of the following chapters is provided in section 1.5.

## 1.1 Transplanting and Broadcasting

Transplanting and broadcasting are the two major techniques of planting rice in Thailand. In transplanting, rice is planted in seedbeds and then transplanted into more intensively prepared fields. A controlled supply of water is applied to the transplanted rice throughout its growth period. With broadcasting, seed is sown directly upon an open field. Little care for the broadcasted rice is required.[1] The two rice production techniques differ mainly in terms of (1) labor requirements per unit of land, (2) fixed capital or land investment, (3) water supply and control, and (4) yield. Transplanting is more labor intensive. A comparison of labor requirements between the two techniques, based on village level data, is presented in Table 1.1. For one unit of land, transplanting requires about twice the amount of labor required by broadcasting. More labor is needed to prepare seedbeds, uproot seedlings, transplant the seedlings, control weeds, regulate water, and maintain the irrigation system. In terms of investment, transplanting generally requires more ground levelling than the broadcasting technique and construction of irrigation facilities, such as dikes and ditches, while broadcasting requires only land clearing. The two techniques also require different water supplies and water control methods at various stages of land preparation and cultivation. Transplanting requires strict water supplies and control. A successfully transplanted crop depends on (1) a sufficient and timely supply of water (either by natural inundation or by pumping from canals) for puddling the soil, preparing seedbeds, and transplanting seedlings, and (2) water regulation in the seedbeds and in the rice fields during the growth period. In general, the intensive practices of transplanting described above result in increased yields. The fact that transplanting increases yield per plant and per acre has been

demonstrated by agronomists and is supported by evidence from around the world (Grist 1986: 157-9, Wickizer and Bennett 1941: 240-4). Results of a comparison of yields between the two techniques, presented in Table 1.2, confirm this conclusion. Although this comparison is not an ideal one, i.e., a comparison based on yields from the same plot or between plots of similar environment and by the same cultivator,[2] it is based on results of careful studies at village level. The main differences between the two techniques are presented in Table 1.3

Table 1.1

Comparison of Labor Requirements for Rice Production between Transplanting and Broadcasting Techniques

| Technique | Labor requirements (man-days per ha) | Source |
|---|---|---|
| Broadcasting | | |
| Northern Thailand | 48.5[a] | Moerman (1968: 166, 170) |
| Central Thailand | 54.7 | NEDECO (1969) |
| Central Thailand | 45.3[b] | Janlekha (1955: 106, 126) |
| Average | 49.5 | |
| Transplanting | | |
| Northern Thailand | 98.9 | Moerman (1968: 160, 166) |
| Central Thailand | 87.5 | NEDECO (1969) |
| Central Thailand | 90.6[c] | Janlekha (1955: 106) |
| Average | 92.3 | |

[a] The sum of the labor requirements for cultivation and harvesting (p.166) and the labor requirements for land preparation (p. 170).

[b] An estimate.

[c] Converted from man-hour to man-day using 8 man-hours = 1 man-day.

Note: Figures are converted from rai to hectare using 6.25 rai = 1 hectare.

Table 1.2

Comparison of Yields between Transplanting and Broadcasting Techniques

| Technique | Average yield (kg per ha) | Source |
|---|---|---|
| Broadcasting | | |
| Northern Thailand | 2,571.3 | Moerman (1968: 162) |
| Central Thailand | 1,281.3 | National Statistical Office (1963) |
| Central Thailand | 1,094.2[a] | Zimmerman (1931: 25, 164-70, 303-15) |
| Average | 1,648.3 | |
| Transplanting | | |
| Northern Thailand | 2,928.8 | Moerman (1968: 162) |
| Central Thailand | 1,675.0 | National Statistical Office (1963) |
| Central Thailand | 1,343.8[b] | Zimmerman (1931: 25, 164-70, 303-15) |
| Central Thailand | 1,980.0 | Janlekha (1955: 52) |
| Northern Thailand | 2,612.0 | Chapman (1967: Table 3) |
| Average | 2,107.9 | |

[a] An average for yields (corrected amount produced in liters) from Ayuthya, Lopburi, and Thanyaburi.

[b] An average for yields (corrected amount produced in liters) from Saraburi, Petchaburi, and Chachoengsao.

Note: Figures are converted to kilograms per hectare using: 1 hap = 2 bang, 1 bang = 11 kilograms, 1 tang = 11 kilograms or 20 liters, and 6.25 rai = 1 hectare.

Table 1.3

Differences between Transplanting and Broadcasting Techniques

| | Broadcasting | Transplanting |
|---|---|---|
| Labor (man-days per ha) | 49.5 | 92.3 |
| Land investment | Land clearing | Land clearing, ground levelling, dikes, and ditches for irrigation system |
| Water supply and control | Early shower for moistening the soil | Timely supply of water and strict water control throughout most production stages |
| Yield (kg per ha) | 1,648.3 | 2,107.9 |

Note: Labor and yield figures are taken from Tables 1.1 and 1.2, respectively.

Apart from the main differences described above, transplanting possesses other advantages over broadcasting. Transplanting requires only about half as many seeds to produce the same level of output as broadcasting (Moerman 1968: 176, A. KS. 15.2/25). It also appears to provide more reliable yields over a number of years, particularly in areas where crops are susceptible to damage from early floods and in areas where the early rains are scanty or not well distributed (Grant 1933: 15). Moerman's two-year study on rice cultivation in a village in northern Thailand substantiates the reliability argument (Moerman 1968: 163, 174-84). Moerman observed that transplanting is practiced by most farmers because the technique provides higher and more reliable yields. In brief, it is generally held that transplanting is a better

technique. Broadcasting involves many problems such as difficulties in controlling weeds and nonuniform seed germination. Broadcasting also often leads to lanky growth plants which are easily damaged by heavy rainfall (Grant 1933: 5-16, Grist 1986: 205-11).

## 1.2 Rice Cultivation Techniques Used on the Central Plain

During the period under study, the Central Plain of Thailand was the most important area of commercial rice production. The location of the Central Plain and a physiographical model showing its different deltaic parts are depicted in Figure 1.1.

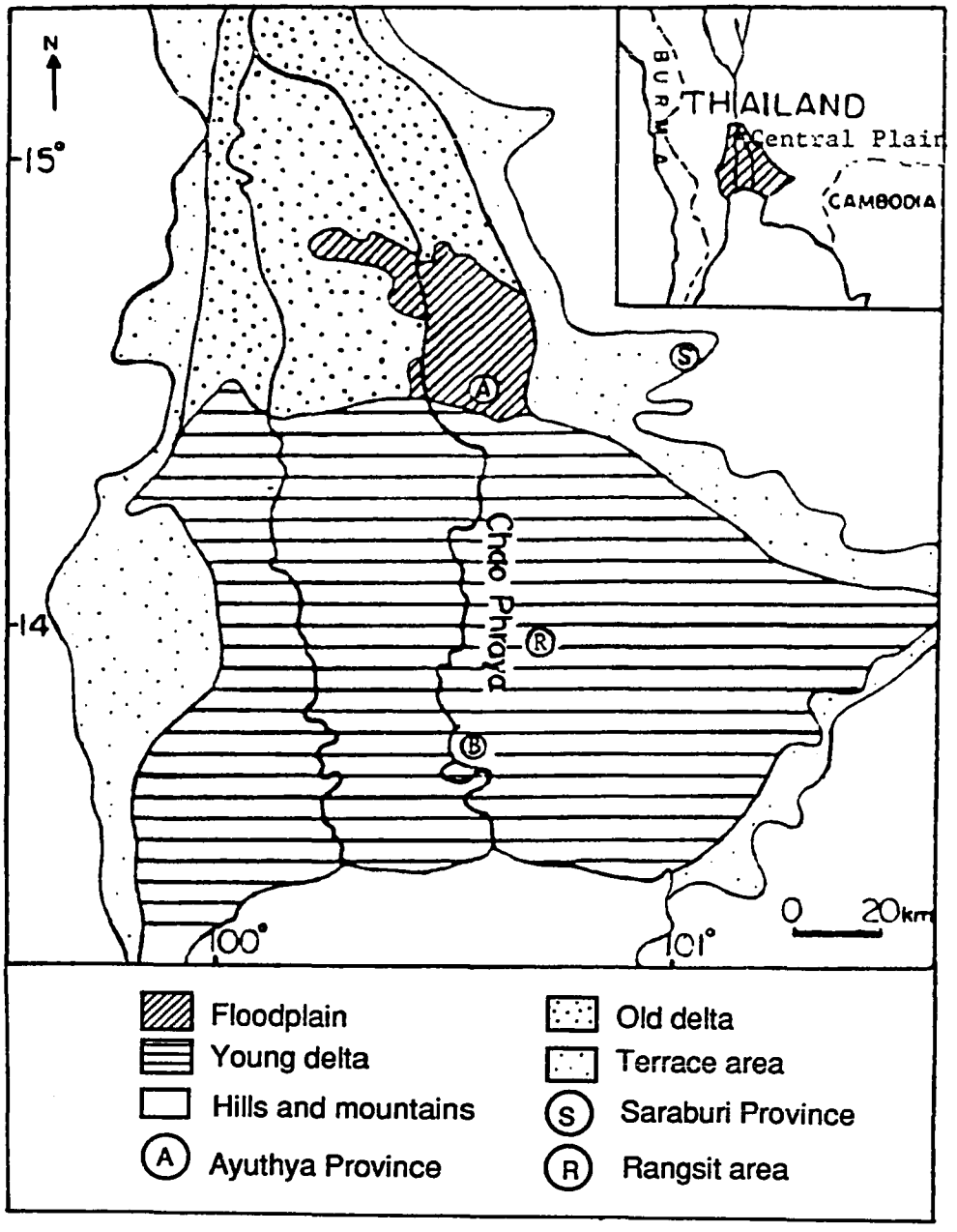



Figure 1.1 A Physiographical Model of Chaophraya Delta

The Central Plain is often referred to as Chaophraya Delta because it lies along the Chaophraya River and its many tributaries. The delta consists of a complex structure of landforms, mainly made up of a low lying flat to gently sloping landscape in a north-south direction. As shown in Figure 1.1, the Chaophraya delta consists of four essential types of landforms: mountain and foothills, floodplain, old delta, and young delta.[3] The regional belts of mountain, foothills, and terraces constitute a flood release zone for monsoon rain water. They have a higher ground elevation and are sloped toward the center of the delta. The main stream of river flows between the belts of the foothills. A floodplain lies on both sides of the river some ten to twenty kilometers wide. During the rainy season, the abundant in situ rainfalls and/or upstream runoffs spill into this floodplain causing prolonged and deep inundations. The rate of increase in water depth is very rapid due to the accumulation of run-off from the upper reaches. The maximum flood depth may exceed 3 meters and overflow into adjacent areas (Takaya 1987: 9). Experience in the period 1903-1962 has shown that the maximum water levels near Ayuthya (a town located on the floodplain) exceeds 3.3 meters once in two years and 4.1 meters once every ten years (Royal Irrigation Department 1967: 132). Water collects on the floodplain during the rainy season and dries up during the dry season. In general, the floodplain is relatively smaller than other parts of the delta. The area marked as the old delta has a flat to slightly undulating ground surface. Its elevation, some four or five meters above the floodplain, normally puts it out of reach of the rainy season's floodwaters. However, some shallow floods may occur on parts of the old delta for short periods of time.

The young delta, which developed and expanded below the adjoining old delta and floodplain, is a broad tract of flat lowland with an elevation of one or two meters above the mean sea level. In the rainy season the floodwaters surge from the floodplain and spread across the flat surface of the young delta. The abundant floods and the general flat landform of the young delta causes the water to accumulate, usually about fifty centimeters to one meter (Takaya 1987: 9). The area of the young delta is greater than any other deltaic parts and, therefore, represents the most typical landform of the Central Plain. Canal networks were built into the young delta connecting rivers that flow from north to south. Although these canals were not able to alter the flow of water or control the amount of water to the area, they facilitated the flow of water from adjacent rivers through the area. Canal networks, therefore, remedy water shortages during the dry season and provide a year-round transportation system. Most of the canal construction on the young delta took place during the 1880s to facilitate the expansion of commercial rice production in this peripheral area of the Central Plain (see van de Heide 1903, Tomosugi 1966).

The Rangsit area located in the middle of the young delta. It covers about 325,956 hectares of land, including portions of six provinces on the Central Plain (Ayuthya, Saraburi, Prathumthani, Bangkok, Nakornnayok, and Chachoengsao). The average height of floods at the peak of the rainy season in Rangsit during the period of study was reported to be about 60 centimeters (Yai S. Sanitwongse 1911: 5). The area consists of extensive canal networks which were constructed in 1890 by a private firm called Siam Canals, Land and Irrigation Company (see Sathian Laiyalak et al., 12: 209, 225). The canal system in Rangsit differed from traditional canals because locks were placed at points where its main canals joined rivers. Therefore, the system could retain

water which flowed into it, although it was not capable of delivering additional water over the amount made available by floods (van de Heide 1903). The canal system in Rangsit was originally designed to make water accessible to every farm in the area.[4] A simple diagram showing the pattern of farm alignment in Rangsit during the late nineteenth century is provided in Figure 1.2. Every farm had at least two sides of its boundaries opened to feeder canals.

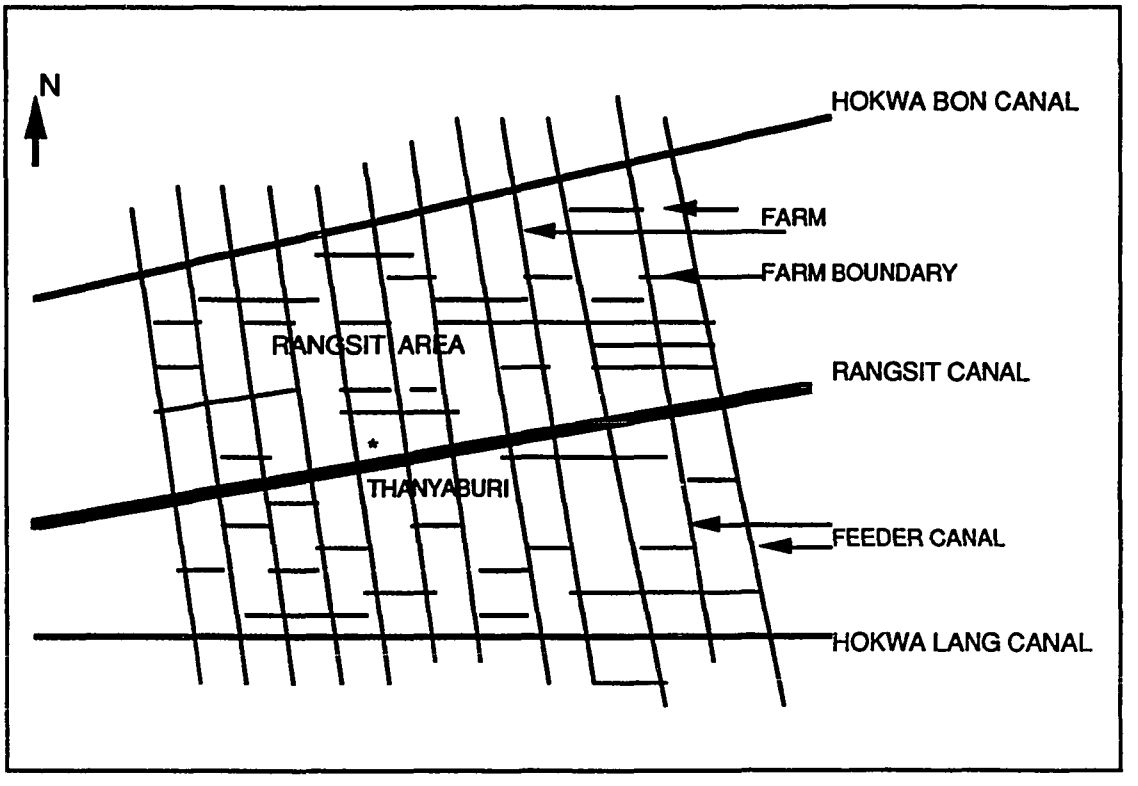



Figure 1.2 Canal System and Farm Alignment in Rangsit

The canal system in Rangsit undoubtedly increased both the availability of water and the cultivatable area. Apart from the canal system, the Rangsit area also possesses additional advantages over other areas of the young delta in terms of the volume of water it receives. It receives flood waters from two rivers: the Nakornnayok and the Chaophraya. Runoff from the Nakornnayok comes early in the rainy season. Runoff from the Chaophraya comes later, but recedes more slowly, so that the period of inundation in Rangsit and other adjacent areas is sufficient for the rice crop to mature. In 1923 the area was further improved by the country's first public irrigation system (see Wright and Breakspear 1908: 200-1).

Due to the level and timing of annual flooding on the delta, transplanting can be practiced in most areas of both the old delta and the young delta. In areas where a canal system exists, for example the Rangsit area, transplanting is not a technical problem. On the floodplain, transplanting cannot be used. First, floodwaters on the floodplain rise so rapidly that transplanting cannot be finished in time. Second, the excessive flooding prevents the strict regulation of water depth required for transplanting.

Broadcasting, on the other hand, is possible in most areas of the delta. On the floodplain, broadcasting is the rule. In this area farmers normally broadcast early in the rainy season to allow seedlings to grow strong before the more turbulent floods come. Deep-water rice varieties which possess the ability to rise with and survive all but the most extreme floods are normally used. Today, deep-water broadcasting is still practiced in excessively flooded areas on the Central Plain.

## 1.3 The Change in Rice Cultivation Technique on the Central Plain in 1890

### 1.3.1 The Dominant Rice Cultivation Technique on the Central Plain Prior to 1890

Transplanting has long been recognized as the typical technique of rice cultivation in Thailand, as well as in other rice producing Asian countries.[5] Contemporary descriptions of rice farming in Thailand consistently point to the dominance of transplanting in Thailand.[6] Most investigators indicate that Thai farmers generally practice transplanting whenever local water conditions allow for it and broadcast only in areas subject to rapid and deep flooding. It is not known when this pattern began. The earliest record about transplanting is found in the writings of de La Loubere ([1691]1969).[7] He wrote that rice was broadcasted in Ayuthya, an area of deep flooding on the Central Plain.[8] Nearby and elsewhere in the country, de La Loubere indicated that transplanting was used. He also observed that transplanting was a more substantial and better method of growing rice (pp. 19-20). Based on this information, transplanting has been the traditional method of growing rice in Thailand at least since the seventeenth century.

Before 1890, transplanting was the dominant technique on the Central Plain. The pattern of growing rice on the Central Plain prior to 1890 can be traced to the pattern of rice variety grown. Prior to 1890, rice varieties were classified into two major categories: *na moung*, or deep-water rice, and *na suan* rice. *Na moung* rice was used in broadcasting on the floodplain. *Na suan* rice was used in transplanting on the shallowly flooded or non-flooded areas on the old delta. The association between rice variety and cultivation technique made the terms used for seed varieties and techniques interchangeable. The term *na*

*suan* rice was synonymous with the transplanting technique, and the term *na moung* rice was synonymous with deep-water broadcasting. The two rice varieties are easily distinguished from one another by the length of the rice stalk. The stalks of *na moung* rice varieties are much longer than those of the *na suan* rice since they have been adapted to different water conditions. As a result, *na suan* rice could be grown successfully only in areas where water supply is controllable and flood levels lie below one meter.[9] This pattern of growing rice points to the fact that, prior to 1890, cultivators on the Central Plain used transplanting whenever water conditions allowed for it. The broadcasting technique was used only on the floodplain. Because the floodplain makes up a relatively small part of the Central Plain, transplanting was the dominant technique.

Rice-land tax assessments and rice-land taxes collected in the middle of the nineteenth century provide additional information regarding the prevalence of transplanting on the Central Plain. Prior to 1890 paddy lands on the floodplain were called *na khukho* and those elsewhere were called *na fangloi.* Farmers used the broadcasting technique in the *na khukho* area and the transplanting technique in the *na fangloi* area. In 1864, the two types of rice lands were subject to different tax rates. The tax rate for *na khukho* was one *salueng* [10] per *rai* and for *na fangloi*, one and a half *salueng* per *rai* (Sathian Laiyalak et al., 20: 163-7). The total annual rice-land tax from the Central Plain for the year 1864 is unavailable, but we know that the amount for the year 1854 was about 2,000,000 baht (Pallegoix 1854).[11] The total area of *na khukko* on the Central Plain in 1864 was about 51,200 hectares (A. R5. KS. 3.2/31). Using these available figures, the area of *na fangloi* on the Central Plain in 1864 can be approximated at 819,200 hectares. Therefore, the transplanted area was

about 16 times greater than the broadcasted area. In reality, the area of transplanting could be higher than the figure obtained here. In those days, owners of *na khukho* paid taxes for all land held under title deeds, but owners of *na fangloi* were liable for taxes based on the area actually cultivated each year (Sathian Laiyalak et al. 7: 120-6). Each cultivator's area of *na fangloi* and consequently the amount of tax was evaluated annually by a tax official. The collection of *na fangloi* land taxes depended heavily on the diligence and honesty of tax officials.[12] Thus, the amount of taxes received by the government may have been lower than the actual amount collected.

Apart from the above evidence, the Thai government's monthly reports on rice cultivation, which were first published in 1858, also shed some light on the dominant technique of rice cultivation on the Central Plain (Rachakitchanubeksa 1876-1888). Information from these official reports appear to indicate that prior to 1890 transplanting was the typical technique used on the Central Plain and elsewhere in the country, except in four provinces of the floodplain, namely Ayuthya, Angthong, Lopburi, and Suphanburi, where deep-water broadcasting was the only technique possible.

### 1.3.2 The Dominant Rice Cultivation Technique on the Central Plain, 1890-1940

In 1890 commercial rice production, which was previously concentrated on the old delta and the floodplain of the Central Plain, rapidly expanded into the young delta. The expansion is carefully documented by Johnston (1976). He indicates that before 1890 settlements on the young delta were sparse, but by the early twentieth century all 17 provinces of the young delta heavily participated in commercial rice production and export (Chapters II and III).

Several investigators point to the increasing practice of broadcasting on the young delta during this expansion. Johnston (1976) indicates that farmers who migrated into the young delta in the late 1880s began to broadcast with *na suan* rice varieties. He also reported that some farmers who began to broadcast in Rangsit in the late 1880s were farmers who had previously transplanted crops in the Prawetburirom Canal area. In 1908 Wright and Breakspear (1908: 144-5) estimated that about 15 to 20 percent of the country's exported rice was broadcasted rice. He also noted the increasing practice of broadcasting using *na suan* rice varieties in the various new commercial rice producing regions.[13] Official reports from the Ministry of Agriculture at the time also indicated the same trend (A. KS. 1.2/119). The practice of *na suan* rice broadcasting on the young delta must have significantly increased during the late nineteenth century, as the term "*na suan* " no longer referred to rice varieties suitable only for the transplanting technique, as had previously been the case (A. R7. P. 8.1/1).

In 1920 the government set up a special committee to assess and investigate the problem. A commune (*tambon* [14]) level survey on rice production was conducted for the period 1922-1924 in order to confirm the prevalence of broadcasting in the commercial rice producing regions of the Central Plain. The survey results are presented in Table 1.4. They reveal that during 1922-1924, about 30 percent of the paddy output from the Central Plain was from transplanted rice and 70 percent was from broadcasted rice (A. R7. P. 8.1/1). The report also stated that these results were consistent with data on custom returns (p. 9). Based on this report, broadcasting probably accounted for more than 70 percent of the total paddy land of the Central Plain since broadcasted yields were generally lower than transplanted yields. One may

also conclude for two reasons that most of the broadcasted area was on the young delta. First, the deep-water broadcasted area on the floodplain is a relatively small area, thus accounting for a small share of the total area of broadcasting. Second, evidence shows that transplanting remained the dominant technique on the old delta. In fact, official reports from the Ministry of Agriculture during 1922-1926 support this conclusion (see A. KS. 1.2/9, A. KS. 1.2/86, A. KS. 1.2/225, A. KS. 1/3464).

Table 1.4

Paddy Output by Cultivation Technique
for the Central Plain of Thailand, 1922-1924

| | Output for years (1,000 metric tons) | | |
|---|---|---|---|
| Technique | 1922 | 1923 | 1924 |
| Transplanting | 1,246<br>(29) | 1,146<br>(26) | 1,421<br>(29) |
| Broadcasting | 3,084<br>(71) | 3,243<br>(74) | 3,549<br>(71) |
| Total output | 4,331<br>(100) | 4,388<br>(100) | 4,970<br>(100) |

Note: Figures in parentheses are percentage. Figures are converted from *picul* to metric ton using 60 *picul* = 1 metric ton.

Source: A. R7. P. 8.1/1.

In 1930 Zimmerman conducted a rural economic survey of Thailand (Zimmerman 1931). The survey results provide some information on the use of rice cultivation techniques in Thailand. Zimmerman's findings regarding the dominant rice production technique on the floodplain, the young delta, and other regions of Thailand are presented in Table 1.5. They reveal that, in 1930, except for the Central Plain, transplanting was the dominant rice cultivation technique in all regions of the country. On the floodplain of the Central Plain, deep-water broadcasting was the only technique used due to the water conditions of the area. Zimmerman indicated that the young delta was the most

highly commercialized rice producing area of the country. Broadcasting was indicated to be the only technique practiced in Rangsit and royal rice lands near Ayuthya. Broadcasting was also common in areas in Bangkok and Thonburi. However, descriptions of the techniques used in other areas of the young delta pointed to a trend toward transplanting. This trend was also indicated by the Ministry of Agriculture in its 1930 annual report on rice farming (A. KS. 1.2/577). In 1955 data from the Department of Rice indicate that broadcasting accounted for about 40 percent of paddy area on the Central Plain with transplanting accounting for 60 percent (Rice Department 1955). Thus, the trend toward transplanting appears to have begun in the 1930s and continued after World War II. This conclusion is consistent with observations by other investigators. Most investigators in the early 1950s indicated that broadcasting was the dominant technique on the Central Plain but that it had previously been replaced by transplanting (Hank 1972; Kaufman 1960: 43, 210-1).

Table 1.5

Dominant Rice Cultivation Technique
in Various Parts of Thailand, 1930

| Location | Dominant technique |
|---|---|
| Central region | Broadcasting and transplanting |
| Floodplain | |
| Pitsanulok | Broadcasting in deep flooded areas, transplanting in higher areas |
| Ayuthya | Broadcasting |
| Lopburi | Broadcasting |
| Suphanburi | Broadcasting in deep flooded areas, transplanting in higher areas |
| Young delta | |
| Saraburi | Transplanting |
| Petchaburi | Transplanting |
| Chachoengsao | Transplanting |
| Bangkok | Broadcasting and transplanting |
| Thonburi | Broadcasting and transplanting |
| Thanyaburi[a] | Broadcasting |
| Other regions | Transplanting |

[a] Thanyaburi Province (*moung*) was established in 1901 as an administrative center for the Rangsit area. As a budget-saving measure during the depression, Thanyaburi Province was amalgamated with Pathumthani Province in February 1932. It has subsequently been a district of Pathumthani Province.

Source: Compiled from Zimmerman (1931: 141-70, 305-10).

According to the data and information presented above, broadcasting was the prevalent technique on the young delta during the period 1890-1940. Although the precise area of broadcasting on the young delta is not known, there is ample qualitative information and data on commercial rice production in the Rangsit area to investigate the change in rice cultivation technique. Information regarding the adoption of broadcasting in the Rangsit area is similar to what has been described for the young delta. Most investigators indicate that *na suan* broadcasting was used in the Rangsit area ever since the area was settled in the late 1880s. Broadcasting continued to be used until the 1930s.[15] In 1901 it was reported to be common and widespread by a manager of the Rangsit land development project (Yai S. Sanitwongse 1911: 5). These observations are consistent with information in official reports. Reports from the Ministry of Agriculture on rice cultivation throughout the period from 1901 to 1929 consistently point to the dominance of broadcasting in the Rangsit area.[16] Although the method of estimation was not specified in these official reports, errors were probably small since the traditional broadcasted rice fields were easily identified by the absence of bunds.

In brief, the foregoing discussion indicates that while transplanting has been the customary method of rice cultivation on the old delta of the Central Plain and other regions of Thailand, it was not so for the young delta during 1890-1940. Broadcasting was used on the young delta when the area was first developed for commercial rice production in 1890. It soon became the dominant technique on the young delta, especially in the Rangsit area, until the 1930s when cultivators gradually reverted back to transplanting. The dominance of rice production techniques in different parts of Thailand before 1890 and during 1890-1940 are presented in Table 1.6.

Table 1.6

Dominant Rice Cultivation Technique in Various Parts of Thailand, 1856-1940

| Region | Dominant Rice cultivation technique in periods | | | |
|---|---|---|---|---|
| | 1856-1890 | 1890-1910 | 1910-1940 | 1940 onward |
| Central region | | | | |
| Young delta | N.A. | B | B | T |
| Rangsit | N.A. | B | B | T |
| Old delta | T | T | T | T |
| Floodplain | DB | DB | DB | DB |
| Other regions | T | T | T | T |

Note: T, B, and DB denote the transplanting technique, broadcasting technique, and deep-water broadcasting, respectively.

## 1.4 Objective of the Study

The objective of this study is to explain the change in rice cultivation technique on the Central Plain of Thailand during 1890-1940, i.e., to explain why cultivators on the young delta chose broadcasting. Conventional explanations regarding choice of rice production technique are in terms of physical factors and factor prices. The explanations on the causes of changes in rice cultivation techniques in all official reports from the Department of Rice and the Department of Agricultural Economics have always been based on these two factors.[17] Janlekha (1955: 93) suggests that the choice of

transplanting is governed by topography, expected conditions of water supply, and availability of labor. Takaya (1987) argues that the water conditions on the young delta prior to the construction of the modern irrigation system were not suitable for transplanting. Johnston (1975: 234) argues that the scarcity of labor during the period led to the extensive practice of broadcasting. Based on the information presented in sections 1.2, and 1.3, however, the dominance of broadcasting on the young delta during 1890-1940 was neither due to local physical factors nor factor prices.

Information on the Central Plain's physiography and hydrology presented in section 1.2 suggests that water conditions necessary for transplanting existed on the young delta. The fact that cultivators used the broadcasting technique to sew transplanted rice varieties provides additional evidence that the transplanting technique can be used in the area. This conclusion is supported by Zimmerman (1931). During the course of his survey in Rangsit in 1930, Zimmerman observed that water was available for transplanting but cultivators in the area did not choose to practice transplanting. Johnston (1975: 211) pointed out that one of his informants reported that the scattered plots that existed in the Rangsit area prior to the canal construction were farmed by transplanting. After a modern irrigation scheme was completed in the Rangsit area in 1922, the Ministry of Agriculture continued to report that cultivators on the young delta practiced broadcasting despite the great availability of irrigation water.[18] In this sense, if the earlier water conditions in the Rangsit area were indeed the cause of broadcasting, the water improvement in the area in 1922 should have prompted farmers to adopt transplanting. Therefore, the choice of broadcasting in the area was not caused by local physical factors.

The explanation based on factor prices is inconsistent with empirical evidence regarding the dominant rice cultivation technique in various parts of Thailand during the period. As presented in section 1.3, transplanting was the dominant technique on the old delta and other regions of the country during the same period that broadcasting was dominant on the young delta. If the use of broadcasting on the young delta was dictated by factor prices, broadcasting should have also been observed on the old delta and other regions as well.[19] Evidence shows that the old delta became a commercial rice producing area a few decades before the young delta. Outer provinces began to participate in the rice trade in 1905 and gradually became important in terms of commercial rice production (Ingram 1971: 44-8). Yet, there was no evidence of changes in rice production techniques in these two area.

The explanation based on factor prices is not plausible even if a lag in the adoption of technique adoption is considered. In general, cultivators may adopt broadcasting during the early years of settlement and might change to a more intensive technique later, after accumulating some production surpluses. This pattern, however, does not apply here. Information presented in section 1.3 indicates that the majority of cultivators in the Rangsit area continued broadcasting rice for over forty years before reverting back to transplanting. There have been no reports of any gradual change to transplanting on the young delta before 1930. Indeed, most official reports on rice production in Rangsit at the time give an impression of the constant dominance of broadcasting over the period from 1890 to 1930.

Some investigators maintain that the practice of broadcasting on the young delta during 1890-1940 and the change to transplanting in the 1930s can be explained by using Boserup's (1965) model of agricultural development

(Hanks 1972: 65; Feeny 1982: 44-6,185) That is, an increase in population and the scarcity of land foster a change in technology. This interpretation is inconsistent with evidence from the Central Plain. Small (1975: 32) found no significant relation between population density and the percentage of area transplanted. In fact, Boserup's hypothesis is irrelevant to the case under investigation. Boserup discusses technological development in terms of technological improvement or technological growth. In Thailand, transplanting was the dominant rice cultivation technique on the Central Plain prior to 1890. Indeed, it has been the traditional rice growing method in Thailand at least since the seventeenth century. Therefore, the change from broadcasting to transplanting on the young delta in the 1930s cannot be interpreted as a process of technological development.

In brief, conventional reasons regarding the choice of rice production technique cannot explain the practice of broadcasting on the young delta during 1890-1940. This study proposes a more consistent explanation for this anomalous choice of technique, with special attention to the fact that the two techniques differ not only in terms of variable input per unit of land but also fixed capital input. An explanation incorporating both the theory of production and the theory of capital investment appears to be more satisfactory in explaining the choice of rice production technique. It takes into account the interdependence between "short-run" production decisions and "long-run" investment planning. In other words, the model will allow a simultaneous analysis of the firm's investment and production decision. A choice model will be developed in this study using this concept and applied to analyze the choice of broadcasting in Thailand during 1890-1940.

## 1.5 Organization of the Dissertation

This dissertation is organized into six chapters. Chapter II develops a simple model of choice of rice cultivation technique. The conditions necessary for the choice of broadcasting will be derived. This model will be used throughout this study as a framework in examining the choice of broadcasting technique in Thailand during 1890-1940. Chapters III through V will be devoted to empirical examinations of the model developed in Chapter II. Chapter VI summarizes and concludes the study.

# CHAPTER II

## ECONOMIC ANALYSIS OF CHOICE OF TECHNIQUE

In Chapter I it was explained that the two rice production techniques differ not only in terms of labor per unit of land but also fixed capital investments. In agriculture, most production processes require some fixed capital input if output is to be produced. This requirement constrains a firm's production flexibility after a decision on technique is made. The inflexibility arises because the physical plant or the stock of appliances of production are fixed and cannot be easily changed once installed.[1] In other words, the presence of a firm's fixed plant conflicts with its short-run profit maximization. It precludes full adaptability to changing amounts of variable factors. Thus, a firm's choice of technique cannot be solely analyzed using the production theory of firm. The concept of the theory of investment must be incorporated in order to allow a simultaneous analysis of a firm's decision on "short-run" profit maximization and "long-run" capital investment.

The need to incorporate the concept of the theory of investment into a choice model is crucial when a decision is made under uncertainty. When the future can be predicted with certainty and the market is competitive, a firm' s choice of technique is simply determined by trends in factor prices or the theory of production. Under perfect certainty, the firm's objective of short-run profit maximization is compatible with long-run profit maximization. Optimal fixed capital decisions can be made because the difference between actual and expected outputs is not anticipated to be very significant. Under uncertainty,

firms may need a flexible production plan. Therefore, a firm's optimal technique under uncertainty may be different from that under perfect certainty.

In this study, the analysis of a firm's choice of technique under uncertainty is examined in terms of two types of uncertainties. They are uncertainty associated with a firm's ownership of a fixed plant and uncertainty in prices. As will be shown later in this chapter, under uncertainty associated with a firm's ownership of a fixed plant, the firm may be better off by investing less. Under price uncertainty, a firm that needs frequent changes in its production plans may also choose to invest less. In this study, the lowering of a firm's investment results in a different choice of production technique. A technique with less fixed capital input represents a more flexible technique and provides the firm with a production optimum which varies through time instead of a stationary optimum as under perfect certainty.

The purpose of this chapter is to formulate a model to explain the observed choice of rice cultivation technique on the Central Plain of Thailand during 1890-1940. Section 2.1 describes inputs in traditional Thai rice production. This information will be used to specify a choice of technique model. Section 2.2 formulates a simple choice of technique model. Emphasis is placed on the firm's choice of technique under the two types of uncertainties outlined above. Section 2.3 summarizes the main results of the model and provides statements regarding conditions under which one should observe each of the rice production techniques. Throughout the analyses, the assumed goal of the firm is economic efficiency, or the subsumed narrower goal of profit maximization. The concepts of the theory of production and the theory of investment are combined to formulate the choice model, with marginal

productivity considerations applied to both the firm's investment decision and the problem of choosing the optimal production plan.

## 2.1 Inputs in Traditional Thai Rice Production

During the period under investigation, land, labor, draft animal, simple tools, and seed were the inputs for both transplanting and broadcasting.[2] No chemical fertilizer was used in rice cultivation (Ingram 1971: 64, A. KS 13/532). Manure was sometimes applied to seedbeds but was seldom used on paddy fields (Zimmerman 1931). Both techniques were characterized by very little mechanization. Almost all production processes, for example land clearing, ground levelling, field diking or bunding, ploughing, planting, weeding, trashing, winnowing, reaping, and irrigation were carried out with manual labor and animal power. Irrigation devices were very primitive and constructed with local materials by the farmers themselves. A variety of local devices for obtaining water from canals, streams, or lakes includes closely woven long handled baskets, buckets, and scoops. Noria worked by hand, or by treadmill or waterwheels was used in the Central Plain in the 1930s, but not to any large extent. Wooden "dragon bone" pumps operated by manpower came into use in the Central Plain in the early twentieth century. Propeller windmill gasoline engines were first used in Bangchan, a rice growing village some twenty miles northeast of Bangkok, in the 1940s.

Based on Janlekha's (1955) estimated average cost of paddy production from 104 sample farms for 1948, land rent and labor costs were the major farm costs under traditional Thai rice production. In transplanting, irrigation facilities represented the manifestation of labor used to create a stock of fixed capital (e.g., dikes and ditches). Hanks (1972: 62) estimated that the process of

building these irrigation facilities required more than 200 man-days for a typical family farm size. Other capital costs for both techniques, for example seed, tools and draft animals, shared only about 6 percent of total farm costs (Janlekha 1955: 140). Feeny (1982: 40-1) estimated these capital costs, in terms of the percentage of the value of annual paddy output of the average farm, and found that they represented a small proportion of the value of the annual farm output. In general, farmers provided their own seed and made most of the tools themselves, except knife blades and metal plow tips (Ingram 1971: 64, Yai S. Sanitwongse 1911). In the mid-nineteenth century, a complete plow cost 1.66 baht (Child 1892: 312). In 1910 a plow cost from 4-5 to 8-10 baht, depending on the wood used, and a metal tip cost only 25 satang, or a quarter of a baht (Yai S. Sanitwongse 1911: 2). Most farmers bought only the tip, which cost about 0.5 baht in 1930 (Zimmerman 1931: 145). Bullock carts cost about 120 baht in the 1920s and about 80 baht during the depression (NA. R7. PH. 13/5). In brief, the costs of tools to the farmers over the period 1880-1940 accounted for a fairly small portion of total production costs.

There was no significant change in the tools used over the period from 1850 to 1940 since contemporary descriptions of the tools and techniques used in the late nineteenth century were almost identical to those for the first half of the twentieth century. Therefore, one may conclude that there was no significant technical change in Thai rice production during the period under study.

## 2.2 A Simple Choice of Technique Model

The choice of technique model formulated below is a simple neoclassical production relation modified to incorporate fixed capital inputs and the firm's

planning horizon. The model differs from the usual production model in that it is a planning model which allows the firm to consider hypothetical alternatives. It is not a model showing changes in production conditions after the firm has already installed the fixed capital. The underlying assumptions include: (1) the firm is a price taker and produces only one homogeneous product--rice--and (2) there are no changes in known technology over the planning period. The two rice production functions express outputs as functions of two variable inputs--land and labor--and one durable capital input--irrigation facilities. The irrigation facilities are attached to the land, and the expected economic life of these irrigation facilities under proper maintenance is quite long. The variable inputs can be freely varied both at the start or during the production period, while the quantity of fixed capital input can be varied prior to installation but is costly to modify once installed. Furthermore, the level of output that can be produced varies directly with the physical quantity of fixed capital input.

The firm maximizes expected profit subject to a production constraint. Thus, the firm's choice of technique is determined by relative profit of the two rice production techniques and can be expressed as

$$COT = \Omega [E(\pi_T), E(\pi_B)] \tag{1}$$

where COT denotes choice of technique, E denotes expected value, $\pi$ denotes profit, T denotes the transplanting technique, and B denotes the broadcasting technique.

The firm's expected profit is expected total revenue minus expected total cost

$$E(\pi_i) = E(R_i - C_i) \tag{2}$$

where i is the transplanting technique (T) or the broadcasting technique (B), R denotes the firm's total revenue, and C denotes the firm's total cost. The two rice production functions are

$$y_i = f_i(x_{i1}, x_{i2}, X_{i3}), \text{ if } i = B \text{ then } X_{B3} = 0, \quad \text{if } i = T \text{ then } X_{T3} > 0 \tag{3}$$

where $x_{i1}$ = labor, $x_{i2}$ = land, $X_{i3}$ = capital input in the form of irrigation facilities. The above production relation shows that the rate of output depends on the level of variable inputs and the stock of capital. The expected total costs expressed in terms of input costs are

$$E(C_i) = E\left(w_1x_{i1} + w_2x_{i2} + \frac{rw_3X_{i3}}{(1 - e^{-rt})}\right), \text{ if } i = B \text{ then } X_3 = 0 \quad \text{if } i = T \text{ then } X_{T3} > 0 \tag{4}$$

where $w_1$ = wage, $w_2$ = land rent, $w_3$ = capital price, r = an instantaneous discounting rate for the total initial capital cost $w_3X_3$, and t denotes the firm's planning horizon and also the economic life of the durable capital input if transplanting is to be chosen. Let p denote product price, then, the expected profit functions become

$$E(\pi_i) = E(py_i - C_i) \tag{5}$$

Substituting equations (3) and (4) in equation (5) yields

$$E(\pi_i) = E\left[pf_i(x_{i1}, x_{i2}, X_{i3}) - w_1x_{i1} - w_2x_{i2} - \frac{rw_3X_{i3}}{(1 - e^{-rt})}\right. \tag{6}$$

Using equation (6) to determine the first-order conditions for profit maximization, the implicit equilibrium is

$$E(\pi_{i1}) = E(pf_{i1} - w_1) = 0$$

$$E(\pi_{i2}) = E(pf_{i2} - w_2) = 0$$

$$E(\pi_{i3}) = E\left[pf_{i3} - \frac{rw_3}{(1 - e^{-rt})}\right] = 0 \tag{7}$$

where $f_{i1} = \frac{\partial f_i}{\partial x_{i1}}$, $f_{i2} = \frac{\partial f_i}{\partial x_{i2}}$, and $f_{i3} = \frac{\partial f_i}{\partial X_{i3}}$,

The sufficient second-order conditions are

$$\Delta = \begin{vmatrix} -p\,f_{i11} & -p\,f_{i12} & -p\,f_{i13} \\ -p\,f_{i21} & -p\,f_{i22} & -p\,f_{i23} \\ -p\,f_{i31} & -p\,f_{i32} & -p\,f_{i33} \end{vmatrix} < 0$$

From equations (7), the marginal productivity conditions are

$$\frac{E(w_1)}{f_{i1}} = \frac{E(w_2)}{f_{i2}} = \frac{E\left(\frac{rw_3}{1 - e^{-rT}}\right)}{f_{i3}} = E(p) \tag{8}$$

Based on the implicit function theorem (see Silberberg 1978: 1340), the following explicit choice functions or the factor-demand curves associated with each technique can be solved from equation (7)

$$x_{i1} = x_{i1}^{*}\,[E(w_1, w_2, rw_3, t, p)]$$
$$x_{i2} = x_{i2}^{*}\,[(E(w_1, w_2, rw_3, t, p)]$$
$$X_{i3} = X_{i3}^{*}\,[E(w_1, w_2, rw_3, t, p)] \tag{9}$$

Substituting equations (9) into equations (6) and (1), the firm's choice of technique prior to the actual installation of $X_3$ is determined by expected factor prices, expected output price, and the firm's planning horizon as shown in the equation below.

$$COT = \Omega\,[E(p, w_1, w_2, rw_3, t)] \tag{10}$$

After the actual installation of $X_3$, $w_3X_3$ becomes a sunk cost and hence irrelevant to the firm's choice of technique. Therefore there is very limited or no

ex-post substitution between $X_3$ and the other inputs and the firm's choice of technique function is simply

$$COT = \Omega [E (p, w_1, w_2)] \tag{11}$$

Equations (10) and (11) are more than simple choice functions. They can be considered a simple general neoclassical model for choice of technique. Given some knowledge of the firm's expectations regarding trends in the parameters $p, w_1, w_2, r, w_3, t$, and the available set of techniques, the model can be applied to a wide range of problems. Institutional factors can also be added to the model as effects on prices

Recall that $X_3$ in the traditional Thai rice farming was mainly created by labor, therefore, if $w_1$ is used to approximate $rw_3$, equation (10) can be reduced to

$$COT = \Omega [E ( p, w_1, w_2, t)] \tag{12}$$

Given knowledge of the parameters $p, w_1, w_2, t$, and some additional assumptions, the firm's choice of rice cultivation technique can be predicted by using the above model.

### 2.2.1 Perfect Certainty and Choice of Technique

If the parameters $p, w_1, w_2$, and $t$, were known with certainty, the firm's optimal choice of technique or optimal factor proportions would be simply determined by trends in relative factor prices. From the principal of factor substitutions, at a given level of output, *ceteris paribus*, the lower the firm's expectation regarding the trend in $w_1$, the more $x_1$ and the less of its substitute is employed. If prior to the installation of the fixed capital input $X_3$, $x_1$ is Hicks-Allen substitute to $x_2$, that is $\frac{\partial x_1}{\partial w_2} = \frac{\partial x_2}{\partial w_1} < 0$, $x_2$ will fall if $w_1$ is expected to fall

in the near future. Therefore, under perfect certainty, if the $\frac{w_2}{w_1}$ rises over time, transplanting will be more likely to be the optimal technique since it requires less $x_2$ and more $x_1$ than the broadcasting technique, for a given level of output. However, if the $\frac{w_2}{w_1}$ decreases over time, broadcasting would be the optimal technique. This analysis applies to choice of technique both before and after the installation of $X_3$.

2.2.2 Uncertainty and Choice of Technique

As stated in the previous section, the analyses of uncertainty and choice of technique will be examined in terms of uncertainties in the parameters t and/or p.

(1) Uncertainty Associated with Ownership of Fixed Plant or Land

In this study, uncertainty regarding the parameter t, the expected economic life of a fixed plant, implies uncertainty regarding a firm's ownership in a fixed plant, or $w_3X_3$. Since a fixed plant is physically attached to the land $x_2$,, uncertainty in $x_2$ will have the same effect as uncertainty in $w_3X_3$. Uncertainty in the ownership of $w_3X_3$ or $x_2$ can arise from several factors. A negative institutional environment, i.e., rules and organizations may bring about an inefficient system of private land ownership and risks in land investment or both. This type of uncertainty may lead firms to shorten their planning horizons and consequently favor a technique which requires less fixed capital input. To the extent that one can attribute short horizons to uncertainty, it can be argued that the greater the uncertainty of all the firm's expectations and, indeed, the firm's expected life, the smaller will be the firm's investment in durable capital inputs. Optimal choice of technique under uncertainty dictates a relatively

greater use of variable inputs. Under this reasoning, broadcasting would be the optimal technique if the firm faces uncertainty regarding its ownership in the fixed plant or land.

In the above model, the amortized cost of the fixed plant for transplanting at each point of time in the planning period t is $\frac{rw_3X_3}{(1 - e^{-rt})}$. If the firm's planning horizon is short, transplanting would not be the optimum choice, since the expected cost of the fixed plant for each sub-period rises and become as large as $w_3X_3$ as t approaches one. Table 2.1 demonstrates some possible values for $\frac{rw_3X_3}{(1 - e^{-rt})}$ in corresponding to different values of t. Let $\frac{rw_3X_3}{(1 - e^{-rt})} = ¶$, $w_3X_3 = 1$, and $r = 0.1$.

Table 2.1

Possible Values for Capital with Respect to Planning Horizon

| Planning horizon (t) | Capital (¶) |
|---|---|
| 1 | 1.0508 |
| 2 | 0.5516 |
| 3 | 0.3858 |
| 4 | 0.3033 |
| 5 | 0.2541 |
| 10 | 0.1582 |
| 20 | 0.1156 |
| 30 | 0.1052 |
| 40 | 0.1018 |
| 50 | 0.1006 |

Therefore, as t approaches one, the greater is the amortized cost of the fixed capital input to the firm and the less likely that the firm will choose transplanting. Because the parameter t enters only one in the third first-order condition of the profit maximization model, the sign of the comparative statics relation $\frac{\partial X_3^*}{\partial t}$ is implied by the above model. In other words, it is possible to prove the postulate that the response of the fixed capital input to a change in the length of the firm's planning horizon is positive or $\frac{\partial X_3^*}{\partial t} > 0$. This result is known as Samuelson's Correspondence Principle (see Samuelson [1953: 5, 258] and Silberberg [1978: 134]). Therefore, the shorter the horizon, the smaller the fixed capital input and the higher the level of substitute input.

(2) Price Uncertainty

Price uncertainty refers to the inability of a firm to predict the price of a product. Uncertainty of this sort implies demand and supply variations. But variation alone does not imply uncertainty, for although price may vary, the firm may be able to predict the variation. Thus, there may be price variation but no uncertainty. For there to be price uncertainty, the firm's ability to explain and predict the variation must be less than perfect. In the standard treatments of economic behavior under uncertainty, it usually is assumed that the ability to make such predictions is nil (see Mills 1959).

Since under price uncertainty the outcomes are multi-valued, the firm now faces decisions regarding (1) the selection of the best short-run operating procedures, including operating inputs, and (2) the determination of the optimal level of investment in durable inputs. If the firm anticipates frequent changes in its production plan, it will plan for production flexibility in such a manner which minimizes costs. Production flexibility here refers to a technique which will

allow the firm to alter its planned output with minimum cost should the need arise.

Stigler (1939) and Hart (1940) recognize that a firm's choice of technique is dependent on expected fluctuations in output. Stigler (1939: 316) argues that under demand uncertainty, firms are willing to concede relatively higher costs for levels of output near capacity output (the minimum point on the average cost curve) in order to obtain relatively lower costs as output departs from capacity output. He suggests two ways in which a firm can make its production plan more flexible under demand uncertainty. The first is based on the divisibility of a fixed plant which will reduce costs at sub-optimum outputs. The second method is to reduce fixed plant costs relative to variable costs, i.e., to transform fixed costs into variable costs. The first method is used when fixed plant is indispensable. The second is used when fixed plant is more or less optional.

The broadcasting technique in this study falls in Stigler's second method of making the production plan more flexible. Broadcasting can be seen as a more flexible technique relative to transplanting since broadcasting requires less durable capital inputs. Therefore, under price uncertainty, broadcasting would be the optimum technique for firms that need a flexible production plan. Were it not for the flexible technique chosen, outputs in excess of the optimum would involve prohibitive marginal costs, while those at less than optimum outputs would be very unprofitable. In the short-run, fixed costs are independent of output, they do not change in magnitude as the amount of the production process changes and are incurred even when production is not undertaken. Under price uncertainty, broadcasting would be optimum through time, i.e., it is a strategy based on expected increases or decreases in outputs.

Following Stigler (1939), Marschak and Nelson (1962) and later Tisdell (1963) defined flexibility rigorously as the reciprocal of the slope of the marginal cost curve, evaluated at the point of minimum average cost curve. That is flexibility is greater when marginal costs rise gently and average costs are flat near their minimum point. They demonstrate this with a quadratic cost curve.

Let the firm's total cost be expressed in terms of output

$$C = ay^2 + by + K \tag{13}$$

The marginal cost curve is

$$MC = 2ay + b \tag{14}$$

The rate of change of the marginal cost curve

$$MC' = 2a \tag{15}$$

The average cost

$$AC = ay + b + \frac{K}{y}$$

The slope of the average cost curve

$$AC' = a - \frac{K}{y^2}$$

At the minimum point of the average cost curve or at the point where AC'=0,

$$K = ay^{*2} \tag{16}$$

The rate of change of the slope of the average cost curve is

$$AC'' = \frac{2K}{y^3} \tag{17}$$

To compare average cost curves which reach their minima at the output y*, substitute equation (16) in equation (17), so that

$$AC'' = \frac{2a}{y^*}$$

Therefore, as a approaches zero, the flatter the average cost curve becomes. Let the subscript F denote the flexible technique and S denote the specialized technique. The definition of flexibility is $| dAC_S | > | dAC_F |$ or $a_S > a_F$ or $MC'_S > MC'_F$ at minimum AC. If transplanting and broadcasting are compared on the basis of flexibility, it follows that $| dAC_T | > | dAC_B |$ or $a_T > a_B$ or $MC'_T > MC'_B$. That is, broadcasting is more flexible than the transplanting technique. The concept of flexibility in technique can be expressed with the aid of two average cost curves as shown in Figure 2.1.

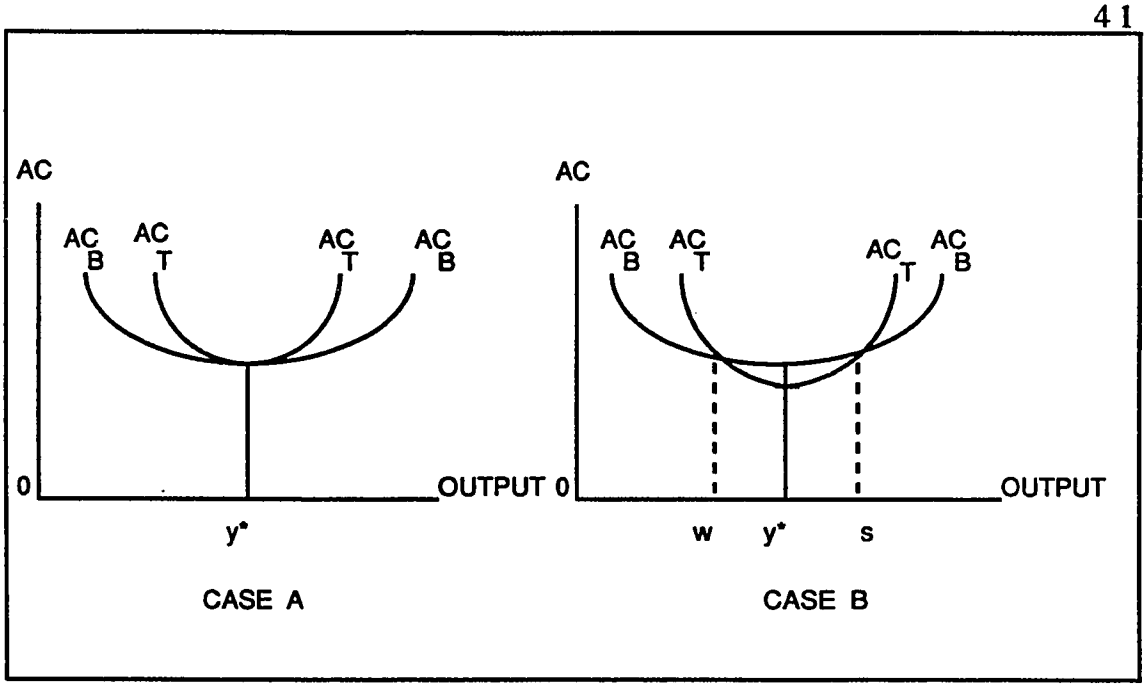



Figure 2.1 Flexibility of Technique Measured by the Flatness of the Bottom of Average Cost Curve

The average cost curve of the flexible technique, or broadcasting (ACB), has a flatter bottom than that of the specialized technique, or transplanting (ACT). For case A, ACT = ACB at output y*. Therefore, the firm is indifferent between the two technique under perfect certainty, but broadcasting is more profitable under price uncertainty. For case B, ACT < ACB at output y*. The greater is the difference in the flatness between the bottoms of the two average cost curves, the smaller is the range ws and the higher the cost of varying output under the transplanting technique. Notice that Stigler's (1939) analysis of flexibility refers to case B where the specialized technique is the least cost technique. For case B, the firm will choose transplanting under perfect certainty. Under price uncertainty, the firm may still choose transplanting if output is

expected to fall within the range ws. This condition describes firms which are operating under short-run land constraint, for example small owner-operators. But if the firm expects that outputs will usually lie outside range ws, it may choose broadcasting. Firms which have large landholdings or excess land and firms which have the ability to add or subtract land over the short run with little cost, for example tenant farmers in the newly developed areas, are two types of firms that are more likely to choose broadcasting. While this means higher costs if the original output plan is expected to be almost stationary, it means better profit prospects if there is a high probability of producing output outside the range ws. This is graphically illustrated in Figures 2.2 and 2.3.

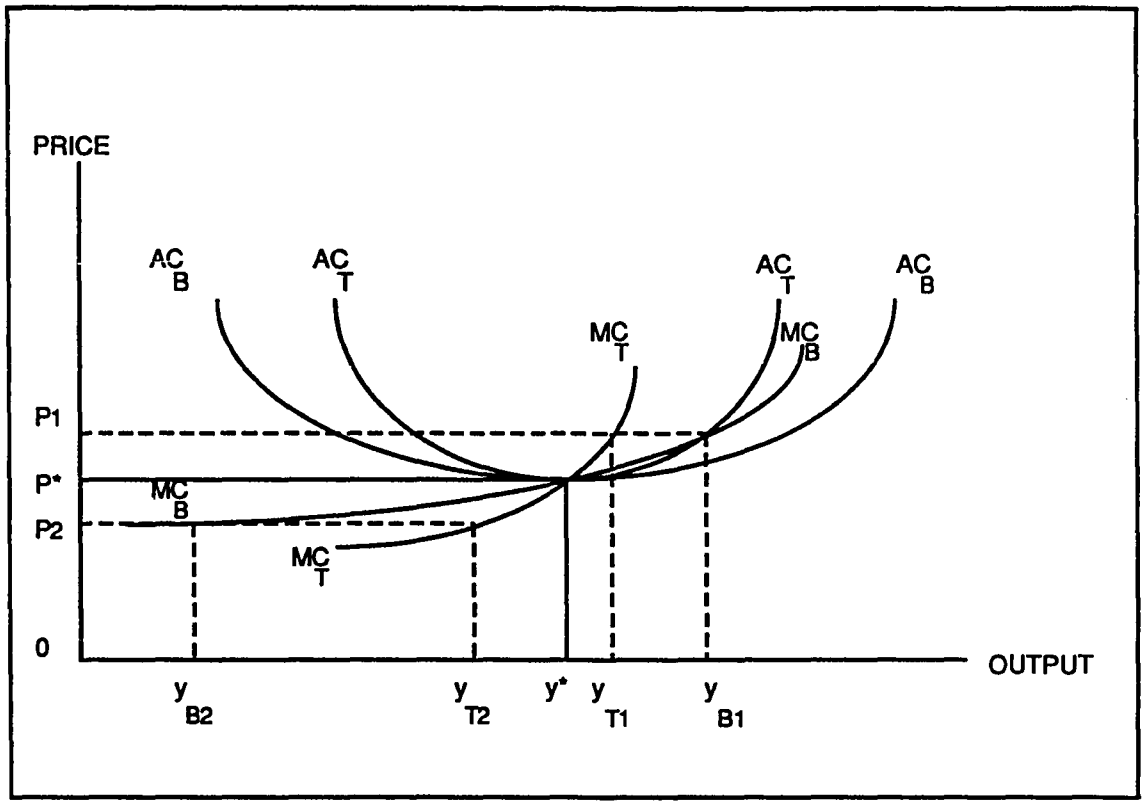



Figure 2.2 Relative Profitability of Transplanting and Broadcasting Techniques under Competition and $AC_T = AC_B$

Figure 2.2 corresponds to case A in Figure 2.1. That is $AC_T = AC_B$ at output $y^*$. Let L denote the firm's loss and $\pi$ denote the firm's profit and assume that the firm produces such that P = MC. The following conditions follow:

At $P^*$, $\pi_B = \pi_T$ , output at $y^*$ for both techniques.

At $P_1$ , $\pi_B > \pi_T$, output $y_{T1}$ for transplanting and output $y_{B1}$ for broadcasting.

At $P_2$ , $L_B < L_T$, output $y_{T2}$ for transplanting and output $y_{B2}$ for broadcasting.

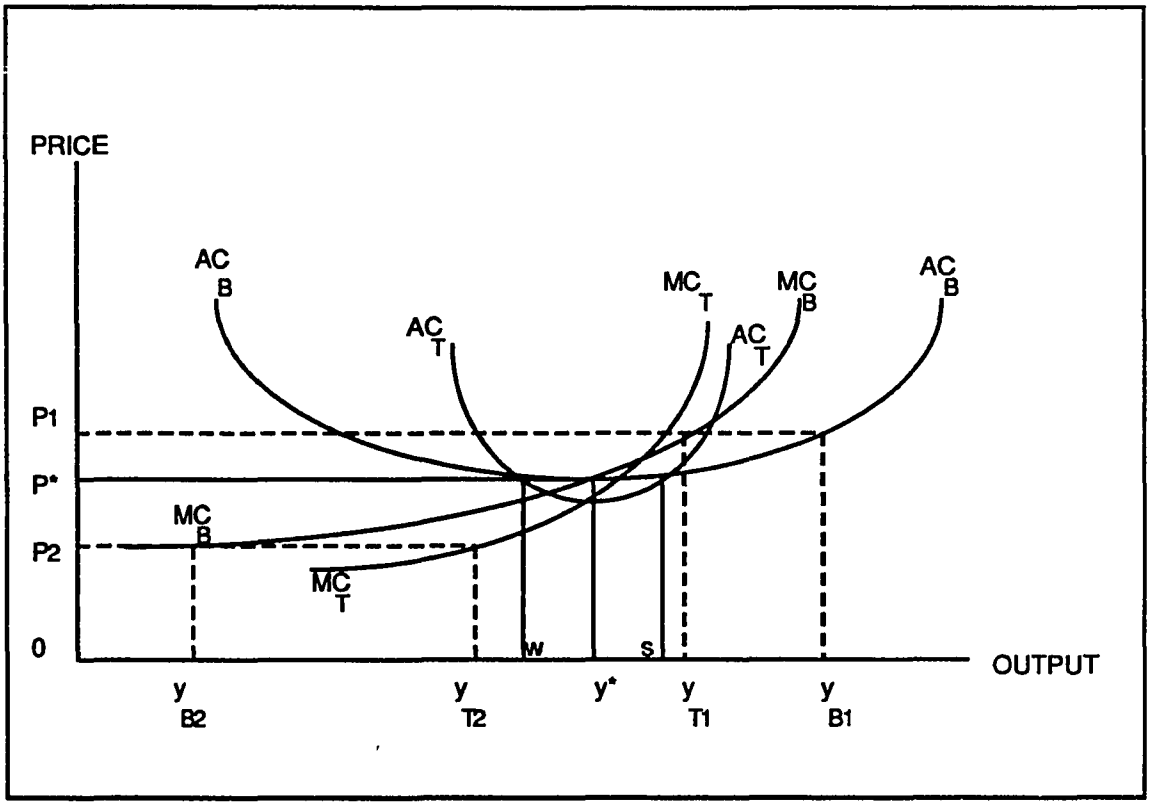



Figure 2.3 Relative Profitability of Transplanting and Broadcasting Techniques under Competition and $AC_B > AC_T$

Figure 2.3 corresponds to case B in Figure 2.1. That is $AC_B > AC_T$ at capacity output y*. The following conditions follow:

At P between P* and P less than minimum $AC_B$, transplanting is the least cost technique.

At $P_1$ , $\pi_B > \pi_T$, output $y_{T1}$ for transplanting and output $y_{B1}$ for broadcasting.

At $P_2$ , $L_B < L_T$, output $y_{T2}$ for transplanting and output $y_{B2}$ for broadcasting.

Therefore, if $AC_B > AC_T$ at capacity output y*, $\pi_B > \pi_T$ for outputs outside the ws range. Under price uncertainty it is possible that broadcasting

will be more profitable for firms that frequently produce output outside the ws range. Using Marschak and Nelson's (1962) measurement of flexibility, the postulate that the flexible technique or broadcasting is more profitable under a certain magnitude of price uncertainty is demonstrated below.

To make the analysis simple, assume that price P which is a random variable is always greater than b, so that optimum output is strictly positive. For a competitive market and from equation (13),

$$P = MC = 2ay + b$$
$$y = \frac{P-b}{2a} \tag{18}$$

The firm's maximum profit at price P expressed in terms of output y can be written as

$$\pi(P) = Py - C(y) \tag{19}$$

Substituting equations (13) and (18) in equation (19),

$$\begin{aligned}
\pi(P) &= P\left(\frac{P-b}{2a}\right) - a\left(\frac{P-b}{2a}\right)^2 - b\left(\frac{P-b}{2a}\right) - K \\
&= P\left(\frac{P-b}{2a}\right) - b\left(\frac{P-b}{2a}\right) - \left(\frac{(P-b)^2}{4a}\right) - K \\
&= \frac{(P-b)^2}{2a} - \frac{(P-b)^2}{4a} - K \\
&= \frac{(P-b)^2}{4a} - K
\end{aligned}$$

Then, expected profit is given by

$$\begin{aligned}
E[\pi(P)] &= E\left(\frac{(P-b)^2}{4a} - K\right) \\
&= \frac{1}{4a}[E(P-b)^2] - K \\
&= \frac{1}{4a}[E(P^2 - 2Pb + b^2)] - K
\end{aligned}$$

Let $\mu$ be the mean of the random price P,

$$
\begin{aligned}
E[\pi(P)] &= \frac{1}{4a}[E(P^2 - \mu^2 + \mu^2 - 2Pb + b^2)] - K \\
&= \frac{1}{4a}[E(P^2 - \mu^2) + E(\mu^2 - 2Pb + b^2)] - K \\
&= \frac{1}{4a}[E(P^2) - E(\mu^2) + (\mu - b)^2] - K
\end{aligned}
$$

Let $V_p$ be the variance of the random price P,

$$
\begin{aligned}
E[\pi(P)] &= \frac{1}{4a} V_p + \frac{1}{4a}(\mu - b)^2 - K \\
&= \frac{1}{4a} V_p + [\frac{1}{4a}(\mu - b)^2 - K] \\
&= \frac{1}{4a} V_p + \pi(\mu) \qquad (20)
\end{aligned}
$$

In the above equation "a" is a measure of flexibility in the Stigler sense while $V_p$ is a measure of price uncertainty. Let $\mu$ remain constant. Then, if $V_p = 0$, that is, there is no price variability, expected profits will be the same for both techniques.[3] That is, the firm is indifferent between the two techniques, as illustrated by case A in Figure 2.1. If $V_p$ is large, the probability that output will lie outside the range ws increases. The expected profit for the broadcasting technique rises as $V_p$ increases relative to the expected profit under the transplanting technique. That is, $E\pi_B > E\pi_T$ for a sufficiently large $V_p$.

Therefore, if the plant is to be used many times and the firm expects a large $V_p$ at the time the plant purchase decision is made, the value of flexibility will be great. If the plant is to be used only once and the decision maker does not know what prices will be like in the future, he can improve his output decision as time approaches the next crop season. In other words, flexibility is more valuable the greater the variance of price P. Note that price uncertainty is a function only of the variance of prices, not the mean. If the mean were higher, then on the average the firm would make higher profits; but the expected

difference between what it can earn, given uncertainty, and what it could earn if the price is certain, is the same for a high mean as for a low mean. Equation (20) also implies that the cost of price uncertainty to the firm, as measured by $V_p$, is small if the slope of the marginal cost curve of the firm is flat, i.e., "a" is small. Similarly, the cost of price uncertainty to the firm is large if the firm's marginal cost curve is steep, i.e., "a" is large. Also, as $V_p$, a measure of the fluctuations in demand, increases, the greater the chance that the firm will adopt the more flexible technique or broadcasting since the difference in the minimum average cost curves will be greater. In other words, if the marginal cost curve is flat, then output can diverge more from planned output. A flatter average cost curve around its minimum point implies small change in per unit costs as output diverges from planned output.

Tisdell (1968) examines some of the effects of price uncertainty under pure competition on production and profit and reached the same conclusion. That is, increased price variability tends to favor techniques which involve the least rate of change in marginal costs. The relevance of the above concept to the behavior of firms in an industry operating under conditions of demand uncertainty is also the subject of papers by Nelson (1959), Tisdell (1963), Sheshinski and Dreze (1976), and Mills (1981). Sheshinski and Dreze (1976) also show that, for a constant number of firms, expected profits increase with increases of either $V_p$ or $\mu$. Garrod and Miklius (1984) apply the theory to explain the existence of owner-operators in the motor carrier industry. They demonstrated that the use of owner-operator trucks by trucking firms is a flexible technique and is indeed optimal when firms face a fluctuating demand for their service in the Stigler sense. A similar result is reached by Pindyck (1988). He shows that uncertainty over future market conditions, for example when random

product demand shifts each period, affect irreversible investment decisions. He found that in markets with volatile and unpredictable demand, firms will hold less capacity than they would if investment were reversible or future demand was known. A technique with less irreversible capital input allows the firm to alter its production plan under price uncertainty. Vercelli (1989) also maintains that an increase in structural uncertainty increase the economic value of flexibility.

The above framework can be extended if the relationship between the control unit (the firm) and the productive unit (the plant) is relaxed. Note that the analyses of Stigler (1939), Marschak and Nelson (1962), Pindyck (1988), and Tisdell (1963, 1968) are all based on the assumption that a firm can select only one technique in each planning period or the firm and the plant are assumed to be one and the same. This is the assumption of fixed management ability among firms. In circumstances where fixed plants are divisible and techniques are technically compatible, some firms may employ both techniques concurrently in one planning period. The firm may assume price certainty and use the specialized technique. At another plant, it can assume price uncertainty and adopt the flexible technique. Technical compatibility between techniques is defined as the capability of two or more techniques existing together in mutually exclusively. For the two rice cultivation techniques, it is a technical fact that water controls used in transplanting, to bring about higher and better yields, cannot be done effectively if the plot is adjacent to a broadcasted field. Therefore, even if a transplanted field can be divided into a number of small plots using bunds, only one technique can be practiced in the same field or area. However, a firm with superior management ability may own a small plot in

the transplanted zone and rent a broadcasted plot in another area whenever it wants to increase output.

A firm which concurrently employs two techniques can increase expected profits. This can be demonstrated by showing that the cost of using broadcasting at output levels other than the planned output is lower than using the transplanting technique. Assume that the cost functions of a rice producing firm are additively separable and can be divided into three components: (1) a fixed cost component F (tools, draft animal) which is assumed to be identical for both techniques, (2) a labor cost component V (planting and harvesting), and (3) a cost component related to owning and operating the transplanted plot I. Further, assume that both V and I for capacity output $y^*$ of the two techniques are strictly increasing functions with positive first and second derivatives with respect to y. Let p denote the output price that is higher than the minimum point on the average cost curve of the broadcasting technique. The subscripts T and B denote transplanting and broadcasting techniques, respectively. Output y is a function of price p and b is the proportion of revenues paid to the owner of the broadcasting land as land rent.

The total cost of using the transplanting technique at output other than the capacity output $y^*$,

$$C_T = F_T + V_T(y) + I_T(y)$$

with marginal cost function

$$MC_T = V_T'(y) + I_T'(y)$$

and the rate of change in the slope of the marginal cost curve

$$MC_T' = V_T''(y) + I_T''(y) \tag{21}$$

The total cost of using the broadcasting technique can be written as

$$C_B = F_B + V_B(y) + bpy$$

with marginal cost function

$$MC_B = V_B'(y) + bp$$

and the rate of change in the slope of the marginal cost curve

$$MC_B' = V_B''(y) \tag{22}$$

In general, for a given level of output, the labor requirements of the transplanting technique is higher than that of the broadcasting technique (see Chapter I, Table 1.1). That is, $V_T''(y) > V_B''(y)$. Assume that $V_T''(y) = V_B''(y)$ for a given level of output, from equations (22) and (23), it follows that

$$MC_T' > MC_B' \quad \text{or} \quad C_T < C_B \tag{23}$$

Equation (24) implies the result in equation (20). In other words, given the divisibility of transplanting and the compatibility of transplanting and broadcasting, expected profit is higher for the firm using both techniques concurrently.

## 2.3 Summary

The simple choice of technique model formulated in this chapter yields refutable hypotheses regarding a firm's choice of rice cultivation technique. A refutable proposition is asserted because under assumed test conditions, the model has logical valid predictions about real and observable events. In other words, the choice model formulated in this chapter can be tested theoretically on the basis of changes in variables when certain test conditions or assumptions change. The model predicts that if the future is certain and the

market is competitive, a firm's choice of technique is simply determined by trends in factor prices. Under certainty, the fixed plant is expected to be secure or run at a given rate of output most of the time during its expected economic life. Therefore, the firm's objective of short-run profit maximization is identical to the objective of profit maximization on its fixed capital investment. When the future is uncertain, the firm's choice of technique may be different. If firms face uncertainty regarding ownership in a fixed plant or land, a technique which incurs less fixed capital input such as broadcasting would be the optimal choice. Under price uncertainty, firms may also choose broadcasting if they anticipate the need for frequent changes in their future production plans. A less capital intensive technique (broadcasting) provides for greater production flexibility and, consequently, higher profits. This condition may apply to two types of firms: (1) firms that have large landholding or excess land, and (2) firms that are able to add or subtract their land in the short run with little cost, for example tenant farmers in the newly developed areas. However, under price uncertainty, firms which expect to vary output within a limited range may still choose transplanting. This condition may apply to firms which have land constraints (in the short run), for example, small owner operators in a transplanted area.

In brief, three conditions which may lead to the choice of broadcasting are: (1) an increase in trend in wages with respect to land prices or land rents, (2) uncertainty associated with the firm's ownership in a fixed plant or land, and (3) uncertainty in prices. To substantiate and confirm these theoretical constructs, the existence and extent of these three conditions in Thailand during the period 1890-1940 will be examined in subsequent chapters.

# CHAPTER III

## TRENDS IN FACTOR PRICES AND CHOICE OF TECHNIQUE

The analysis in Chapter II concludes that there are three conditions which may lead to the choice of broadcasting. They are: (1) an increase in trend in wages with respect to land prices or land rents, (2) uncertainty associated with the firm's ownership in a fixed plant or land, and (3) uncertainty in prices. The purpose of this chapter is to examine whether the first condition was the cause of the choice of broadcasting in Thailand during 1890-1940. In section 3.1, the importance of rice in the Thai economy during the period under study is discussed. This information is presented to justify the use of rice price as a deflator for factor prices in the subsequent section. Section 3.2 examines the trends in factor prices in both absolute and relative terms. Section 3.3 summarizes the main results of the chapter.

The reliability of the data used in this study has been questioned and examined by a number of investigators (see Feeny [1982: 25, 151]; Ingram [1971]; and Behrman [1968]). The foreign trade data are considered to be relatively accurate since export taxes were collected in Bangkok. The city was the major port for overseas trade through which over 85 per cent of the value of trade flowed (Central Statistical Office 11: 159). In addition, Bangkok shipments probably accounted for about 95 to 99 percent of total rice exports (Ingram 1971: 40). For other series of data, conclusions reached by most investigators are that they appear to be accurate indicators of trends. In this study, most of the data are used to show the trends, and therefore the reliability problem should be overcome.

## 3.1 The Importance of Rice in Thailand, 1856-1941

The importance of rice exports to the Thai economy during the period under study has been extensively investigated by a number of investigators.[1] Conclusions reached by most investigators are that rice was the main staple of the Thai diet and the principal crop of Thailand prior to the middle of the nineteenth century. After the country was opened to international trade in 1856, the increase in the foreign demand for rice led to a rapid expansion in rice production and an impressive growth in rice exports. A summary of the increase in quantity and value of rice exports from 1857 to 1941 is shown in Table 3.1. Details are provided in Appendix Table 1. Export volume peaked at over 2 million metric tons in 1934. It increased more than thirty-seven-fold, from about 54 thousand metric tons in 1857 to over two thousand metric tons in 1934. The value of rice exports also increased rapidly over most of the period due to the increase in rice prices. Although there is considerable year-to-year variation in exports, the trend over the whole period is clearly upwards. The average annual rates of growth of the quantity (1857-1941 and value of rice exports (1864-1941) calculated using a five-year-moving average are 4.1 and 5.1, respectively.

Table 3.1

Quantity and Value of Rice Exports, 1857-1941

| Year | Quantity (1,000 per metric tons) | Index (1857=100) | Value (millions of baht) | Index (1857=100) | Price (baht per metric tons) | Index (1857=100) |
|---|---|---|---|---|---|---|
| 1857 | 54.4 | 100 | 1.6[a] | 100 | 20.0[a] | 100 |
| 1864 | 145.2 | 267 | 7.3 | 456 | 50.3 | 252 |
| 1870 | 156.0 | 287 | 6.5 | 408 | 41.8 | 209 |
| 1880 | 208.7 | 384 | 9.8 | 611 | 46.9 | 235 |
| 1890 | 489.3 | 899 | 25.1 | 1,568 | 51.3 | 257 |
| 1900 | 421.5 | 775 | 37.5 | 2,344 | 89.0 | 445 |
| 1910 | 1,063.8 | 1,956 | 91.1 | 5,691 | 85.6 | 428 |
| 1920 | 284.9 | 524 | 29.2 | 1,826 | 102.6 | 513 |
| 1930 | 1,034.8 | 1,902 | 103.1 | 6,442 | 99.6 | 498 |
| 1940 | 1,219.3 | 2,241 | 93.6 | 5,848 | 76.7 | 384 |
| 1941 | 1,173.3 | 2,157 | 148.8 | 9,300 | 126.8 | 634 |

[a] Value of the year 1850.

Source: Appendix Table 1.

The increase in rice prices was the most important economic incentive for the expansion in rice production and exports.[2] Using a five-year-moving average, average annual rates of change of rice prices are calculated for various sub-periods and shown in Table 3.2.

Table 3.2

Average Annual Rates of Change in Rice Prices, 1864-1941

| Period | Average annual rates of change in rice prices |
|---|---|
| 1864-1941 | 0.98 |
| 1864-1890 | 0.16 |
| 1890-1900 | 5.66 |
| 1900-1915 | 0.04 |
| 1915-1930 | 2.54 |
| 1931-1941 | -1.94 |

Source: Computed from the data on rice prices in Appendix Table 1.

As shown in Table 3.2, the trend in prices over the whole period is upwards. Prices grew at an average annual rates of about 1 percent over the period covered. Prices fluctuated throughout the period as shown by their large differences in average annual rates of change between sub-periods. Prices rose drastically during 1890-1900, the period in which rice production expanded rapidly into the young delta and *na suan* broadcasting was first practiced there.

The growth in rice exports increased the dominance of rice in the Thai economy. Rice became the most important export commodity in addition to being the staple of the Thai diet. Its cultivation rapidly expanded throughout the period. Ingram (1971) shows that about 80-90 percent of the total labor force

during 1929-1947 was engaged mainly in rice farming (p. 57). The area planted in crops other than rice accounted for less than 5 percent of the total cultivated area throughout the period from 1911 to 1948 (p. 50). The area under paddy cultivation increased along with the growth of rice exports during the period. The area planted in paddy increased more than four-fold during 1850-1941: from about 928 thousand hectares in 1850 to 3,969 thousand hectares in 1941 (p. 43). The proportion exported increased from about 5 percent of total production in 1850 to about 50 percent in 1907-09. During the period from 1907 to 1940, rice exports averaged between 40 and 50 percent of total rice production (p. 52). Rice exports also accounted for about 60 to 70 percent of the country's total export (p. 94). During the period under examination, export rice production was concentrated on the Central Plain of Thailand. Van de Heide (1906: 77-80) indicates that about 98 percent of the total 879 thousand metric tons of exported rice in 1905 was produced there. Ingram (Ingram 1971: 44-48) also notes that during 1905-09, about 74 percent of the total paddy area planted in Thailand was on the Central Plain. After 1905 other regions increasingly began to contribute to the total rice exports of Thailand. Nevertheless, the Central Plain remained the major source of exports.

## 3.2 Trends in Factor Prices, 1850-1941

### 3.2.1 Trend in Wages, 1850-1941

There are some early data on wages of urban unskilled labor from Bangkok and official wage data for the twentieth century period. These two series of nominal data are spliced together and shown in Table 3.3 along with

the constructed real wage series for the period 1850-1941. The real wage rate is the rice equivalent of the money wage rate, i.e., the kilograms of rice that could be purchased with the daily money wage. Since rice was the most important component of the Thai economy, changes in the rice-wage rate provided a crude approximation of changes in the 'real wage' during the period. Furthermore rice was the largest single item of consumption. Therefore, in large measure, the price of rice determined saving rates and consumption of other goods.[3] The real wage rate is shown graphically in Figure 3.1.

Table 3.3

Nominal and Real Wages in Terms of Rice for Unskilled Laborers in Bangkok, 1850-1941

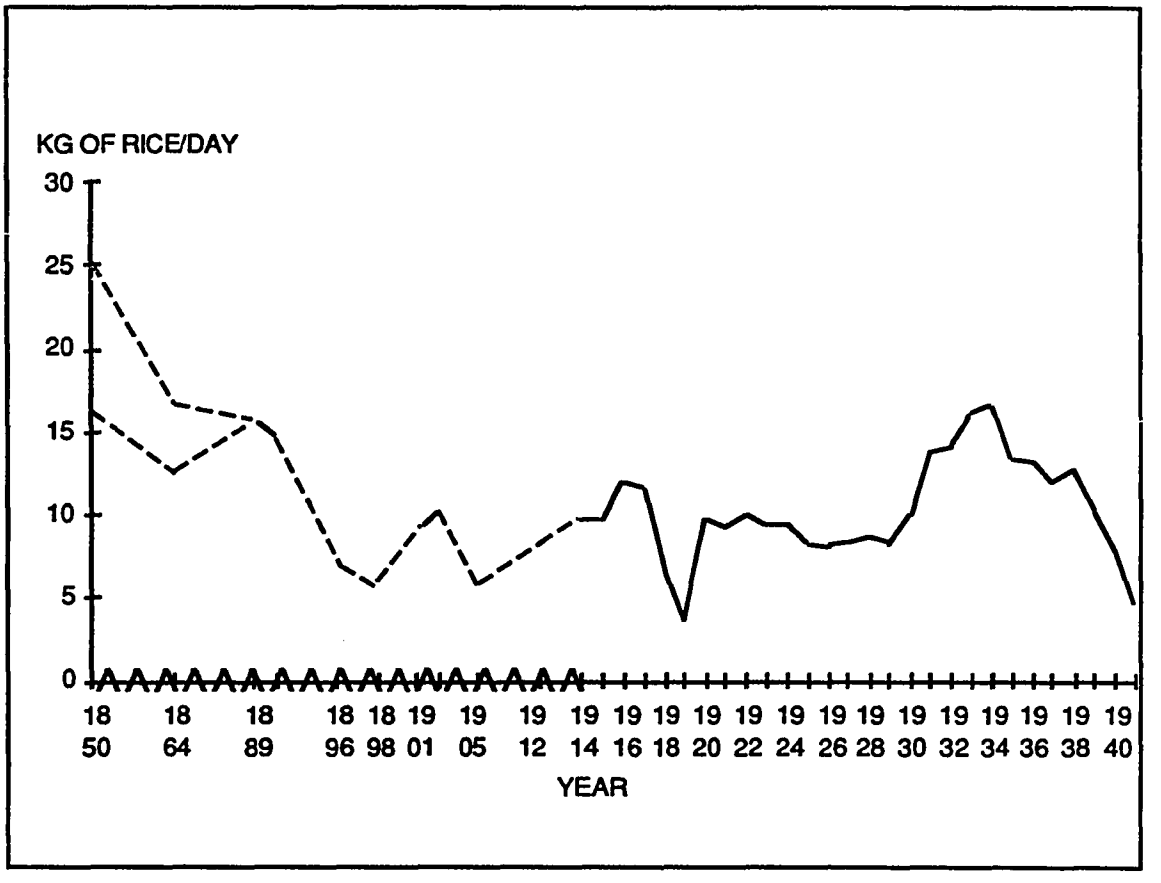
| Year | Nominal wage (baht per day) | Index (1864=100) | Real wage (kg of rice per) daily wage) | Index (1864=100) |
|---|---|---|---|---|
| 1850 | 0.3-0.5 | 60 | 16.2-25.2 | 148 |
| 1864 | 0.6-0.8 | 100 | 12.0-16.2 | 100 |
| 1889 | 0.8 | 107 | 16.0 | 115 |
| 1890 | 0.8 | 107 | 14.6 | 105 |
| 1896 | 0.5 | 71 | 6.8 | 49 |
| 1898 | 0.5 | 71 | 6.0 | 43 |
| 1901 | 0.8 | 119 | 9.6 | 69 |
| 1902 | 0.9 | 125 | 10.2 | 73 |
| 1905 | 0.5 | 71 | 5.3 | 38 |
| 1912 | 0.9 | 125 | 8.0 | 58 |
| 1914 | 0.8 | 107 | 9.8 | 70 |
| 1915 | 0.8 | 107 | 9.7 | 70 |
| 1916 | 1.0 | 143 | 12.0 | 86 |
| 1917 | 1.0 | 143 | 11.6 | 83 |
| 1918 | 1.0 | 143 | 6.5 | 47 |
| 1919 | 1.0 | 143 | 3.6 | 26 |
| 1920 | 1.0 | 143 | 9.7 | 70 |
| 1921 | 1.0 | 143 | 9.3 | 67 |
| 1922 | 1.0 | 143 | 10.1 | 73 |
| 1923 | 1.0 | 143 | 9.4 | 67 |
| 1924 | 1.1 | 160 | 9.4 | 68 |
| 1925 | 1.0 | 143 | 8.3 | 60 |
| 1926 | 1.0 | 143 | 8.0 | 57 |
| 1927 | 1.0 | 143 | 8.6 | 62 |
| 1928 | 1.0 | 143 | 8.5 | 61 |

Table 3.3 (Continued)

| Year | Nominal wage (baht per day) | Index (1864=100) | Real wage (kg of rice per) daily wage) | Index (1864=100) |
|---|---|---|---|---|
| 1929 | 1.0 | 143 | 8.2 | 59 |
| 1930 | 1.0 | 143 | 10.0 | 72 |
| 1931 | 0.8 | 114 | 13.9 | 100 |
| 1932 | 0.8 | 114 | 14.3 | 103 |
| 1933 | 0.8 | 114 | 16.2 | 116 |
| 1934 | 0.8 | 114 | 16.6 | 119 |
| 1935 | 0.8 | 114 | 13.3 | 96 |
| 1936 | 0.8 | 114 | 13.1 | 94 |
| 1937 | 0.8 | 114 | 11.8 | 85 |
| 1938 | 0.8 | 114 | 12.9 | 93 |
| 1939 | 0.6 | 87 | 10.3 | 74 |
| 1940 | 0.6 | 86 | 7.8 | 56 |
| 1941 | 0.6 | 84 | 4.7 | 33 |

Note: The real wage rates are constructed by dividing the nominal wages by export rice prices. Figures of the nominal wages for 1939-1941 were extrapolates using the mean wage of the period 1915-1938.

Sources: See Appendix Tables 1 and 2 for data and sources of data for rice prices and wages, respectively.




Source: Table 3.3.

Figure 3.1 Real Wages in Terms of Rice for Unskilled Laborers in Bangkok, 1850-1941

As shown in Table 3.3, money wages tended to rise during 1850-1930 and declined during the depression of the 1930s. The rise and fall in money wages were quite sticky in both directions. The daily wage rates were between 0.5 to 0.8 baht during 1889-1915 and were between 0.8 to 1.0 baht during 1916-1938. The ratios of the nominal wages to rice prices, or real wages, showed considerable yearly fluctuation. Real wages decreased rapidly during 1850-1900, then fluctuated until 1931. Real wages rose during the 1930s due to the collapse of rice prices during the depression. This means the agricultural sector during the depression was even more depressed than the urban sector. After 1935, real wages declined sharply. Overall, the trend in real wages declined over most of the period from 1850-1941, especially during 1850-1900. This means the trend in real wages during the period studied moved in favor of the transplanting technique. The decrease in the real wages during in the late nineteenth century was corroborated by Price Narathip, the former Minister of Finance and an active entrepreneur at the time. He indicated in 1899 that rice prices were rising faster than wages (A. R5. KS. 9.2/25). The average annual rates of change in real wages for various sub-periods are calculated and shown in Table 3.4.

Table 3.4

Average Annual Rates of Change in Real Wages, 1850-1941

| Period | Average annual rates of change in real wages |
|---|---|
| 1850-1941 | -0.4 |
| 1850-1890 | -1.1 |
| 1890-1900 | -1.6 |
| 1900-1915 | 1.8 |
| 1915-1930 | -0.2 |
| 1931-1941 | 0.4 |

Source: Computed from the data on real wages in Table 3.3.

Ingram observes that labor markets during the period were quite competitive since there were no unions, no labor contract, and workers were hired and paid on a daily basis. Given the downward trend in the rice wage rates and the inflexible nominal wages for such a competitive labor market, it is unlikely that labor scarcity was a problem during the period 1850-1941. Undoubtedly, occasionally annual fluctuations in the demand and supply of agricultural labor services may occur since rice prices fluctuated and rice was almost the sole source of money income during the period. The fluctuation of the rice wage rates shown in Tables 3.3, 3.4, and Figure 3.1 support this conclusion. Contemporary reports regarding the high demand for labor in Rangsit and other commercialized districts during the 1900s and 1920s also

corroborate this conclusion.[4] Ingram concludes that previous writers have been misled by occasionally reports on the high demand for labor and have erroneously concluded that wage labor was an increasingly attractive alternative in the period (Ingram 1964: 112-3).

The wage data shown in Table 3.3 are for unskilled workers in Bangkok but are probably reasonably representative of other wage series for two reasons. First, the available information on rural wages shown in Table 3.5 indicates a relatively stable relationship with urban unskilled wages. Second, qualitative information points to a considerable degree of labor mobility (Pendleton 1943: 24-5, A. R5. N. 3.2 k/116). Lao laborers from the northeast often migrated to work on farms on the Central Plain, especially after 1900 when the completion of the northeastern railroad project facilitated the migration. Chinese as well as Lao laborers were also hired for up-country public works projects.

Table 3.5

Comparisons of Urban Unskilled and Rural Wages,1889-1931

| Year | Urban unskilled wage (baht per day) | Rural or agricultural wage (baht per crop season) |
|---|---|---|
| 1889 | 0.8 | 80 |
| 1890 | 0.8 | 80 |
| 1892 | N.A. | 60 |
| 1905 | 0.5 | 85 |
| 1911 | N.A. | 80 |
| 1925 | 1.0 | 85 |
| 1926 | 1.0 | 81 |
| 1927 | 1.0 | 85 |
| 1928 | 1.0 | 85 |
| 1931 | 0.8 | Angthong: was 60-80, now 30-50 |
| | | Pitsanulok: was 80, now 40 |
| | | Lopburi: was 60-100, now 40-60 |

Source: Appendix Table 2.

### 3.2.2 Trend in Land Prices and Land Rents

There are limited extant data on land rents, and therefore the trend in land prices is used as a proxy for the trend in land rents. This is a reasonable proxy since there appears to have been no significant decline in interest rates during the period under examination (see Feeny [1982: 70-1]). For the period prior to 1915, there is only scattered information both on land prices and land

rents. Table 3.6 shows observations on land prices and land rents and constructed real land prices and real land rents for Central Plain paddy land during the period from 1880 to 1942. Real land prices and real land rents are in terms of rice export prices. Although there is considerable variation in both nominal and real land prices, both trends are upward. Therefore, the trend in land prices, and presumably land rents, moved in favor of the transplanting technique like the trend in real wages. The upward trend in land prices is supported by van der Heide (1906: 85) and others (see Tanabe [1978], A. R5. KS. 2/1, and A. R.5. KS. 9.2/25). Van der Heide indicated in 1906 that land values had indeed appreciated since the country was opened to trade in 1856 and rice production had become the leading commodity export. The observations on land prices and land rents presented in Table 3.6 are drawn from various areas of the Central Plain. As a control for variation of land quality, only observations of Rangsit paddy land are presented in Table 3.7. The result confirms the upward trend in both nominal and real land prices. The upward trend in land prices for the Rangsit area is confirmed by data on sale prices for Rangsit land. Table 3.8 presents nominal and real sale prices for Rangsit land by the Siam Canals, Land and Irrigation Company during 1892-1904. They also show an upward trend in land values. The company's sale prices were lower than land prices in Table 3.7 because sale prices were for uncleared paddy land while land prices in Table 3.7 were for developed paddy land (see A. KS. 13/229).

Table 3.6

Land Prices and Land Rents for Central Plain Paddy Land, 1880-1942

| Year | Land price (baht/ha) (land rent in parenthesis) | Index (1880=100) | Real land price (kg of rice/ha) (real land rent in parenthesis) | Index (1880=100) |
|---|---|---|---|---|
| 1880 | 6.3 | 100 | 133 | 100 |
| 1889 | 31.3 | 496 | 666 | 500 |
| 1890 | 26.9 | 427 | 524 | 393 |
| 1891 | 25.0 | 397 | 498 | 374 |
| 1892 | 33.1 | 526 | 610 | 458 |
| 1894 | 30.0 | 476 | 563 | 422 |
| 1896 | 39.4 | 625 | 536 | 402 |
| 1897 | 47.9 | 760 | 730 | 547 |
| 1899 | 141.7 | 2,249 | 1,687 | 1,265 |
| 1900 | 218.8 | 3,473 | 2,509 | 1,882 |
| 1901 | 218.8 | 3,473 | 1,734 | 1,301 |
| 1902 | 165.6 | 2,629 | 1,923 | 1,443 |
| 1903 | 219.0 | 3,473 | 796 | 597 |
| 1903 | (0.003) | N. A. | (263) | N. A. |
| 1904 | 195.0 | 3,102 | 2,069 | 1,552 |
| 1905 | 187.5 | 2,976 | 1,982 | 1,487 |
| 1906 | 156.5 | 2,481 | 1,666 | 1,250 |
| 1906 | (0.003) | N. A. | (269) | N. A. |
| 1907 | 234.5 | 3,721 | 2,507 | 1,881 |
| 1908 | 450.0 | 7,143 | 5,288 | 3,967 |
| 1911 | (0.008) | N. A. | (800) | N. A. |
| 1915 | 150.0 | 2,381 | 1,943 | 1,458 |
| 1925 | 640.5 | 1,017 | 1,726 | 2,655 |
| 1930 | 250.0 | 3,968 | 2,510 | 1,883 |
| 1931 | 54.2 | 1,294 | 544 | 408 |

Table 3.6 (Continued)

| Year | Land price (baht/ha) (land rent in parenthesis) | Index (1880=100) | Real land price (kg of rice/ha) (real land rent in parenthesis) | Index (1880=100) |
|---|---|---|---|---|
| 1932 | 62.5 | 992 | 1,118 | 839 |
| 1931 | 24.2 | 384 | 431.3 | 323 |
| 1936 | 162.5 | 2,579 | 2,660 | 1,995 |
| 1942 | 325.0 | 5,159 | 2,321 | 1,741 |

Note: Figures are averages.

Sources: Data on land prices and land rents are taken from Appendix Table 3. The average rice prices that used in constructing real land prices and real land rents are taken from Appendix Table 1. The average rice price for 1942 is 8.2 baht per picul or 1.55 baht per kilogram (Ingram [1964: 122]).

Table 3.7

Land Prices for Rangsit Paddy Land, 1880-1925

| Year | Land price (baht per ha) | Index (1880=100) | Real land price (kg of rice per ha) | Index (1880=100) |
|---|---|---|---|---|
| 1880 | 6.3 | 100 | 133 | 100 |
| 1890 | 26.6 | 425 | 518 | 389 |
| 1892 | 33.1 | 530 | 610 | 459 |
| 1894 | 30.0 | 480 | 563 | 423 |
| 1896 | 39.4 | 630 | 536 | 403 |
| 1897 | 47.9 | 767 | 729 | 548 |
| 1899 | 141.7 | 2,267 | 1,687 | 1,268 |
| 1900 | 218.8 | 3,500 | 2,458 | 1,848 |
| 1901 | 218.8 | 3,500 | 2,526 | 1,899 |
| 1902 | 165.6 | 2,650 | 1,924 | 1,446 |
| 1903 | 218.8 | 3,500 | 2,295 | 1,726 |
| 1904 | 234.4 | 3,750 | 2,483 | 1,867 |
| 1905 | 125.0 | 2,000 | 1,321 | 993 |
| 1906 | 156.3 | 2,500 | 3,332 | 2,505 |
| 1915 | 281.3[a] | 4,500 | 3,643 | 2,739 |
| 1925 | 562.5 | 9,000 | 4,660 | 3,504 |

[a] Land price for the Rangsit land in the Pasak project area.

Source: Appendix Table 3.

Table 3.8

The Siam Canals, Land and Irrigation Company's Sale Prices for Rangsit Land, 1892-1904

| Period | Sale price (baht per ha) |
|---|---|
| 1892-1898 | Land near small feeder canals: 12.5, land near feeder canals: 25, land near main canals: 31.25 |
| 1899-1900 | Land near small feeder canals: 25 land near feeder canals: 50 |
| | Land near main canals: 100 |
| 1901-1904 | 156.3 |

Sources: Compiled from A. R5. KS. 9.4 k/14, A. R5. KS. 9.4/7, A. KS. 13/229, A. KS. 91/3967, and A. R5. KS. 9.4/8.

For the period from 1915 to World War II, a series of average values per rai of newly mortgaged land is available. The data are dominated by transactions that took place on the Central Plain. This series of data is used as a proxy for trends in land prices and land rents. The use of such proxies assumes that the percentage of total land prices that was acquired with mortgages remained the same over the period. The mortgage amounts in terms of baht per hectare of land on the Central Plain are shown in Table 3.9 and Figure 3.2. Nominal and real land prices for 1915-1941 show similar patterns. Real land prices declined from 1915 until 1919, rose from 1920 to 1930, dropped during the depression and then improved. Despite the variation in the nominal and real land prices, the overall trend is clearly upward. The average annual rates of change in real land prices for various sub-periods are calculated and shown in Table 3.10.

Table 3.9

Mortgage Land Values for the Central Plain of Thailand, 1915-1941

| Year | Mortgage land value (baht per ha) | Index (1915=100) | Real mortgage land values (kg of rice per ha) | Index (1915=100) |
|---|---|---|---|---|
| 1915 | 102.0 | 100 | 1,321 | 100 |
| 1916 | 87.9 | 86 | 1,051 | 80 |
| 1917 | 71.9 | 70 | 833 | 63 |
| 1918 | 82.6 | 81 | 537 | 41 |
| 1919 | 104.4 | 102 | 380 | 29 |
| 1920 | 111.9 | 110 | 1,091 | 83 |
| 1921 | 112.8 | 111 | 1,044 | 79 |
| 1922 | 127.3 | 125 | 1,286 | 97 |
| 1923 | 124.6 | 122 | 1,166 | 88 |
| 1924 | 127.9 | 125 | 1,074 | 81 |
| 1925 | 154.6 | 152 | 1,281 | 97 |
| 1926 | 152.5 | 150 | 1,217 | 92 |
| 1927 | 155.0 | 152 | 1,336 | 101 |
| 1928 | 174.5 | 171 | 1,486 | 112 |
| 1929 | 176.2 | 173 | 1,445 | 109 |
| 1930 | 180.9 | 177 | 1,816 | 137 |
| 1931 | 161.4 | 158 | 2,797 | 212 |
| 1932 | 142.6 | 140 | 2,551 | 193 |
| 1933 | 116.9 | 115 | 2,362 | 179 |
| 1934 | 107.4 | 105 | 2,224 | 168 |
| 1935 | 121.6 | 119 | 2,027 | 153 |
| 1936 | 113.8 | 112 | 1,863 | 141 |
| 1937 | 118.4 | 116 | 1,746 | 132 |
| 1938 | 115.5 | 113 | 1,857 | 141 |

Table 3.9 (Continued)

| Year | Mortgage land value (baht per ha) | Index (1915=100) | Real mortgage land values (kg of rice per ha) | Index (1915=100) |
|---|---|---|---|---|
| 1939 | 148.2 | 145 | 2,495 | 189 |
| 1940 | 144.0 | 141 | 1,877 | 142 |
| 1941 | 136.8 | 134 | 1,079 | 82 |

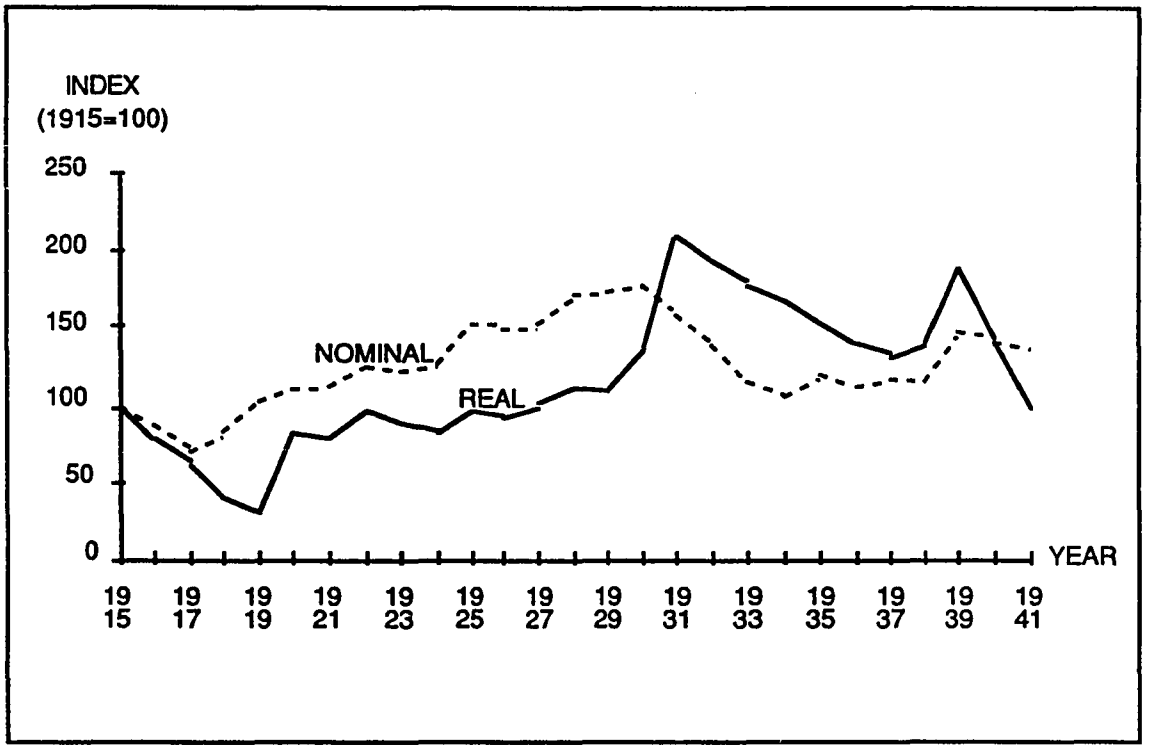
Sources: Central Statistical Office (Nos. 5, 11, 12, 15, 17, 18, 19, 20, 21).

Table 3.10

Average Annual Rates of Change in Real Land Prices, 1915-1941

| Period | Average annual rates of change in real land prices |
|---|---|
| 1915-1941 | 4.7 |
| 1915-1930 | 9.4 |
| 1931-1941 | -1.6 |

Source: Computed from the real land price data in Table 3.9.




Source: Table 3.9.

Figure 3.2 Nominal and Real Mortgage Land Values for the Central Plain of Thailand, 1915-1941

### 3.2.3 Trends in Relative Factor Prices, 1850-1941

An examination of wages and land prices found that while real wages show no upward trend for the period from the mid-nineteenth century to 1941, paddy land prices and presumably land rents increased. Tables 3.11 and 3.12 present the ratios of land prices to wages. An index of the ratios is also shown. The ratios of land prices to wages can be interpreted as the number of days of labor required to earn enough to purchase one hectare of Central Plain paddy land. Table 3.11 covers the period 1880-1915, Table 3.12 covers the period 1915-1941. The two tables show that the trend in land prices increased with respect to wages. This result reenforces the conclusion drawn in the previous sections that the trends in factor prices during 1890-1940 moved in favor of the transplanting technique. Therefore, the choice of broadcasting on the young delta was not caused by factor prices. The upward trend for the period 1915-1941 is graphically shown in Figure 3.3. Again, the trend declined during the 1930s. The average annual rates of change in relative land prices are calculated for various sub-periods and are shown in Table 3.13.

Table 3.11

Ratios of Land Prices to Wages, 1880-1915

| Year | Ratio of land price to wage (day per ha) | Index (1880=100) |
|---|---|---|
| 1880 | 9 | 100 |
| 1889 | 42 | 468 |
| 1890 | 36 | 403 |
| 1891 | 33 | 375 |
| 1894 | 60 | 674 |
| 1896 | 79 | 885 |
| 1897 | 96 | 1,078 |
| 1899 | 283 | 3,184 |
| 1900 | 264 | 2,961 |
| 1901 | 181 | 2,033 |
| 1902 | 200 | 2,242 |
| 1903 | 264 | 2,961 |
| 1904 | 391 | 4,390 |
| 1905 | 375 | 4,213 |
| 1906 | 313 | 3,511 |
| 1907 | 469 | 5,267 |
| 1908 | 511 | 5,742 |
| 1915 | 200 | 2,247 |

Note: Average values are used in the computation.

Sources: Data on land prices are taken from Appendix Table 3, data on wages from Table 3.3.

Table 3.12

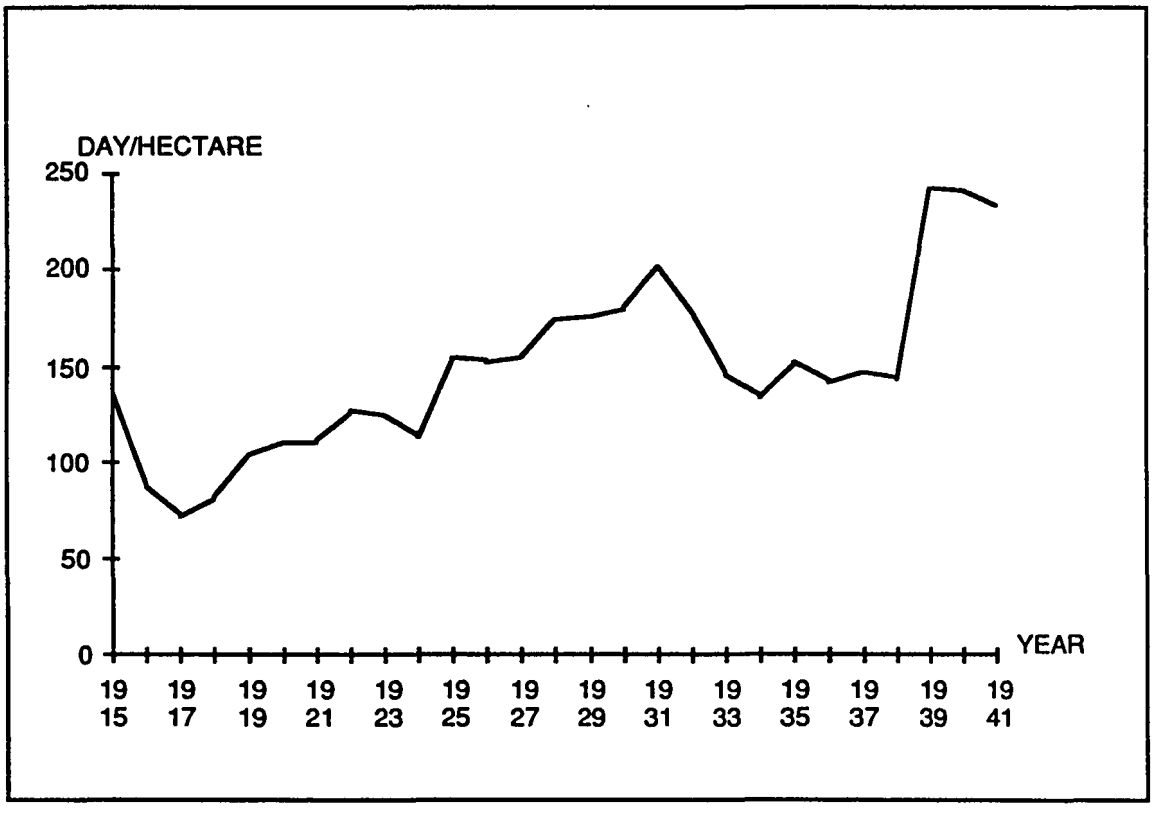
Ratios of Land Prices to Wages, 1915-1941

| Year | Ratio of land price to wage (day per ha) | Index (1915=100) |
|---|---|---|
| 1915 | 136 | 100 |
| 1916 | 88 | 65 |
| 1917 | 72 | 53 |
| 1918 | 83 | 61 |
| 1919 | 104 | 77 |
| 1920 | 112 | 82 |
| 1921 | 113 | 83 |
| 1922 | 127 | 94 |
| 1923 | 125 | 92 |
| 1924 | 114 | 84 |
| 1925 | 155 | 114 |
| 1926 | 153 | 112 |
| 1927 | 155 | 114 |
| 1928 | 175 | 128 |
| 1929 | 176 | 130 |
| 1930 | 181 | 133 |
| 1931 | 202 | 148 |
| 1932 | 178 | 131 |
| 1933 | 146 | 107 |
| 1934 | 134 | 99 |
| 1935 | 152 | 112 |
| 1936 | 142 | 105 |
| 1937 | 148 | 109 |
| 1938 | 144 | 106 |

Table 3.12 (Continued)

| Year | Ratio of land price to wage (day per ha) | Index (1915=100) |
|---|---|---|
| 1939 | 247 | 182 |
| 1940 | 240 | 176 |
| 1941 | 228 | 168 |

Sources: Data on land prices are taken from Table 3.9, data on wages from Table 3.3.




Source: Table 3.9.

Figure 3.3 Ratios of Land Prices to Wages, 1915-1941

Table 3.13

Average Annual Rates of Change in Ratios of Land Prices to Wages, 1915-1938

| Period | Average annual rates of change in ratios of land prices to wages |
|---|---|
| 1915-1941 | 3.7 |
| 1915-1930 | 1.9 |
| 1931-1938 | -2.2 |
| 1932-1938 | 3.4 |

Source: Computed from the data in Table 3.12.

The trends in factor prices examined in this chapter are also investigated for purposes different from this study by Ingram (1964) and Feeny (1982), and reach the same conclusion made here. In these two studies, trends in terms of trade are regarded as an important measure of comparative advantage and the incentives that lead to the expansion of rice production and changes in relative factor prices. Feeny also offers a systematic analysis regarding interactions between trends in terms of trade, resource endowments, and changes in factor prices. His model is based on the concept that in an open economy, relative product prices are determined on world markets rather than within the economy itself. Real land rents are linked to the endowments of land, labor, capital, production technology, and the external terms of trade. As the relative price of an agricultural product rises, resources move from other sectors that have less comparative advantage (i.e., manufacturing) into agriculture. Labor and capital

are, however, imperfect substitutes for land. Thus, as people seek to expand agricultural output in response to the favorable prices, land rents are bid up. Therefore, over the period there would have to be increased production and specialization in export activities and an appreciation in land rents with respect to wages. Feeny used Hueckel's (1972) simple general equilibrium model to predict trends in relative factor prices and found that the framework is consistent with the available information and data on trade, resource endowments, and factor prices in Thailand during 1890-1940. He, thus, concludes that terms of trade could be used as a proxy to predict factor prices. Since the trends in terms of trade moved in favor of agriculture during most of the period from 1865 to 1941, one would expect land prices to have appreciated with respect to wages over the period.

### 3.3 Summary

This chapter examines the trends in factor prices for the period from the mid-nineteenth century to 1940. Information regarding rice prices and factor prices are summarized in Table 3.14. The period from the mid-nineteenth century to 1941 was one in which rice prices and land prices appreciated and real wages declined. Although the trends in these market prices were subject to considerable variation as shown by their average annual rates of change for various sub-periods, the trends in relative factor prices moved in favor of transplanting. When broadcasting became first dominant on the young delta during 1890-1900, rice prices rose drastically, nominal and real land prices increased, real wages dropped more rapidly than any other sub-periods, and relative factor prices moved in favor of transplanting. Although real wages

increased during 1900-1915, real land prices appear to rise faster as reflected in the increase in ratios of land prices to wages.

Table 3.14

Average Annual Rates of Change in Rice Prices and Factor Prices, 1850-1941

| Period | Rice price | Real land price | Real wage | Ratio of land price to wage |
|---|---|---|---|---|
| 1850-1941 | 1.09 | N.A. | -0.4 | N.A. |
| 1850-1890 | 0.53 | N.A. | -1.1 | N.A. |
| 1864-1941 | 0.98 | Increase[a] | -0.4 | Increase[a] |
| 1864-1890 | 0.16 | Increase[a] | -1.1 | Increase[a] |
| 1890-1900 | 5.66 | Increase[a] | -1.6 | Increase[a] |
| 1900-1915 | 0.04 | Increase[a] | 1.8 | Increase[a] |
| 1915-1930 | 2.54 | 9.4 | -0.2 | 1.9 |
| 1915-1941 | 0.67 | 4.7 | -0.1 | 3.7 |
| 1931-1941 | -1.94 | -1.6 | 0.4 | -2.2 (1931-1938) 3.4 (1932-1938) |

[a] Based on the qualitative information presented in section 3.2 and land price data in Tables 3.6 through 3.13.

Sources: Tables 3.2, 3.4, 3.10, and 3.13.

In conclusion, the information summarized in Table 3.14 is sufficient to refute the hypothesis that the choice of broadcasting on the young delta during 1890-1940 was a result of the trends in factor prices. Evidence shows that the trend in land prices or land rents rose with respect to wages. This means, the trends in factor prices during the period moved in favor of transplanting. Therefore, cultivators in the young delta like those in the old delta and outer provinces, should have adopted the transplanting technique, if factor prices dictated their choice of technique. In the next two chapters, evidence for alternative hypotheses based on uncertainty will be examined.

# CHAPTER IV

## LAND OWNERSHIP AND CHOICE OF TECHNIQUE

The examination on trends in factor prices in the previous chapter reveals that the trends in factor prices during the period under investigation moved in favor of the transplanting technique. Therefore, the choice of broadcasting on the young delta was not caused by trends in factor prices. Instead, uncertainty in land ownership and prices may be the explanations. The objective of this chapter is to examine empirical evidence regarding land ownership uncertainty on the young delta. Evidence regarding uncertainty in land ownership will be presented in terms of land disputes. This is because this type of uncertainty is manifested as the risk of losing one's land from a dispute over ownership. Three types of evidence will be presented in this chapter. First, land disputes or events that led to land disputes present only on the young delta. This condition must hold because in other areas of Thailand during that time transplanting was the dominant technique. Second, land disputes were widespread in the area. The existence of land disputes can only foster uncertainty in land ownership. It is the amount of land that was affected by land disputes that explained the dominance of broadcasting in the area. Third, most cultivators in the area were landowners and most landowners were small owner-operators. This evidence will confirm the hypothesis that cultivators on the young delta during 1890-1910 broadcasted rice because of land ownership uncertainty. If most cultivators in the area were not owners of the land they farmed, uncertainty in landownership would not be relevant to their choice of technique. In addition, evidence regarding the dominance of small owner-operators will confirm that the choice of broadcasting during the period was caused by land ownership uncertainty,

not price uncertainty. This is because small owner-operators will normally choose transplanting under price uncertainty as demonstrated in Chapter II.

The manner of land development and land acquisition--the specific events on the young delta--that led to widespread land disputes during 1890-1910 are presented in section 4.1. Section 4.2 examines the extent of land disputes and the form of land tenure in the Rangsit area during 1890-1910. Section 4.3 describes the situation of land dispute and the change in the pattern of land ownership in Rangsit after 1910. Section 4.4 summarizes the main results of the chapter.

## 4.1 Land Development, Land Acquisition, and Land Disputes, 1890s

As mentioned briefly in Chapter I, in 1890 commercial rice production, which was previously concentrated on the old delta and the floodplain, rapidly expanded southward onto the vacant young delta. This advent of expansion took place during the period in which rice prices and land prices rose more rapidly than any other sub-periods from 1890 to 1940 (see Chapter III, Table 3.14). The expansion was facilitated by private investment in the construction of canals and irrigation systems in the area. Canal construction played a major role in the expansion of rice production and settlement on the young delta during 1890-1914. Table 4.1 presents data regarding the area of paddy land on the young delta opened by the newly constructed canals during 1861-1914. The area of paddy land opened during 1889-1914 increased five times from the period 1861-1880. This accounted for about 84 percent of all new paddy land opened by canal construction on the young delta during 1861-1914.

Table 4.1

Area of Paddy Land on Canal Banks on the Young Delta, 1861-1914

| Period | Area (1,000 ha) | As % of the total paddy area on canal banks |
|---|---|---|
| 1861-1880 | 66.9 | 15.9 |
| 1889-1914 | 353.9 | 84.1 |
| Total | 420.8 | 100.0 |

Source: Computed from the data in Appendix Table 5.

Contemporary descriptions of rice production on the young delta during the late nineteenth century consistently point to the importance of canals for settlements and rice production.[1] The information presented in Table 4.1 supports these descriptions. In 1914 the total area of paddy land on the Central Plain was about one million hectares.[2] Therefore, the total area of paddy land opened by canal construction during 1861-1914 accounts for about 40 percent of the total paddy area on the Central Plain in 1914. Statistics on paddy area on the young delta during 1890-1900 are unavailable. However, since settlement on the young delta started in the late 1880s and was mainly along canal banks to facilitate rice cultivation and transportation, the area of paddy land opened by canal construction during 1889-1914 would account for most of the total paddy area on the young delta during 1889-1914. Johnston (1975)

estimated that in 1905 the east bank alone contained a significant share, about 25 percent, of the total rice land of central Thailand.

The expansion in paddy land and private investment in canal construction on the young delta during 1890-1900 were not only induced by the opportunities on the international rice market, but the government also accelerated the process through three important edicts.[3] The first, enacted in 1877, granted land along the newly constructed canals to cultivators who contributed labor and/or capital to the government's canal construction (Sathian Laiyalak et al., 9: 221-5). Then, when rice prices boomed in 1890, the government enacted several land laws granting permission for canal excavation and irrigation investment to private companies.[4] The private companies received rights on all new land opened by canal construction. Cultivators in the area covered by canal construction projects could retain their rights of ownership if they possessed land papers dated before the signing of the company's contract.

The system of owning land through investment in canal construction was used in addition to the traditional system of land squatting (*chubchong*). Squatters' rights on the land were recognized by the customary land law, given two conditions: the payment of annual land tax and the continued use of the piece of land (A. R5. K.S.4.1/3, A. R6. K.S. 5/10). These two methods of owning land, and a poorly administered system of land registration in existence at the time, led to many land ownership conflicts on the young delta during 1890-1910.[5]

Prior to 1900, preliminary land papers establishing preemptive rights to squatters were issued by officials of local government upon application. In the next year, two kinds of land documents, which conferred a more permanent

degree of ownership, called *bai chong* and *tra daeng* were issued by a tax assessor appointed by the central government. *Bai chong* was the land document issued for *na fangloi* and *tra daeng* was for *na khukho*. In addition, the assessor issued receipts for taxes paid. Land tax receipts could be used as proof of occupancy and identification of ownership. Official forms and seals for land documents and land tax receipts were not standardized or well controlled. When one tax assessor was replaced by another or died, the official seals often remained in the possession of the former tax assessor's family, and the successor might obtain a new set of forms and official seals.[6] Thus, unless the tax assessor and local officials were extremely diligent and honest, misunderstanding or deception may often take place. For a single plot of land, different claimants might possess different kinds of land documents issued by different assessors, and tax receipts for one or more years. Moreover, the precise descriptions of the location and boundaries of the land owned were not specified on any of the land documents (A. R5. K. 14.2/3, A. R5. KS. 3.2/10). Also, central records of land registrations or land transactions were not maintained (A. R5. KS. 1/1, A. KS. 3.2/10, A. K. 14.1/2). This made it difficult to identify who was the legitimate landowner when mistake or deception occurred in the stage of issuing land documents.

The increase in land values and rice prices during 1890-1900 increased the incentive for paddy landholding. Private investment in canal construction during the late nineteenth century was concentrated on the young delta (Sathian Laiyalak et al.; 9: 202, 221). This can be explained by two factors: the vacancy and the relatively ease of accessibility to the Bangkok international port of the young delta. The vacancy of the young delta meant that investors could own the land opened by canal construction. The accessibility to the Bangkok

international port of the young delta made the area a more favorable place for export rice production. Therefore, the manner in which the young delta was opened up, settled, and brought under cultivation differed significantly from other areas of the country. In other commercial rice growing areas, settlement had either taken place long before 1890, for example the old delta, or gradually taken place by population growth. There was no large scale canal construction for land settlement. Land acquisition was mainly done through the traditional squatting system. Therefore, land ownership was enforced by custom and kinship. Acquisitions were well publicized and society reenforced the system. The legal apparatus of land ownership often came after the informal pattern of land ownership was settled. The size and intimacy of a village also made detection and enforcement costs low.

This customary system of land ownership was inadequate on the young delta. Canal construction, the two methods of land acquisition, and the poorly administered system of land registration described above caused a great number of land disputes. During the late nineteenth century, paddy areas along various newly constructed canals, for example Prawetburirom, Phraya Bunlu, Prang, Udomchon, and Phra Rachaphimon, were often noted in official documents as frequently disputed areas.[7] Numerous enterprises and individuals submitted proposals of canal excavation to the government.[8] Official documents indicated that many of the proposals, which were not granted permission, illegally carried out their plans.[9] Land disputes in these areas were more severe because the rights of investors on the land developed were not recognized by the government.[10] In some areas of canal construction, land disputes were reported as early as 1878-80.[11] Franscis H. Giles, an official of the Department of Revenue at the time, wrote that land disputes were a major

problem in many east bank districts during the late nineteenth century (A. KS. 46/1794). In 1885 Col. G. E. Gerini, an instructor in the Thai army, noted that the settlement in the area was not of the permanent type (SWA May 2, 1885). Ten years later, the same impermanence of settlement in the area was observed by land registration officials of the Ministry of Agriculture (A. KS. 65/2740). The character of temporary houses and the mobility of farmers along the Prawetburirom Canal and the Rangsit area, observed by these various observers during 1885-1895, support the Giles report on land disputes in the areas. Land disputes on the young delta is also noted in Hanks' s (1971) work on the oral history of rice culture on the Central Plain. He recorded that when canal construction in Bangchan, a village near Bangkok, was completed in the late nineteenth century, most farmers who migrated to the area were often threatened by others who desired the newly settled land. In order to retain the land they had developed, they had to seek protection from the powerful people in Bangkok (Hanks 1971: 113-5). In 1895 the Land Dispute Commission was set up to deal with the great number of land disputes in Rangsit and the adjacent Prawetburirom Canal area (Sathian Laiyalak et al., 15: 21-2). In 1896 the area of responsibility of the commission was extended to include the areas in Bangkok, South Ayuthya, and Prachinburi (Sathian Laiyalak et al., 15: 134-5).[12] Land disputes in areas along canals on the young delta during 1890-1910 took many forms. First, the scale of the lands owned by canal investors were large and the boundaries of the lands were not clearly defined. Oftentimes, squatters were not aware of the boundaries. Careless officials issued multiple land-tax receipts and land documents, which led to disputes over ownership. Second, land acquisition by canal investors was subject to the condition that the government would issue official land titles to investors only when canal

construction was completed. This condition created a time period during which squatters could migrate onto the land. Although most investors sold the land as soon as the contract with the government was signed, such sales were not recognized by the government. The companies sold their land by collecting down payments before work on the canal was begun and issued receipts of down payments to individuals who purchased the land. Additional payments were due when the canal had reached the plot of the party concerned.[13] Disputes arose because purchasers regarded the down payment receipts as temporary proofs of ownership, while the land squatters possessed official land documents. Third, the large land area claimed by investors increased the opportunity for deception. Deception of officials in issuing multiple copies of land tax receipts and land documents to squatters or affixing wrong dates of initial occupancy on land tax receipts and land documents posed major difficulties. Fourth, the lack of central land title offices and precise descriptions of boundaries meant that when disputes over ownership occurred, either by carelessness or deception, they could not be easily resolved. Since land ownership could not be unambiguously determined, enforcement could not be effective due to the lack of information on ownership.

Since paddy areas of newly constructed canals account for about 40 percent of total paddy land on the Central Plain and most of the paddy land on the young delta at the time, the extent of land disputes on the young delta during the period is clear. This event appears to have a significant effect on the Thai economy because it was explicitly noted in the 1901 land law as the major reason for adopting a modern land ownership system in Thailand. Although data and detailed information on land disputes for the young delta as a whole are limited, extensive information is available regarding land disputes in the

Rangsit area. Documents from the Rangsit land development project is by far the most detailed source of information available on land disputes during the period. Since Rangsit was one of the new settlement areas on the newly constructed canals on the young delta during the period, information from this area allows us to extend the experience in Rangsit to the entire young delta. The effect of land disputes in Rangsit on the choice of technique will be examined with respect to (1) the dominant type of cultivator in the area, and (2) the extent of land disputes in the area. To support the argument that most cultivators were uncertain in their land ownership, one expects to observe (1) the dominance of owner operators and small owner-operators in Rangsit, and (2) the widespread occurrence of land disputes. If these two conditions existed in Rangsit within the period 1890-1940, the dominance of broadcasting on the young delta could be caused uncertainty in land ownership.

## 4.2 Land Disputes and Land Tenure in Rangsit, 1890-1910

### 4.2.1. Land Disputes in Rangsit, 1890-1910

As mentioned briefly in Chapter I, canal networks were constructed in Rangsit by a private firm called Siam Canals, Land and Irrigation Company in 1890 (see Sathian Laiyalak et al.; 12: 209, 225). The canal system in Rangsit was the largest and most advanced system in the country during the period under study. According to official reports and company documents, rapid settlement in this vast tract of land started in 1890 (A. R5. KS. 3.1/2, A. KS. 86/3842). The area soon became the most important commercial rice producing area of the country.

Land disputes were a major problem in Rangsit during 1890-1910.[14] Grassi, one of the company's managers, reported that disputes over land ownership in Rangsit erupted almost immediately when the company began its canal construction in 1890. Disputes peaked during 1893-1900 and declined in the 1900s. In over two thousand available land disputes petitions in Rangsit, almost every canal out of a total 50 (including feeder canals) constructed in Rangsit during 1890-1905 was associated with a dispute. Narratives show that it was common for farmers who cleared a plot of land one year, to lose it the next year or two. Violent and prolonged land disputes are contained in almost every document of the Rangsit Development Project. Princes, high ranking nobles, and officials were often reported to be involved in the disputes. Some were also reported to support the use of violence in land appropriation. Most disputes took about 10 years to settle, mainly because of the absence of precise information regarding land registration. Officials and the company reported that some legitimate claimants chose to move on to other more peaceful areas but many chose to remain. There were at least five major parties involved in land disputes in Rangsit: (1) squatter farmers, (2) farmers who purchased land from SCLIC, (3) officials involved in forging land documents, (4) SCLIC, and (5) high ranking nobles and officials. These major five parties pursued their claims of ownership through both violence and the legal system.

There were two cases of land disputes in Rangsit that were thoroughly and comprehensively investigated by the Land Dispute Commission: the case of Phra Sewee and the case of Luang Wathit. The two cases were named after persons judged to be guilty in the disputes. Information from both the testimony files of the Land Dispute Commission and the general records of Rangsit development project indicate that each case covered a considerable land area

in Rangsit and took a decade to settle. Testimony given by witnesses during the investigations point to the widespread land disputes and violent evictions of squatter farmers in Rangsit. Witnesses of the Wathit case also expressed their fear of losing their lands to Luang Wathit, although many of them did not live in the vicinity of the disputed area.

The case of Phra Sewee involved deceptions of a tax assessor. Phra Sewee was a tax assessor during the 1880s. According to the testimony files, he issued thousands of land documents (*tra chong*) covering a vast area of Rangsit to squatter farmers sometime before 1890.[15] In 1890, when the company started to excavate canals and sell land, disputes erupted between the company, the purchasers of the land, and squatter farmers who regarded themselves as the legitimate land owners. In 1891 the company started to evict squatter farmers who possessed Phra Sewee's land documents in many communes (*tambon)* in Rangsit and accused them of forging land documents. Some cultivators moved away but many remained and petitioned the court. Judicial decisions could not be made easily due to the lack of immediate and precise information regarding who was first on the land in question.

In 1895 a commission called the Land Dispute Commission was set up to deal with land disputes in the Rangsit area. The Sewee case was reinvestigated by the commission. In 1896 the commission ruled against the company on the basis that squatter farmers possessed official land documents dated before the signing of the company's contract. The company resubmitted the petition in 1897 and the case was reinvestigated. In 1898 Sewee, but not the farmers, was found guilty. This meant that the land in dispute still belonged to squatter farmers. A petition by the company was submitted again in 1899. Ultimately in 1899 the commission and the Ministry of Agriculture reached a

final decision. All land documents issued by Wathit were considered illegal, and the company was judged to be the sole owner of all land in the disputed area.

The Luang Wathit land dispute occurred during 1893-1900.[16] In terms of land area, it was one of the largest disputes in Rangsit. The case covered at least five communes in northern Rangsit. The dispute, involving land document forgeries and conflicts in land acquisition between squatters, the company, and land purchasers, erupted in 1893. In 1894, a group of officials, nobles, and 1,543 farmers led by Wathit submitted a petition to the Ministry of Agriculture against the company. In response, a large number of petitions filed by squatters and land purchasers were also submitted to the same ministry. Squatters who came to settle in the Rangsit area sometime in the 1880s and many farmers who had purchased land from the company in 1891 were violently forced to abandon their lands by armed bands of Luang Wathit. These armed bands would then broadcast their victims' lands, sell some plots to powerful individuals, and repeat their violent acts in other areas. The bands were apparently supported by some high ranking officials and nobles in Bangkok. This continued for a long time since most parties often resubmitted petitions.

In 1899 the commission finally ruled in favor of the company. Wathit and his party were found guilty of forging land documents, including land tax receipts, and of committing violence. After the decision was handed down, the commission ordered an eviction of Wathit's people from the disputed area. The eviction, conducted by officials of the Ministry of Town and officers of SCLIC, was very violent. Official reports indicate that hundreds of farm houses of those who resisted were torn down or burnt. It was also noted that the eviction

affected more than those settlers who were involved with the case, because boundaries of the disputed land were difficult to determine.

In 1899 the government appointed more officials to issue land documents and arbitrate land disputes in Rangsit and Prawetburirom Canal, but land disputes continued (Sathian Laiyalak et al. 17: 297-8). The severity and the great number of land disputes in Rangsit and other commercial rice producing areas on the young delta during 1890-1900 finally led to the government's adoption of a modern system of private land ownership in 1901 (Wright and Breakspear 1908: 124-5). This included the Torrens system of land titling with central provincial land-record offices and complex cadastral surveys. The government also issued standard paddy land tax forms and land title documents, standardized procedures, and enacted a comprehensive land law with provisions for permanent land deeds. The system initially concentrated on the Rangsit area but was later expanded into most of the major rice-exporting areas on the Central Plain. In 1903 a cadastral act was passed, followed by a six-year survey.

The new land registering system required detailed cadastral surveys and a much more complex administrative machinery and institutions. Therefore, the change in the system of private land ownership in 1901 did not immediately improve the situation in Rangsit and other commercialized districts on the Central Plain.[17] Between 1900 and 1907, about 3,411 petitions of farmers were submitted to the Ministry of Agriculture. These cases covered an area of about 42,593 hectares in Rangsit. The details of these land disputes are presented in Table 4.2. The total area of disputed land accounts for about 19 percent of the 1905 developed land. Note that the figures represent only those cases filed with the government. As in the early years of turmoil, many additional farmers

had simply moved away. In addition, it is possible that the government received more petitions than are today contained in the National Archives.

Table 4.2

Land Disputes in Rangsit, 1900-1907

| Type of dispute | Case | Area (ha) | As % of the 1905 developed area[a] |
|---|---|---|---|
| Ownership | 1,859 | 41,738 | 19.01 |
| Misallocation | 380 | 55[b] | 0.03 |
| Eviction | N.A. | 800 | 0.36 |
| Total | 2,239 | 42,593 | 19.39 |

[a] Figure for the total developed area in 1907 is unavailable. The total developed area in 1905 was 219,647 hectare.

[b] The total area for all 380 cases is unavailable. This figure represents only the area for five of the cases.

Sources: Compiled from A. KS. 10/1262-1283, A. KS. 10/36, A. KS. 10/1232, and A. KS. 10/1183-1234.

In brief, it is evident that land disputes in Rangsit during 1890-1910 were severe and widespread. The information contained in farmers' petitions and official reports on land disputes reveals that farmers were fear of losing their land by violent evictions, encroachment, and false challenges from others. In the next subsection, the pattern of land ownership in Rangsit will be examined. If most of the cultivators in Rangsit during this period were landowners, it is

possible that most cultivators in the area felt uncertain in long-term land investment. Consequently, the choice of broadcasting during 1890-1910 could be governed by uncertainty in land ownership.

4.2.2 Land Tenure in Rangsit, 1890-1910

During the first two decades of land development and settlement in Rangsit, the area was farmed by four types of cultivators: (1) cultivators who were squatters and possessed one or more kinds of official land papers as proofs of occupancy or ownership, (2) cultivators who purchased land and held SCLIC's down-payment receipts as proof of ownership, (3) cultivators who rented land, and 4) wage labor and debt bondsmen. Official reports and company documents stated that the first two types of cultivators had small landholding and farmed their land with family labor. They also regarded themselves as owners of the land since they possessed some type of land document. Information from official reports and company documents reveal that most tenant farmers in the area rented land from absentee landlords who owned large land holdings. Prince Narathip who owned a large estate in Rangsit wrote that most absentee landlords preferred to divide their land into parcels and rented them to tenant farmers. He also noted that most large landowners found it more profitable to leave the farm operation to tenant farmers (A. K. 3.2/28). Wage laborers and debt bondsmen were mostly hired by landowners of medium size farms (Tad Srihasaksanitwongse 1944: 10, 75).

Information on the manner of rice farming in Rangsit and data from SCLIC's land sale records can be used to estimate the proportion of land farmed by each of the four types of cultivators. The company sold a total area of about 77,000 hectares during 1892-1901. Lands were sold by all plot sizes

depending on order placed. For the purpose of showing the area owned by each type of landowner, all plots purchased by one individual (distinguished by names and addresses) are summed and the total area is then used as the size of that individual's holding. The results of the data compilation are presented in Table 4.3.

Table 4.3

The Siam Canals, Land and Irrigation Company's Land Sales in Rangsit by Plot Size, 1892-1901

| Plot size (ha) | Area (1,000 ha) | As % of the total land sale |
|---|---|---|
| 1.6 - 24 | 13.2 | 17.2 |
| 24.1 - 96 | 28.6 | 37.1 |
| 97.6 - 160 | 3.2 | 4.1 |
| 168 - 4,056 | 32.0 | 41.6 |
| Total land sales | 77.0 | 100.0 |

Note: Figures are converted from rai to hectare using 6.25 rai = 1 hectare.

Sources: Appendix Tables 6 and 7.

Contemporary descriptions on subsistent rice farming indicate that an average family size could work on an area of about 4 hectares using transplanting and 8 hectares by broadcasting (A. KS. 15.2/30). In commercialized areas of the young delta, the same size of family could farm about 16-24 hectares with an aid of one or two hired workers (van de Heide 1903: 44, Anuman Rajadhon 1956). In Rangsit, official reported that people owning 1.6 to 24 hectares were family operator farms. Therefore, cultivators who purchased land from 1.6-24 hectares can be classified as small owner-operator. People who purchased land from 24 to 96 hectares, farmed the land themselves with wage labor. This type of cultivator will be classified as medium owner-operator. Plots larger than 168 hectares were owned by members of the royal family, high ranking nobles and officials, and people who resided in Bangkok.[18] They leased their lands to tenants under fixed-rent contracts and were not involved in any farming decisions. Owners of land between 97.6 and 160 hectares were either medium owner-operators or renters. For the purpose of estimating a lower bound of the area cultivated by owner-operators, plot sizes between 97.6 and 160 hectares will be assumed to be rented. As shown in Table 4.3, the total area sold during 1892-1901 (77,000 hectares), accounts for about 64.9 percent of the total developed area in Rangsit in 1901 (118,701 hectares).[19] If all the land developed in 1901 were farmed, about 35.1 percent of the paddy land in Rangsit would be farmed by small landholding squatter farmers, about 35.3 percent would be farmed by land owners who bought the land from the company, and about 29.6 percent would be farmed by tenant farmers. Adding the areas farmed by squatter farmers and owner-operators together, about 73.1 percent of the land would be farmed by owners themselves. In addition about 46.3 percent of the land would

be farmed by small owner-operators. These estimates are presented in Table 4.4.

Table 4.4

Area Farmed by Different Types of Cultivators in Rangsit, 1892-1901

| Type of cultivator | Area farmed (ha) | Area farmed as % of the 1901 developed area (118,701 ha)[a] |
|---|---|---|
| (1) Small owner-operators (Land purchasers) | 13,243 | 11.2 |
| (2) Medium owner-operators (Land purchasers) | 28,572 | 24.1 |
| (3) Small owner-operators (Squatter farmers) | 41,719 | 35.1 |
| (4) Small owner-operators [(1) + (3)] | 54,962 | 46.3 |
| (5) Owner-operators [(1) + (2) + (3)] | 83,534 | 70.4 |
| (6) Tenants | 35,167 | 29.6 |
| Total area farmed [(5) +(6)] | 118,701 | 100.0 |

[a] See Appendix Table 8 for details.

Source: Computed from the data in Table 4.3.

The results in Table 4.4 are consistent with the information on rice farming in Rangsit contained in official reports, correspondence between SCLIC and the government, and more than two thousands land dispute petitions. Progress reports from SCLIC on canal construction to the government before 1900 often complained about the difficulty of canal construction in Rangsit due to land squatters (A. R5. K. 9.2/7). Information on parties involved in land disputes also shed some light on the prevalent type of cultivators in Rangsit. Most of the land dispute petitions were filed by squatter farmers, land purchasers, and the company itself. There was only a limited number of petitions filed by absentee landlords. If tenants were dominant in Rangsit during the period, most petitions should be filed by absentee landlords.

In brief, there were severe and widespread land disputes in Rangsit during the period 1890-1910. In addition, most cultivators in the area were small owner-operators. Therefore, it is possible that most cultivators in Rangsit were uncertain in their land ownership. These findings are consistent with predictions of the model in Chapter II. Under uncertainty, firms are better off if they concentrate on activities which promise benefits in the relatively near future or on types of investments which can be easily moved whenever their lands are appropriated. Since uncertainty in land ownership implies uncertainty regarding the expected economic life of the fixed plant or irrigation system, firms would choose a shorter planning horizon. In consequence, a technique such as broadcasting which requires less fixed capital input would be the optimal technique.

There is some evidence on the shift back to transplanting of small owner-operators in Rangsit after 1910. The 1910 annual report on rice farming from the Ministry of Agriculture indicated that there were relatively more owner

operators in Amphoe Lamlukka of Thanyaburi Province (A. KS. 5/15). Reports from the same ministry in the 1920s enables us to conclude that these owner-operators were small owner-operators and farmed their land by the transplanting technique. These reports indicated that bunded rice fields existed only in the area of Amphoe Lamlukka and were owned by small family farmers (A. KS. 1.2/99, A. KS. 1/2827, A. SB. 2.8/7). In 1918 a survey report from of the Department of Irrigation also stated that bunding and more intensive farming practices appeared only in areas of small family farms where these farmers were owners of the land (A. KS. 1/3226). A petition from a group of farmers, submitted to the Department of Irrigation concerning the construction of bunds, supported the proposition that only small owner-operators bunded their rice fields (A. R7-R8. 2/2378). Since there is no evidence on transplanting among small owner-operators in Rangsit before 1910, its existence after 1910 supports the hypothesis that the choice of broadcasting during 1890-1910 was the result of land ownership uncertainty.

Although the choice of broadcasting can be a result of uncertainty in land ownership and/or price uncertainty as demonstrated in Chapter II, it is possible to conclude that the practice of broadcasting in Rangsit during 1890-1910 was governed by uncertainty in land ownership alone. This is because under price uncertainty, only large landholding firms would choose broadcasting while small landholding firms would still employ transplanting. Since about 46.3 percent of the land in Rangsit was owned by small owner-operators, the choice of broadcasting in the area during 1890-1910 was caused by land ownership uncertainty. The information that rice prices prior to 1890 were quite stable (see Chapter V, section 5.1) further confirms that the choice was caused by land ownership uncertainty alone, not price uncertainty.

Evidence from elsewhere supports the postulation that insecure land ownership affects investment. In a study of the economic implication of land titling in Costa Rica, positive correlations (0.4-0.7) between the degree of ownership security and farm investment per unit of land were found (Salas et al. 1970). Similarly, data from three Brazilian states in 1978 reviewed by Villamizar (1984) revealed that capital per hectare was substantially greater on titled land than on undocumented or entrenched land. The analysis was made for groups of farms of various sizes, and within most groups the proposition held. The fact that land investment reflects a stream of net income over a long period led to several studies focusing on the effect of ownership security on output or income. In a study conducted in Costa Rica, a positive correlation of 0.5 between income per unit of land and security of ownership was found (Salas et al. 1970). A recent study in Ecuador reports that income levels of farmers with land titles were twice those of farmers without land titles, when the amount of land owned was held constant (IDB 1986: 187). Recent survey results from Jamaica indicate that areas planted in permanent and semi-permanent crops by farmers with land titles were almost twice those of farmers without land titles. The areas planted in permanent and semi-permanent of the latter group of farmers increased after a more secure status of land ownership was granted to them (IDB 1986: 189). A recent study on land ownership and farm productivity in Thailand found that insecure land ownership among squatters causes underinvestment in farms, which in turn results in low productivity (Feder et al. 1988).

## 4.3 Land Disputes and Land Tenure in Rangsit after 1910

Most land disputes in Rangsit were gradually resolved in the 1900s.[20] In most cases, the government ruled in favor of the company and assigned ownership rights on the disputed land to the company. The government decided that, even though the squatter farmers were innocent of forging land papers, it would be unfair for the company to lose vast areas of land to squatter farmers. Based on this decision, only people who purchased the land from the company could retain their rights of ownership. Squatter farmers had to yield their land to the company. During the 1900s, many squatter farmers opposed the government's decision, tried to regain their land, but failed. As a result, after 1910 most of the 35.1 percent of the area previously occupied by squatter farmers belonged to the company (see Table 4.4). Other incidents also increased the amount of land owned by the company. For example, when the Wathit case was resolved in 1899, squatter farmers and land purchasers who were forced to abandon their lands by the Wathit group were no longer in the area to reclaim their land. Many settlers who lived near by the eviction areas were also frightened to move away by the violent eviction in 1899. The company assumed the ownership of all these unoccupied lands and resold them.

During the 1900s, when the government was issuing more secure title deeds to landowners in Rangsit and other commercial rice producing areas on the Central Plain during the 1900s, the pattern of land ownership in Rangsit also gradually changed. In 1910 official reports from the Ministry of Agriculture on rice farming indicated that most of the land in Rangsit was owned by large landowners who were nonresidents (A. KS. 3.1/11).[21] These large landowners did not farm the land themselves but rented it to tenants. Therefore, with the

change toward more secure ownership titles, more and more farmers lost their land and became tenants instead. Because of this change, not all cultivators switched back to transplanting. The majority of cultivators in Rangsit became tenants and these tenants continued to use the broadcasting technique. Because after 1910 most cultivators in the area were no longer landowners, uncertainty in land ownership is irrelevant to the broadcasting practice during 1910-1940. Instead, price uncertainty and the pattern of large landholding will be hypothesized as the cause of the choice of broadcasting in the latter period.

## 4.4 Summary

Evidence for the hypothesis that the choice of broadcasting during 1890-1940 was the result of land ownership uncertainty is examined in this chapter. The results reveal that, during 1890-1910, there were widespread land disputes on the young delta, especially in Rangsit. In addition, most of the cultivators in the area were small owner-operators. Therefore, the evidence is consistent with the hypothesis. Uncertainty in land ownership did lead to the choice of broadcasting on the young delta. There is also some evidence on the shift back to transplanting by small owner-operators after 1910, and this confirms the hypothesis under examination. After 1910 most of the land in Rangsit was owned by large landowners and the majority of cultivators in the area became tenants. Tenant farmers continued to use the broadcasting technique until the 1930s. Because after 1910 most cultivators in the area were no longer landowners, uncertainty in land ownership is irrelevant to the choice of broadcasting in the latter period. The causes of the choice of broadcasting during 1910-1940 will be examined in the next chapter.

# CHAPTER V

## PRICE UNCERTAINTY, LARGE LANDHOLDING, AND CHOICE OF TECHNIQUE

The results from Chapter IV show that uncertainty in land ownership can explain the choice of broadcasting on the young delta, particularly for Rangsit, for the period 1890-1910. After 1910 a more secure system of private land ownership became available. In addition, the majority of cultivators in Rangsit also became tenants of large absentee landlords. The available evidence shows that small owner operators reverted back to transplanting, but tenants continued to use broadcasting until 1940. The purpose of this chapter is, therefore, to explain the continued practice of broadcasting on the young delta until the 1930s.

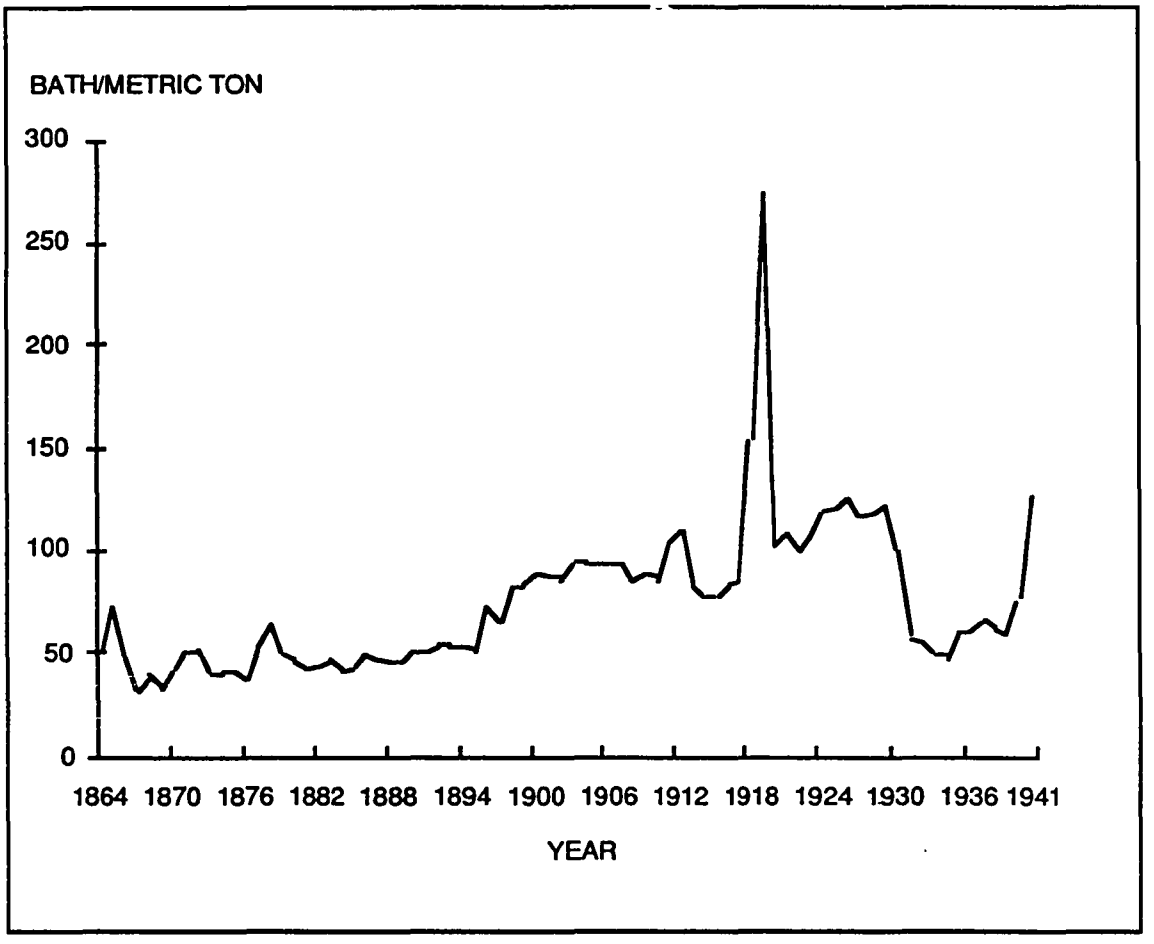
As demonstrated through the model in Chapter II, large firms that are either renters or landowners, are likely to choose broadcasting under price uncertainty. This is because broadcasting allows them to retain production flexibility resulting in higher expected profits over the planing horizon. This hypothesis will be examined here. Large firms are defined as large landowners and tenant farmers because there were no reports of large owner-operators in Thailand during 1890-1941. Also, evidence from Rangsit shows that large landholding was associated with tenancy. Thus, two conditions are expected to be present during the period studied: (1) uncertainty in rice prices, and (2) the dominance of large landowners, tenancy, and large tenant farmers on the young delta.

Evidence regarding price uncertainty will be presented in section 5.1. Section 5.2 presents evidence regarding the existence and extent of large landowners, tenancy, and large tenant farmers. Section 5.3 presents evidence to support the argument that large landowners and large tenant farmers needed production flexibility under price uncertainty. Section 5.4 summarizes the main results of the chapter.

## 5.1 Uncertainty in Rice Prices, 1864-1941

Extensive and consistent data on average paddy prices at the farm gate for the Central Plain are unavailable. Time series data of average prices for rice exports presented in Appendix Table 1 will be used as their proxies. The use of rice export prices for farm gate paddy prices assumed that the rice markets were competitive. Available evidence shows that rice markets at the time were characterized by a reasonable degree of competition. For areas on the Central Plain, the most commercialized area in the country where production and market surpluses were larger than in other areas, the degree of competition was probably even higher. Ingram concludes, on the basis of marketing structure studies, that the rice market was highly competitive (Ingram 1971: 249). The results from Zimmerman's 1929-1930 survey on paddy prices support this conclusion. Zimmerman recorded paddy prices in Bangkok and in rural villages, for the same grade, for the same time period, and using the same units of measure, and found that, with a lag, rural prices followed Bangkok prices closely (Zimmerman 1931: 186-93). Feeny also presents some evidence on the close relationship between farm or provincial market prices for paddy and Bangkok rice export prices for the period 1888-1965 (Feeny 1982: 164-7).

The pattern of movement in rice export prices are shown in Figure 5.1. Rice prices increased over time with some annual variation throughout the period. Prices rose slowly from 1864 to 1890. After 1890 prices increased more rapidly, peaking in 1919. Prices then dropped sharply during the depression, but rapidly resumed the pre-depression upward trend after 1938.




Source: See Appendix Table 1.

Figure 5.1 Average Prices of Rice Exports, 1864-1941

The means, standard deviations, and coefficients of variation of rice export prices for various sub-periods from 1864-1941 are presented in Table 5.1. Judging from the means, prices were fairly constant during 1864-1890 but increased rapidly during 1890-1930. The variation in rice prices during the period 1890-1941 was more than twice the variation during the period 1864-1890. However, there was an even greater variation during the period 1910-1941. Overall, the coefficients of variation for each ten-year-period from 1890-1941, show that export rice prices varied considerably.

Table 5.1

Means, Standard Deviations, and Coefficients of Variation of Average Prices of Rice Exports, 1864-1941

| Period | Mean | Standard deviation | Coefficient of variation |
|---|---|---|---|
| 1864-1890 | 46.3 | 8.5 | 18.4 |
| 1890-1941 | 88.9 | 36.0 | 40.6 |
| 1864-1874 | 45.3 | 11.4 | 25.2 |
| 1874-1890 | 46.6 | 6.2 | 13.2 |
| 1890-1910 | 76.7 | 17.3 | 22.6 |
| 1910-1941 | 96.7 | 42.2 | 43.6 |
| 1890-1900 | 64.4 | 15.3 | 23.7 |
| 1900-1910 | 90.2 | 4.1 | 4.6 |
| 1910-1920 | 112.3 | 58.2 | 51.8 |
| 1920-1930 | 112.4 | 9.5 | 8.4 |
| 1930-1941 | 68.8 | 22.8 | 33.2 |

Source: Computed from data in Appendix Table 1.

What conclusion can be drawn regarding the uncertainty in rice prices? In economic theory, price uncertainty has generally meant an inability to exactly predict market prices. Uncertainty of this sort implies price variation, for if prices do not vary, they will be constant and, by definition, predictable and certain. But variation alone does not imply uncertainty, for in reality, there is no such thing as constant market prices. Therefore, prices may vary and the firm may be able to predict the variation. For there to be price uncertainty, price must vary, and, in addition the firm must be unable to predict prices with any substantial degree of accuracy. In standard treatments of economic behavior under uncertainty, it usually is assumed that ability to make such predictions is nil.

Evidence regarding rice prices shows that prices varied considerably throughout the period covered. The large variation in means and variances of rice prices for various sub-periods, especially the periods after 1910, suggests that prices were uncertain and hence difficult to predict. In order to statistically confirm the result, the next step is to test whether the underlying stochastic process that generated the price series can be assumed to be stationary or non-stationary. If the process is stationary, i.e., if it is invariant with respect to time, then, it is possible to predict future prices using past experiences. In economics, this is done by estimating its fixed coefficients via a structural equation or a system of equations using past data. Since stationarity implies equilibrium over time around a constant mean level, the probability of a given fluctuation from that mean level can be assumed to be the same at any point in time. Stationarity is an important property because it guarantees that there are no fundamental changes in the structure of the process that would render prediction difficult or impossible. On the other hand, if the characteristics of the stochastic process are nonstationary, i.e., if they change over time, then, it is

very difficult or sometimes even impossible to predict future prices. Therefore, if the process that generated the series of rice prices under examination is nonstationary, one can conclude that there was indeed price uncertainty during the period under study.

Although it is usually impossible to obtain a complete description of a stochastic process via any statistical tools, the autocorrelation function (or, as it is sometimes called, the correlogram is recognized as a device used to obtain a partial description of the process. The autocorrelation function is a measure of the correlation between neighboring data points in a series. It is generally used to test whether a series is stationary or not.[1] In the paragraphs that follow, the autocorrelation function will be used to analyze the stochastic process involved in the series of rice prices. But first, the concepts of stationarity and nonstationarity of a stochastic process will be examined further.

Let Y be the series of rice prices, so that $y_1$ denotes the first observation, $y_2$ the second, and $y_t$ the last observation in the series. The stochastic processes of sequences of random rice prices, $y_1, y_2, \ldots, y_t$, can be thought of as having been generated by a set of jointly distributed random variables. In other words, the set of data points $y_1, y_2, \ldots, y_t$ represents particular outcomes of the joint probability distribution function $p(y_1, y_2, \ldots, y_y)$. Also, a future observation $y_{t+1}$ can be thought of as being generated by a conditional probability distribution function $p(y_{1+1} | y_1, y_2, \ldots, y_t)$. A stationary process is defined as one whose joint distribution and conditional distribution are invariant with respect to time. That is, if the series of rice prices, $y_t$, is stationary, then

$$p(y_t, \ldots + y_{t+k}) = p(y_{t+m}, \ldots + y_{t+m+k})$$

and

$$p(y_t) = p(y_{t+m}), \text{ for any } t, k, \text{ and } m.$$

When the series is stationary, the mean of the series, defined as

$$\mu_y = E(y_t)$$

must also be stationary or constant, so that

$$E(y_t) = E(y_{t+m}) \text{ for any t and m.}$$

The variance of the series, defined as

$$V_y = E[(y_t - \mu_y)^2]$$

must also be stationary or constant, so that

$$E[(y_t - \mu_y)^2] = E[(y_{t+m} - \mu_y)^2]$$

Finally, for any lag k, the covariance of the series, defined as

$$r_k = Cov(y_t, y_{t+k}) = E[(y_t - \mu_y)(y_{t+k} - \mu_y)]$$

is stationary, so that

$$Cov(y_t, y_{t+k}) = Cov(y_{t+m}, y_{t+m+k})$$

Autocorrelation with lag k is defined as

$$@_k = \frac{Cov(y_t, y_{t+k})}{S_{yt}S_{yt+k}}$$ , where S is the standard deviation.

For a stationary process the variance at time t is the same as the variance at time t+k, thus

$$@_k = \frac{Cov(y_t, y_{t+k})}{V_y}$$

or $$@_k = \frac{r_k}{r_o}$$

Therefore, when a series of $@_k$ is calculated from the data, the sample autocorrelation function or the relationship between $@_k$ and k can be plotted.[2] If the autocorrelation function drops off quickly as k (the number of lags)

increases, the series is stationary. On the contrary, if the series is nonstationary, the autocorrelation function will remain large even for the long lags.[3] What is important for determining stationarity is the sharp declined in $@_k$ for the first few periods. In a case in which the autocorrelation tapers off slowly, the considered process is likely to be nonstationary. For example, consider the process

$$y_t = y_{t-1} + x_t$$

where x is a stationary time series with mean $\mu \neq 0$, at time $t = 0$, with $y_0 = 0$. In this case

$$y_t = (y_{t-2} + x_{t-1}) + x_t = y_{t-3} + x_{t-2} + x_{t-1} + x_t = \ldots x_1 + x_2 + \ldots + x_t$$

and, $E(y_t) = t\mu$.

In this case, the mean is not constant since it follows a linear trend. Hence, the series is nonstationary because stationarity requires a constant mean. When a process is suspected to be nonstationary, differencing is suggested as a tool for testing and converting a nonstationary process to a stationary process. This method is very useful and has received considerable attention in recent time series analysis. In using differencing to test for nonstationarity, the series is differenced one or more times to remove the trend. The autocorrelation function of each succeeding differenced series is then recalculated and compared to determine the appropriate number of times the series should be differenced to arrive at a stationary series. A time series that is stationary after d time differencing is sometime called homogeneous nonstationary of degree d. For example, if the second round of differencing results in a series whose autocorrelation function drops off rapidly, then we can

determine that the original series is second-order homogeneous nonstationary. Thus, if $y_t$ is first-order homogeneous nonstationary, the series

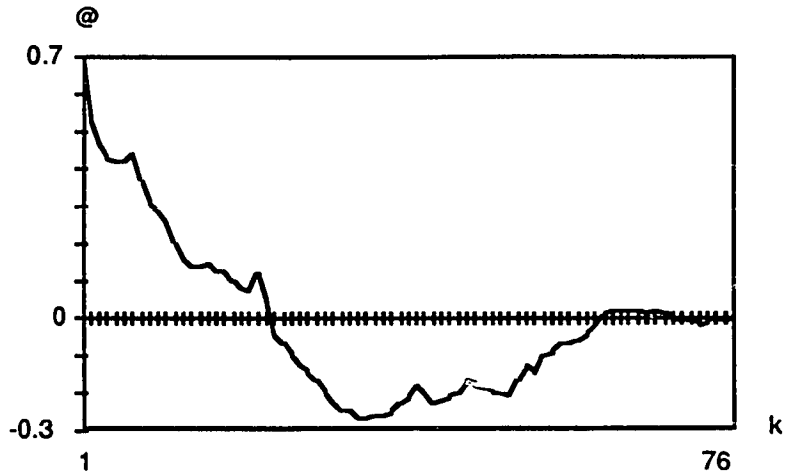
$$w_t = y_t - y_{t-1} = \Delta y_t$$

is stationary. Similarly, if $y_t$ is second-order homogeneous, then the series

$$w_t = \Delta^2 y_t = \Delta y_t - \Delta y_{t-1}$$

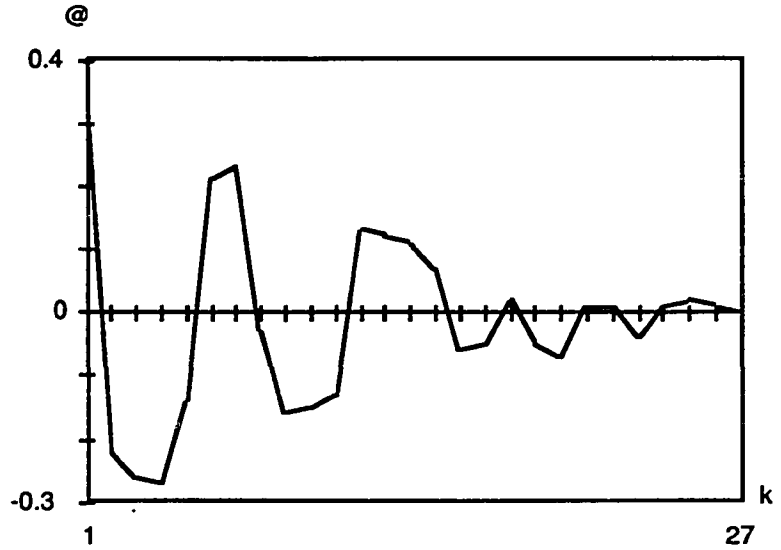
is stationary.

The above methodologies will now be applied to analyze the stationarity of the time series of rice prices. Figure 5.1 and the information regarding rice prices presented in Table 5.1 suggest that rice prices before 1890 may be stationary because the means for sub-periods during 1864-1890 are fairly stable and the differences in the standard deviations are also relatively small. Therefore, three periods of rice prices will be tested for stationarity: (1) the whole period 1864-1941, (2) the period 1864-1890, and (3) the period 1890-1941. The autocorrelation functions of rice prices for the three periods are shown in Figures 5.2 through 5.4.



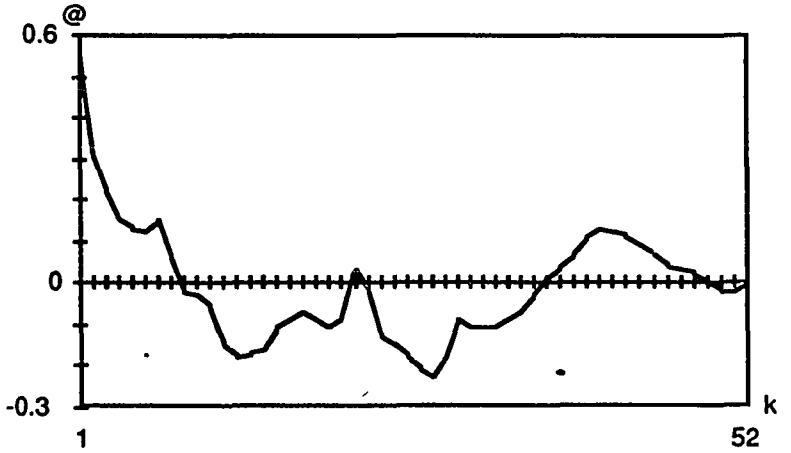

Source: Appendix Table 11.

Figure 5.2 Rice Export Prices: Autocorrelation Function of Yt, 1864-1941




Source: Appendix Table 11.

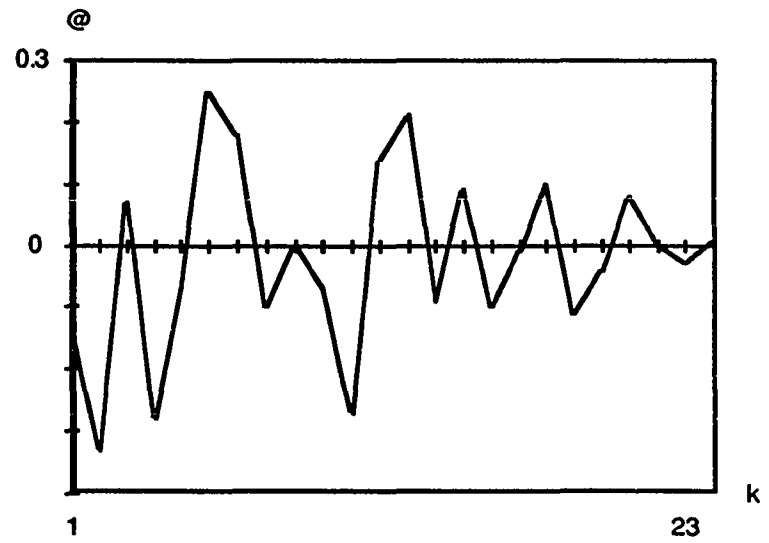
Figure 5.3 Rice Export Prices: Autocorrelation Function of Yt, 1864-1890




Source: Appendix Table 11.

Figure 5.4 Rice Export Prices: Autocorrelation Function of Yt, 1890-1941

The autocorrelation function of rice prices for the period 1864-1890 tapers off rather quickly with a growing k. The remaining portion of the graphs appears to be random with zero means. This result implies that rice prices during 1864-1890 were quite stable and hence predictable. The stationarity of this series is also confirmed by the autocorrelation functions of the differenced series, which is presented in Figure 5.5. The resulting autocorrelation functions have not changed and hence imply the stationarity of the original series.

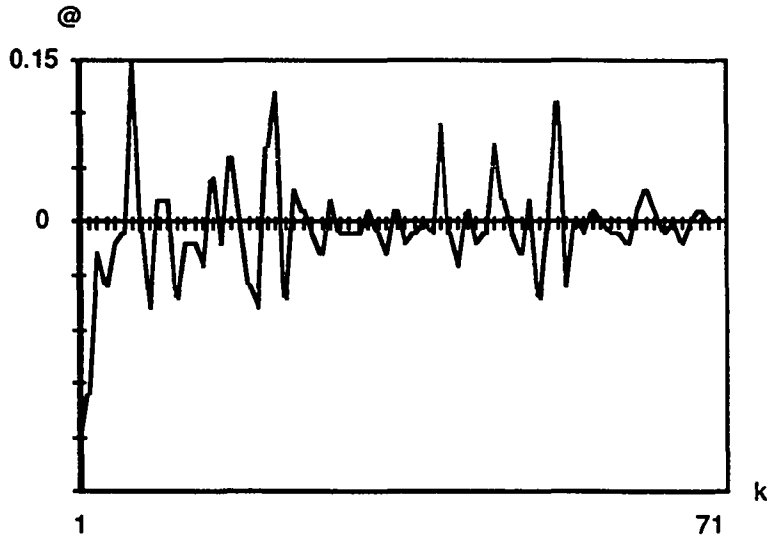



Source: Appendix Table 12.

Figure 5.5 Rice Export Prices: Autocorrelation Function of ΔYt, 1864-1890

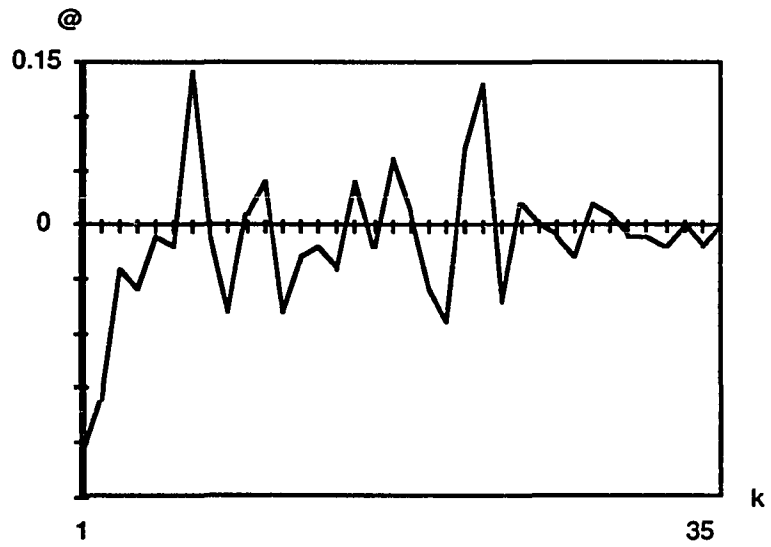
For the periods 1890-1941 and 1864-1941, the corresponding autocorrelation functions do seem to decline as the number of lags becomes large. Thus, one might at first suspect that the two series are stationary. Both series, however, exhibit upward trends (this means the means are not constant over time) and the autocorrelation functions declined only slowly. The two series are probably homogeneous non-stationary processes. To check, the two series are differenced two times and their autocorrelation functions are recalculated. As shown in Figures 5.6 through 5.9, the resulting autocorrelation functions of both series appear more stationary as do the series themselves. The autocorrelation functions of the twice-differenced series decline more rapidly than do the autocorrelation functions associated with differencing once. To confirm the conclusion, the two series are differenced a third time. As shown in Figures 5.10 and 5.11, the results do not seem qualitatively different from

those obtained from the twice-differenced series. Therefore, the second differencing is sufficient to ensure stationarity for both series. The series of autocorrelations of the original and the differenced series for these three periods are provided in Appendix Tables 11 and 12, respectively.



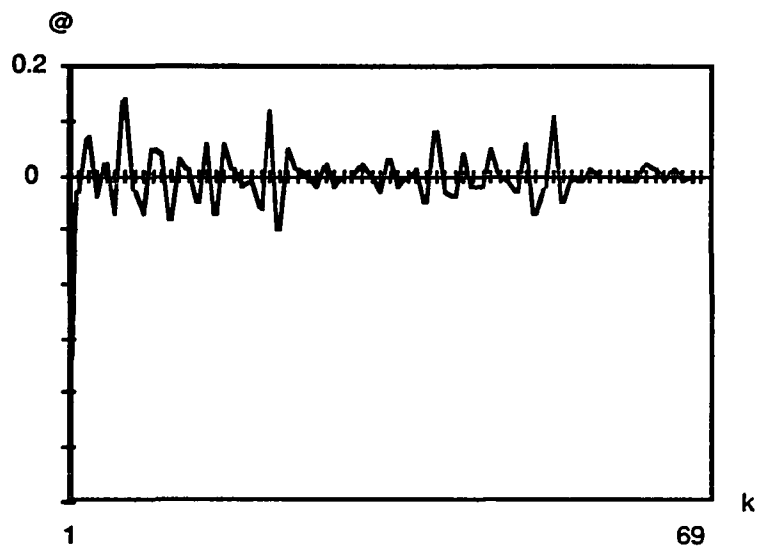

Source: Appendix Table 12.

Figure 5.6 Rice Export Prices: Autocorrelation Function of ΔYt, 1864-1890



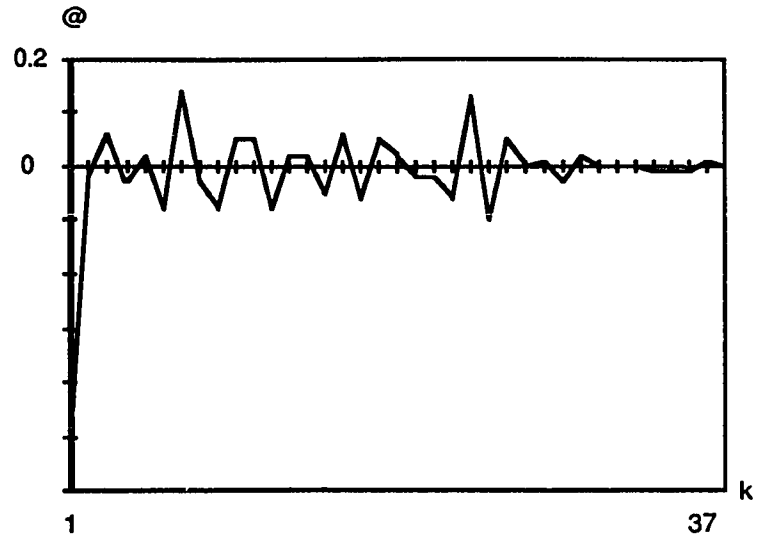

Source: Appendix Table 12.

Figure 5.7 Rice Export Prices: Autocorrelation Function of ΔYt, 1890-1941



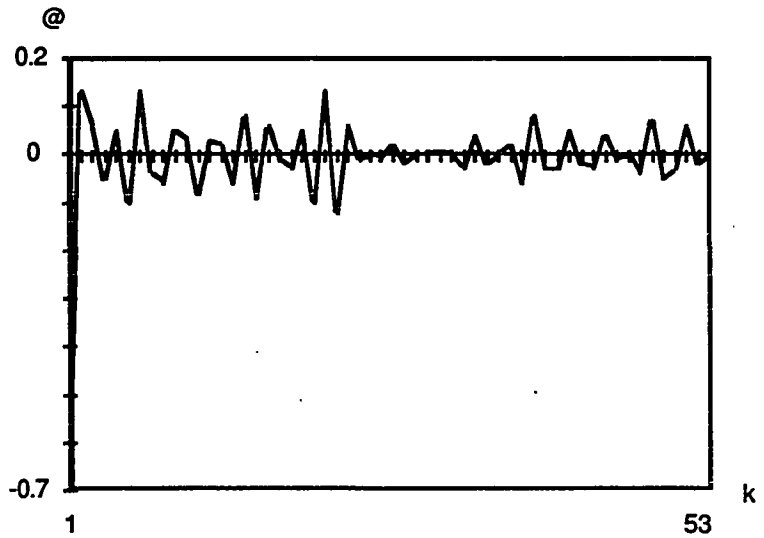

Source: Appendix Table 12.

Figure 5.8 Rice Export Prices: Autocorrelation Function of $\Delta^2$Yt, 1864-1941



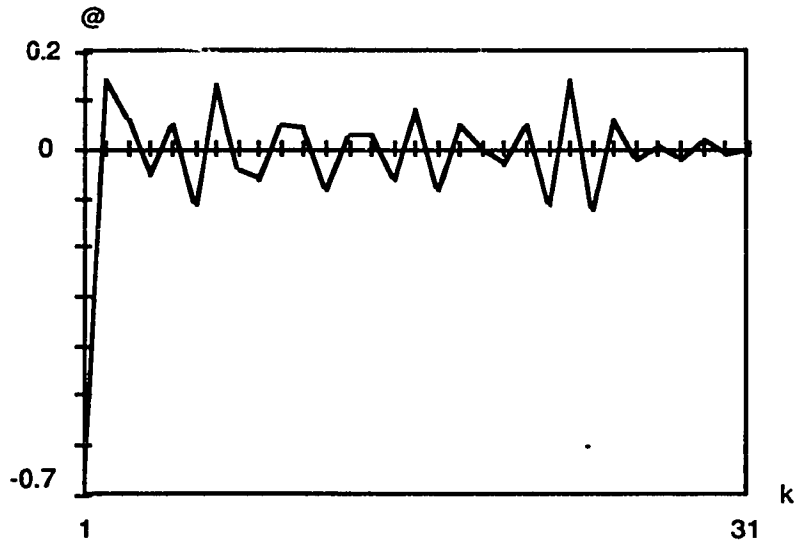

Source: Appendix Table 12.

Figure 5.9 Rice Export Prices: Autocorrelation Function of $\Delta^2 Yt$, 1890-1941




Source: Appendix Table 12.

Figure 5.10 Rice Export Prices: Autocorrelation Function of $\Delta^3 Yt$, 1864-1941




Source: Appendix Table 12.

Figure 5.11 Rice Export Prices: Autocorrelation Function of $\Delta^3 Yt$, 1890-1941

The results of the examination of rice prices during 1864-1941 show that there was significant price uncertainty during 1890-1941, but not during 1864-1890. These results imply that it was difficult for rice producing firms to predict prices during the period 1899-1940. They also reenforce the conclusion of Chapter IV, that the choice of broadcasting on the young delta during 1890-1910 was caused by uncertainty in land ownership. Since rice prices prior to 1890 appear to be predictable, cultivators and landowners who migrated onto the young delta may have expected future prices to follow the same pattern. Therefore, it is reasonable to argue that, without uncertainty in landownership, those areas in the young delta which were dominated by broadcasting would have been farmed by using the transplanting technique.

Although the conclusions on price uncertainty in this section are solely drawn from an analysis based on nominal prices. It is possible to infer that

these nominal prices were the ones that cultivators faced. During the period rice exports dominated the Thai economy. They were almost the only source of income for commercial cultivators on the Central Plain. Moreover, rice was the main staple of the Thai diet. In this regard, the movement in nominal rice prices dominated the economy. It should also be noted here that this pattern of rise and fall in rice prices was also faced by other Asian rice-export countries during the period, for example Burma (Cheng 1968: 73). Birnberg and Resnick (1975) observe high volatility of various export commodities during the same period. Indeed, the pattern is similar to the world business cycle at the time. During World War I, prices fell. After the war ended, prices rose again. Prices declined during the late 1920s and dropped drastically in the 1930s due to the world wide trade depression. Prices of all agricultural products fell more heavily than the already drastic fall in prices in general. From 1935 on wards, prices rose until the outbreak of World War II. In the next section, the condition such that firms will choose broadcasting under price uncertainty will be examined.

## 5.2 Large Landowners, Tenancy, and Large Tenants, 1890-1940

The trend in farm size on the Central Plain during the period under investigation appears to have increased and, thus, follows the same pattern as the dominance of broadcasting. Feeny shows that the trend in farm size on the Central Plain for the period from 1884 to 1949 appears to have increased until the 1930s. This trend is consistent with the trends in paddy area cultivated per person and cultivated area of all major crops per person during the same period (Feeny 1982: 44-6, 145). The family farm size in the commercialized areas of the Central Plain were higher than in other regions. Zimmerman (1931) reported that, in 1930, the average number of rai cultivated per family on the

Central Plain was 24 versus ten in the north, six in the south, and seven in the northeast (Zimmerman 1931: 18). The average family farm size in the Rangsit area was larger than anywhere else in the country. It was as large as 58 rai. The larger farm size on the Central Plain and in the Rangsit area was not due to family size because differences in family size between regions and provinces on the Central Plain were not significant (see Zimmerman 1931: 21-4).

The increase in farm size on the Central Plain during the period also appear to correlate with the emergence of tenancy in the area. Johnston (1975) and various investigators[4] indicate that, tenancy developed and increased in the late nineteenth century in newly settled areas on the young delta, such as the area around Bangkok and Rangsit. The proclamation pertaining to the Nakornnougkhet Canal issued in 1877 clearly indicated that large landowners were increasing in areas of newly constructed canals (Sathian Laiyalak et al., 9: 202-4). In older settled areas on the Central Plain and other regions, tenancy was rare. Zimmerman (1931) and Andrews (1935) provide various indicators of the degree of tenancy in different parts of Thailand during the 1930s. Feeny (1982) also computed the amount of land rented per family in terms of percentage of the total area cultivated using the Zimmerman survey data. All these indicators are presented in Table 5.2. Tenancy in the commercialized provinces of the Central Plain was higher than in other regions. The degree of tenancy in Rangsit is the highest, about 94 percent of cultivators owned no land, and 97 percent of the total cultivated area was rented land. Zimmerman (1931:19) also states that most of the land in Rangsit and other east bank districts was held by absentee landlords who resided in Bangkok.

Table 5.2

Indicators of the Degree of Tenancy in Thailand, 1930-1935

| Location | Land rented as % of the total area cultivated per family | Proportion of families owning no land | Average rent on farm paid per family (baht) |
|---|---|---|---|
| Central Plain | 37.6 | 36.0 | 19.6 |
| Bangkok | 47.9 | 78.0 | 16.6 |
| Thonburi | 26.5 | 54.0 | - |
| Thanyaburi | 96.5 | 94.0 | 56.7 |
| Ayuthya | 39.3 | 42.0 | 40.3 |
| Lopburi | 16.7 | 12.0 | 9.9 |
| Saraburi | 7.9 | 36.0 | 9.5 |
| Pitsanulok | 2.0 | 2.0 | 0.3 |
| Suphanburi | 7.4 | 8.0 | 17.6 |
| Petchaburi | 37.5 | 46.0 | 35.3 |
| Chachoengsao | 49.3 | 42.0 | 17.8 |
| Chandaburi | 13.5 | 9.0 | - |
| Northern Region | 12.0 | 27.4 | 2.1 |
| Southern Region | 15.2 | 14.5 | 1.3 |
| Northeastern Region | 5.7 | 18.0 | 0.2 |

[a] Computed by Feeny (1982: 161), using the Zimmerman survey data (1931: 25-32).

Sources: Data on proportion of families owning no land are taken from the Zimmerman survey (1931: 25-8). Data on average land rent on farm paid per family are taken from the Andrews survey (1935: 111-5).

In conclusion, tenancy and large absentee landlords appear on the young delta in the late nineteenth century and increased in number during the twentieth century. They developed from the traditional patrimonial system manifested by the granting of lands to members of the royal family, nobles, and government officials.[5] Although the total area owned by large absentee landlords at the time is unavailable, the extent of this pattern of land ownership can be traced to edicts and writings at the time. The reclaimed lands along newly constructed canals were often taken by nobles and officials in the early days of canal construction.[6] Prince Narathip, an important entrepreneur at the time, also described the same situation in his personal letter to the king in 1898 (A. R5. KS. 15/25). In fact, much of the land along newly constructed canals, presented in Appendix Table 5, was reported to be owned by large landowners.[7] The increase in large landowners in commercialized areas of the Central Plain during the early twentieth century was an issue of government concern as indicated as indicated in documents on land laws and one of the king's edict on prohibiting such landholding.[8] The extent of increase can be inferred from land laws issued during the period.[9] Clauses were included in land laws to prevent large scale landownings. For example, there were complicated procedures for granting permission and issuing land documents to individuals who applied for a plot larger than an average family farm. The Land Act of 1908 did not specify an amount a person could claim, but the Land Act of 1936 fixed the limit at 8 hectares. Documents regarding royal rice lands (*na luang*) during 1868-1910 reveal that most royal rice lands were located in commercialized areas on the young delta and covered a considerable area.[10] Although this information does not provide a comprehensive picture of royal rice lands during the period, it outlines the location of principal royal rice lands. In

brief, new commercialized areas on the young delta were characterized by large absentee landlords, tenancy, and large tenants. Detailed information from Rangsit is described below.

As discussed in Chapter IV, after 1910 most of the cultivation in Rangsit was conducted by tenants of large absentee landlords. Indeed, an inspection survey report in 1906 from the Department of Revenue and official reports for the period 1910-1930 from the Ministry of Agriculture indicated that rice farming in Rangsit after 1910 was characterized by large farms, the use of more hired labor than in other regions, and a higher degree of tenancy than in other Central Plain rice farming areas.[11] These official reports also stated that most of the paddy land in Rangsit was managed by overseers and belonged to large absentee landlords who resided in Bangkok. Data regarding area owned by resident and nonresident owners in Rangsit after 1910 are available for Thanyaburi Province which was the province established in 1901 as an administrative center for the Rangsit area. Table 5.3 presents data regarding areas owned by local farmers and nonresidents in Thanyaburi for 1914. As shown, only 18.7 percent of the total paddy land in Thanyaburi was owned by local people. The rest belonged to nonresidents including SCLIC, the king, the royal family, and people who resided in Bangkok. If one assumes that the 18.7 percent of the paddy land owned by local people was farmed by landowners themselves, then, about 81.3 percent of the total paddy land in Thanyaburi was farmed by tenant farmers. In addition, it is possible that some local landowners might have rented out their land. If this was true, the percentage of rented land in Rangsit may have been higher than 81.3 percent.

Table 5.3

Areas Owned by Different Types of Landowners in Thanyaburi, 1914

| Type of landowner | Area owned (1,000 ha) | Area owned As % of the total area |
|---|---|---|
| (1) SCLIC | 1,291.0 | 1.2 |
| (2) The king and royal family | 3,201.8 | 3.0 |
| (3) Bangkok residents | 81,090.4 | 76.7 |
| (4) All nonresidents [(1) + (2) + (3)] | 85,583.2 | 80.9 |
| (5) Residents | 19,792.8 | 18.7 |
| (6) Vacant land | 320.0 | 0.3 |
| Total | 105,696.0 | 100.0 |

Source: A. R6. N. 10.4/5. Figures are converted from rai to hectare using 6.25 rai = 1 hectare.

Thanyaburi did not cover the whole Rangsit area, which extended into five adjacent provinces on the Central Plain (A. KS. 10/47). Nevertheless, the pattern of landownership in Thanyaburi appears to have been representative of the pattern in the whole Rangsit area. Evidence to support this conclusion is based on data and information on SCLIC's land sales and estimates of the areas owned and farmed by different types of landowners for Rangsit in the 1910s.

The pattern of SCLIC's land sale indicates a tendency toward large landholding in Rangsit since 1901. Information regarding the number of purchasers of each plot size and the average size of landholding is incorporated into Table 4.4 (in Chapter IV) and shown as Table 5.4. About 45.7 (41.6 + 4.1) percent of the total land sales was sold to a small number of people. The information regarding large agricultural landholding on the Central Plain in 1946 reveals that the pattern of large landholding in Rangsit and other provinces on the young-delta in the 1910s remained that way (A. M. 0601.4.8/6). Therefore, one may assume that the pattern of large landholding in Rangsit remained constant throughout the period under study. In addition, another 37.1 percent of the total land sales was of plot sizes that could be farmed only with the aid of hired labor. Only 17.2 percent of the total land sales were small plots sold to small farmers.

Table 5.4

The Siam, Canals, Land and Irrigation Company's Rangsit Land Sales, 1892-1901

| No. of purchaser | Average size size of landholding (ha) | Area as % of the total land sales |
|---|---|---|
| 986 | 13.4 | 17.2 |
| 614 | 46.5 | 37.1 |
| 25 | 127.6 | 4.1 |
| 55 | 581.4 | 41.6 |

Sources: Appendix Tables 6 and 7.

As discussed in Chapter IV, about 35.1 percent of the 1901 developed land in Rangsit was occupied by squatter farmers, with the land later reassigned to SCLIC. During the 1900s, the company resold this land in large plot sizes to nonresidents. Rangsit land developed after 1901 was sold in the same manner. The data and information presented in Table 5.4 can be used to estimate areas owned by different types of landowners for the Rangsit area in the 1910s. Information on the area developed after 1905 in Rangsit is limited, but company and official documents regarding the Rangsit land development project indicated that land development in Rangsit after 1905 was minimal. Therefore, the developed area in Rangsit (219,647 hectares) in 1905 will be used as the approximate cultivated area for Rangsit in the 1910s. The results of the estimation shown in Table 5.5 demonstrate that, after 1910, about 81 percent of the Rangsit land was owned by large absentee landlords. These estimates support the conclusion that after 1910 most of the lands in Rangsit were owned by large absentee landlords.

Table 5.5

Estimates of Area Owned by Different Types of Landowners for Rangsit, 1910s

| Type of landowner | Area owned (1,000 ha) | Area owned as % of the 1905 developed area (219,647 ha)[a] |
|---|---|---|
| (1) Small owner-operators | 13.2 | 6 |
| (2) Medium owner-operators | 28.6 | 13 |
| (3) Large landowners (bought from SCLIC during 1892-1901) | 35.2 | 16 |
| (4) Large landowners (bought lands occupied by squatters in 1900) | 41.7 | 19 |
| (5) Large landowners (bought lands developed during 1901-1905) | 100.9 | 46 |
| (6) Total area owned by large landowners [(3) + (4) + (5)] | 277.8 | 81 |
| Total | 219.6 | 100 |

[a] See Appendix Table 8 for details.

Sources: Estimated from the data in Tables 4.4 and 5.4.

Since large absentee landlords did not farm their lands but rented them to tenants, the estimates in Table 5.5 are consistent with Zimmerman's survey data on the dominance of tenancy in Rangsit presented in Table 5.2. The 10 percent different from the Zimmerman data may have been due to an increase in renting out land by medium size landholding owners through time. In brief, evidence from Rangsit shows the dominance of large absentee landlords, tenancy, and large tenants in the area after 1910.

The official reports cited earlier indicated that the dominant type of tenure form in Rangsit was fixed-cash rent. Nine available original copies of contracts between landlords and tenants in Rangsit dated between 1899-1932 revealed the same information.[12] This evidence on type of contract employed, confirms the conclusion that most of the land in Rangsit was owned by large absentee landlords and farmed by tenant farmers. Experience elsewhere shows that most absentee landlords favored fixed-rent contracts (Alston and Higgs 1982, Bliss and Stern 1982, Chao 1983). Modern contract theory holds that fixed-rent contracts are designed to control labor shirking (Eswaran and Kotwal 1985). Since most absentee landlords lacked farming management experience and had better alternative jobs or both, they may not have wanted to assume management roles and therefore tended to choose fixed-rent contracts.

In conclusion, there was price uncertainty during 1890-1940. In addition, rice cultivation in the commercialized areas on the young delta during the period was characterized by large absentee landlords, tenancy, and large tenants. As predicted by the model in Chapter II, under price uncertainty, large firms that are either renters or landowners are likely to choose broadcasting. Therefore, the choice of broadcasting on the young delta during the period was the result of price uncertainty.

## 5.3 Price Uncertainty, Large Landholding, and Production Flexibility

Evidence presented in the previous sections on price uncertainty and the dominant type of rice producing firms on the young delta are consistent with the hypothesis under examination. This section will present two types of evidence to support the argument that large landowners and large tenants needed production flexibility and that broadcasting was the optimal technique under such economic conditions. They are: (1) the dominance of short-term leases in commercialized areas on the young delta, and (2) the fluctuation in demand for rented land and wage labor.

### 5.3.1 Short-term Leases

Short-term leases were observed in the commercialized areas of the Central Plain during the period under study (A. R7. M. 31/3). Prior to that, royal rice lands were cultivated by clients attached to the king under the supervision of various ministries (*phrai luang*), and the harvest was delivered to royal warehouses (A. R4. KS. 3.2/19, A. KS. 1/90). Nobles'lands were worked by their clients (*phrai som*) and slaves (Tomosugi 1980: 125).[13] After the rapid increase in rice prices during 1890-1900, officials in charge of the management of royal rice lands on the Central Plain were ordered by King Chulalongkorn to rent out royal rice lands on a yearly basis.[14] For the Rangsit area and the east bank districts, short-term leases, mostly of one year, were reported in annual crop survey reports from the Ministry of Agriculture during 1900-1930 as the dominant lease form.[15] The nine original contracts in Rangsit cited earlier were all short-term leases. Six of them were one-year leases, one was for two years, and the other two were for three years. The dominance of one-year leases in

Rangsit was also reported in Zimmerman's 1930 survey (Zimmerman 1931:305).

A number of reasons for the existence of short-term leases emphasize the flexibility advantage of short duration leases over long-term leases (Williamson 1985, Cheung 1969, Maguire 1972, Mokyr 1983, Currie 1981). Williamson (1985: 339) states that a leading advantage of recurrent short-term contracting over long-term contracting is that the former facilitates adaptive and sequential decision making. Cheung (1963: 83-5) states that in a world where transaction costs are greater than zero, relatively short lease durations are chosen to reduce costs of enforcing contract terms and costs of negotiating these terms. He argues that short-term leases in share contracts are chosen as a device to facilitate contractual renegotiation because resource allocation under shared contracts is more complicated than fixed-rent contracts. Differential knowledge by the contracting parties to market conditions may lead to differences of opinion as to whether a revision is desirable. The revision may entail a distribution of income, causing one party to be worse off. A relatively short lease duration is therefore a convenient device which allows resource reallocation in the event of unsuccessful renegotiation.

Maguire (1972:130-1) argues that the main cause of the movement from long leases to short leases in Ireland in the decades before the Irish famine was the postwar agricultural depression and the long period of fluctuation in the value of agricultural produce during 1790-1820 (see also Mokyr 1983: 83-4]). Many Irish landlords were reluctant to renew leases and inclined to replace leaseholders with tenants-at-will during the period. The author explains that when price movements are not fully anticipated, long-term leases create inflexibility between landlords and tenants. When prices rise, the real value of

the rents decline and the landlords cannot adjust nominal rents upward to reflect the new price level, unless the leases expire. When prices drop, the real value of the rents due does not rise accordingly. Most tenants will demand and often receive reductions in rents. Others often fall into arrears or may simply abandon their holdings. Eviction of tenants in this situation does not compensate for the landlords' previous loss of income. Therefore, landlords might forego a portion of future income if they granted long-term leases during violent price movements.

Currie (1981: 95-6) provides evidence from England similar to the case of Ireland. During the depression following the Napoleonic wars, English tenant farmers on long-term leases suffered considerably because they were unable to meet the commitments. Some landlords agreed to permanent rent reductions or temporary rent abatements, but these remedies came too late for the farmers. Thereafter, English farmers were extremely suspicious of long-term commitments. As a result of this general disenchantment with long leases, the landlords instituted one year tenancies.

For competitive markets, the existence of short-term leases often reflects the need for flexibility of both contracting parties. If prices are unpredictable, leases lasting for fixed and certain but relatively short periods of time would create less institutional rigidities limiting the responsiveness of rents to changing market conditions. Under price uncertainty, it is extremely difficult for both parties to have a long-term view in determining what rents they would be prepared to commit themselves to each year. This explanation is consistent with the existence of short-term leases on the young delta and Rangsit during the period under examination. As shown in the previous section, rice prices varied considerably with an unpredictable pattern. Given the situation, long-

term leases would restrict the opportunities of both parties to adapt their production plans.

Short-term leases are seen by some economists as a cause of underinvestment in agricultural improvements. This particularly concerns classical economists.[16] The essence of this argument is that short-term leases reduce the expected value to the tenant of the marginal product of semi-durable and durable inputs (Marshall 1920). Classical economists argue that with a short-term lease and in the absence of any provisions for compensatory payments, a tenant would have no incentive to undertake any land development because all or most of the benefits would accrue to the landlord if and when the lease is terminated. Mill (1899) also adds that short-term leases are detrimental to agricultural development. McCulloch (1843) states that there are considerable hazards to those who invest capital in agricultural improvements under short-term leases. Land improvements increase the rental value of the land. Therefore, the tenant might not only end up bearing the costs of the development but also suffer higher rents or eviction as a consequence.

The above argument on the effects of short-term leases is criticized by Mokyr (1983). He argues that some increase in the rent following the tenant's improvements is perfectly consistent with competitive behavior and will not lead to underinvestment. He terms this type of landlord behavior "neoclassical" behavior. In production theory, factors of production in agriculture are complementary in the sense that increasing one input raises the marginal product of the other. Therefore, capital employed in land improvements can raise the marginal product of land. Since rent is not only a payment for the natural and indestructible properties of the land but also the quantities of reproducible factors utilized in the production process, rent charged by the

landlord would have to be increased after land improvements. Investment results in higher competitive rents regardless of who carries it out. Therefore, the inference that land improvements made by the tenant results in a higher land rent is sufficient evidence for the argument is false.[17] Mokyr, however, considers further the effect of short-term leases on agricultural improvements. He states that it is conceivable that the landlord may raise the rent to the full value of the improvements his tenant makes. In this case, the tenant's incentive for investment may be impaired and underinvestment may indeed occur as a consequence. Mokyr distinguishes this type of landlord behavior from "neoclassical" behavior and terms it "predatory" behavior.[18]

The above framework implies that the neoclassical landlord earns a steadily increasing rent along with the accumulation of his tenant's capital. The predatory landlord would earn a once-and-for-all windfall at the cost of a continuous stream of future rents, since his tenants would learn to translate such behavior into their expectations of future income. Therefore, the theory appears plausible under only some circumstances, for example for a declining industry, but systematic evidence has not yet been found. Another shortcoming of the framework lies in the empirical testing of the hypothesis. Since the essence of the framework is the extent of the increase in rent, it requires knowledge of marginal factor productivities in order to determine if the rent increase was indeed predatory. It is extremely difficult to measure the magnitude of the rent increase and consequently to distinguish between predatory and competitive behavior. What may seem predatory behavior in the presence of a short-term lease could be considered as competitive behavior in the presence of a longer-term lease. Furthermore, it is possible that the

tenants'decisions were dictated by their perceptions of their landlords'behavior rather than the actual behavior.

In Rangsit, the available evidence regarding predatory behavior on the part of landlords is anecdotal. In an official report of the Minister of Agriculture to the king in 1907, the minister reported that in the 1890s, there were some landlords who rented land to tenants on a rent-free basis during the initial years of cultivation. Once the lands were cleared and developed, rents were charged and increased through time (A. KS. 3.1/13). In 1930, during the course of Zimmerman's survey in Rangsit, one case was found where a tenant improved the farm by bunding, expecting that he would receive the return from such land improvements for ten years. In three years the land was sold and the rent was raised (Zimmerman 1931). Another complaint from tenants in Rangsit during the period concerned increases in land rents (A. R5. KS. 3.1/11).

As discussed earlier, increases in rents following land improvements is consistent with neoclassical theory. Increasing rents following a period of free rent during the early years of land development may simply represent payments for land improvements costs from landlords to tenants. Only one case of what appears to be a predatory relationship was found by Zimmerman. The increases in rents may only represent a competitive return to landlords since rice export prices were rising over the period. Information on the magnitude of rent increases and farmers' returns is needed before a conclusion of excessive rent increases can be made.

Although one may infer that the dominance of short-term leases may be due to tenants' belief of predatory behavior on the part of landlords, predatory landlordship is not likely to persist among a large number of rational landlords since they must sacrifice some of their own future income. Even if the tenant

perceives predatory landlord behavior and does not want to undertake any land investment, the landlord may make the investment and both may arrive at a first best solution. The landlord may recoup his costs of the investment by raising the rent. If the landlord expects that the tenant does not intend to renew the lease in the next period and might behave in ways which would lead to exhaustion of the soil, devices for protecting his property can be incorporated into the contract. This statement is supported by evidence on lease contracts in England during the nineteenth century (Currie 1981: 71). In those days, English landlords who employed fixed-rent contracts used a variety of precautionary devices to protect their properties from abuse. One method was to set leases at twenty-one years, with an additional seven years exercised at the option of the landlord. Under this arrangement, if the tenant exhausted the fertility of the land at the termination of the twenty-one-year lease, he could be forced to stay on and suffer the consequences himself.

Furthermore, the security of tenure and the flexibility of rents can be reconciled in a number of ways. First, both parties may agree on a formula relating rents to specified indicators of economic conditions in agriculture. Second, both parties may employ a formula using agricultural prices. The rental payment could be based on a bundle of agricultural commodities, converted into a money payment at prevailing market prices. In brief, the argument that short-term leases lead to underinvestment in agricultural improvements or the choice of broadcasting lacks systematic evidence and theoretical support. Short-term leases observed on the young delta provided flexibility or, in other words, reflected the need for production flexibility of both contracting parties. This evidence supports the hypothesis that, under price

uncertainty, large landholding firms need production flexibility, and a flexible technique like broadcasting is the optimal choice.

5.3.2 Fluctuation in Demand for Rented Land and Wage Labor

Since rice was the major agricultural export during the period, movements in rice prices had a great impact on the manner of production. Evidence regarding the fluctuation of rice production support this conclusion. The rapid settlement and investment on the young delta during 1890-1900 took place during the period of highest increase in rice prices. The declining of rice prices in the late 1900s, the 1910s, and 1920s and a sharp drop in the 1930s worked to a slower pace of expansion. Between 1880-1909, prices increased rapidly, exports increased more than four-fold in terms of volume and more than eight-fold in terms of value. Between 1905-1929, prices and quantity of exports fluctuated significantly. The volume of exports doubled, while the value of exports increased slightly more than two-fold. The 1930s depression was followed by World-War II, which led to disruption in international trade. During and since World War II, rice exports have formed a much smaller share of total production. Farmers had diversified their sources of income, and to reduce their dependence on a single crop. Fluctuation in rice production was due to uncertainty in international market conditions.

Under price uncertainty, the demand for rented rice land and agricultural wage labor also fluctuated. During the period under examination, the mobility of the population and the impermanence of settlers in the Rangsit area and other commercialized districts were reported. As documented in Chapter IV, impermanent settlements in Rangsit and other east bank districts were observed in 1885 and 1895. In 1909 officials from the ministry of Agriculture

indicated that numerous tenants in the Rangsit area resided there only temporarily during the farm season. After the harvest, they returned to permanent homes elsewhere (A. R5. K. 3.1/13). Some abandonment of the land in the Rangsit area was also noted in 1906-1912, 1913, and 1917 ( A. R5. M. 1-23, A. KS. 13/294). Officials noted that the population in different districts of Thanyaburi and Ayuthya, the areas of the highest degree of tenancy and largest farm size, continued to fluctuate (see Johnston 1975: 112-6). Such movement was also reported by Zimmerman (1931: 305-10) to be the characteristic of settlement in the Rangsit area in 1930. This phenomenon appeared obscure to a number of investigators. In this study, it is possible to explain it with the model formulated in Chapter II. These mobile cultivators could be cultivators who settled and owned a small plot in the transplanted zone elsewhere but came to rent and broadcasted additional land in the Rangsit area and the east bank districts during periods of high rice prices. The model demonstrates that a firm which concurrently employs two techniques can increase expected profits. Although, there may be other causes underlying the mobility of tenants, the large variation in rice prices was one of the major causes. When prices dropped during 1910-1912, landlords had difficulty in finding tenants (A. KS. 5/15). Many offered land rent-free, requiring only that the tenants be responsible for payment of the land tax.[19] Rent deduction was reported in commercialized areas of the Central Plain, for example rents were decreased by 50 percent in Nakomprathom. In 1930 rice prices dropped about 18.3 percent [20] from the former year and continued to fall during the next four years, reaching a low point in 1934 at somewhat less than 40 percent of pre-depression levels. In 1932 provincial officials reported that millers and middlemen were able to purchase rice at only one-third to one-half of pre-

depression prices. The typical farmer in Angthong received about 125 baht for a crop which two years earlier would have sold for 400 baht.[21] Zimmerman (1931: 305-10) provides a gloomy description of the 1930 for the Rangsit area as follows:

> The first characteristic of this area is that it is farmed by a mobile population of farm tenants....The farmers came from all sections of Siam and settle on large farm, averaging about 16 hectares in many communes, without any village development. They build their houses along the banks of the canals, of the most flimsy material and according to the crudest patterns....There was no homestead of settled village life as in other sections of Siam....The rice is broadcasted and farming is done by the most extensive of methods....no machinery is used in cultivation other than wooden plow and harrow...no fertilizer is used....The averaged peasant moves very often, especially when the crop was poor or the prices were low....The rent and the tax were not paid if the tenant could move away to other places and started all over again....During the period, the tenants were often advised by officials who understood the problem to bund their fields and transplant but they were not convinced.

Zimmerman's description of rice farming in Rangsit in 1930 is consistent with the hypothesis that, under price uncertainty, a flexible technique such as broadcasting is the optimal technique for large landholding firms. It also explains why landlords did not want to made farming more capital intensive or, in other words, adopt transplanting. One landlord wrote in 1898 that the extensive method like broadcasting was the most profitable choice (A. KS. 3.2/28, A. KS. 9.2/25).

The demand and supply of wage labor during the period appear to follow the same pattern. Throughout the 1890s and early 1900s, seasonal Lao workers came to the Central Plain in gradually increasing numbers.[22] Disruptions of this yearly migration were often reported in official reports during the late 1900s, 1920s, and 1930s, the periods in which prices changed

drastically.[23] Some investigators indicated that the migrant laborers worked as wage labor in government railroad construction projects in years of low prices (Thompson 1941: 613, Ingram 1931). In 1910, when rice price began to increase, after the fall during the recession of the late 1900s, many farmers were still reluctant to farm. They migrated to Bangkok looking for temporary jobs (see Johnston 1975). When rice price increased in 1920, an official report noted that there was no labor shortage in that year (A. KS. 1/2068). This phenomenon was often mistaken by some writers as representative of a labor shortage. In fact, there was a decline in the demand for labor during periods of falling rice prices.

The dominance of rice production in the economy, the uncertainty in rice prices, and the consequent fluctuation in demand for rented rice land and wage labor made the flexible technique, like broadcasting, the optimal technique for large firms. Were it not the technique chosen, outputs in excess of optimum would have involved prohibitive marginal costs, while those at less than optimum would have been very unprofitable. Moreover, the broadcasting technique also required less labor per unit of land. This allowed more ready expansion in cultivated land during boom years. As demonstrated in Chapter II, under price uncertainty, it is more profitable for large landowners and large tenants to choose broadcasting. Evidence regarding the choice of short-term lease and the need for flexibility presented in this section supports this conclusion. Some evidence on cultivators who settled elsewhere but came to rent and farm additional land in the Rangsit area and the east bank districts occasionally also supports the optimality of broadcasting for tenant farmers.

## 5.4 Summary

Evidence examined in this chapter is consistent with the hypothesis that the choice of broadcasting on the young delta during 1910-1940 was a result of price uncertainty. An analysis of the time series of rice prices for the period 1864-1941 shows that prices during 1864-1890 fluctuated but were predictable. Prices during 1890-1941 were subject to a considerable degree of uncertainty. During the period under examination, large landowners, tenancy, and large tenants were characteristic of rice production in the new commercialized areas on the Central Plain. Short-term lease, which was the dominant form of tenure in the area, reflected the need for flexibility on the part of landowners and tenants. Evidence regarding fluctuation in the demand for rented rice land and wage labor supports the conclusion that, under price uncertainty, large landowners and large tenants needed a flexible technique like broadcasting to adjust their production plans. In conclusion, the major finding of this chapter is that the choice of broadcasting on the young delta during 1910-1941 was the result of price uncertainty. The choice was, indeed, optimal under such economic conditions.

# CHAPTER VI

# SUMMARY

## 6.1 Restatement of the Problem

Transplanting and broadcasting are the two major rice production techniques practiced in Thailand. Transplanting is more labor and capital intensive but provides higher and more reliable yields. Evidence shows that transplanting has long been the traditional method of growing rice in the country. During 1890-1940, however, most rice cultivators who migrated into the young delta of the commercialized Central Plain adopted the broadcasting technique. In the older commercial rice producing areas of the Central Plain and other regions, cultivators continued to use the transplanting technique. The majority of cultivators in the newly developed areas continued broadcasting rice for over forty years before reverting back to transplanting.

Conventional explanations for choice of rice cultivation are in terms of local water conditions and factor prices. These two factors, however, cannot explain why cultivators on the young delta during the period chose broadcasting. An investigation of the young delta's physiography and hydrology reveals that the water conditions necessary for transplanting did exist in the area. The fact that cultivators used the broadcasting technique to sew transplanted rice varieties provides additional evidence that the transplanting technique can be used in the area. An explanation based on factor prices appears inconsistent with empirical evidence. Transplanting, the dominant technique in the commercial rice producing areas of the country prior to 1890, remained the dominance technique in those areas during 1890-1940. If the

choice of rice production technique is dictated by factor prices alone, broadcasting should have also been observed in other areas as well. Also, technological development has not played a role in the change from broadcasting to transplanting in the 1930s. Available evidence shows that transplanting has been the traditional rice growing method in Thailand at least since the seventeenth century. Therefore, the practice of broadcasting during 1890-1940 and the change to transplanting in the 1930s cannot be interpreted as a process of technological improvement.

In short, conventional reasons regarding the choice of rice production technique cannot consistently explain the choice of broadcasting in Thailand during the period under study. Since the two rice production techniques differ both in terms of variable input per unit of land and fixed capital input, it appears that an explanation based on both the theory of production and the theory of capital investment would be more satisfactory.

## 6.2 Justification of the Study

This study contributes to conventional knowledge regarding factors affecting choice of rice cultivation technique and, thus, improves the understanding of a firm's choice of technique. Both the theory of production and the theory of investment are employed to study this issue. In this regard, the model allows a simultaneous analysis of the firm's short-run production decision and long-run capital investment. The differences in choice of technique under certainty and uncertainty are analyzed. It was expected that through an analysis focusing on this particular observed choice of technique, greater insights as to the firm's choice of technique could be obtained. The model formulated in this study is simple and empirically oriented, but

nevertheless is adequate to analyze a firm's decision making process. The findings also illuminate relationships between external trade, internal institutions, and agricultural development. While the empirical results presented are specific to Thailand, the process employed here can be applied elsewhere.

## 6.3 Summary

The objective of this study is to explain the choice of broadcasting on the young delta during 1890-1940. The choice of technique model formulated in this study is a simple neoclassical production relation modified to incorporate fixed capital inputs and the firm's planning horizon. The underlying assumptions include: (1) the firm is a price taker and produces only one homogeneous product, and (2) there are no changes in known technology over the planning period. The model yields refutable hypotheses regarding a firm's choice of rice cultivation technique. In a competitive market, if the future is predictable and certain, a firm's choice of technique is simply determined by trends in factor prices. This is possible because the fixed plant is expected to be secure or run at a given rate of output most of the time during its expected economic life. Therefore, the firm's short-run profit maximization objective is identical to the objective of profit maximization on its fixed capital investment. When the future is uncertain, the firm's choice of technique may be different. If firms face uncertainty regarding ownership of a fixed plant or land, a short planning horizon and consequently a technique such as broadcasting which requires less fixed capital input would be the optimal choice. Under price uncertainty, firms which need production flexibility are likely to choose broadcasting. A less capital intensive technique such as broadcasting provides

for greater production flexibility and, consequently, higher profits. Firms which have large landholdings or excess land and firms which have the ability to add or subtract land over the short run with little cost, for example tenant farmers in the newly developed areas, are two types of firms that are more likely to use broadcasting. However, under price uncertainty, firms which expect outputs to vary within a limited range may still choose transplanting. This condition describes firms which are operating under short-run land constraints, for example, small owner operators.

This study hypothesizes that the choice of broadcasting on the young delta during 1890-1940 was not caused by factor prices. Instead, it was the result of uncertainty in land ownership and prices. An examination of trends in factor prices for the period from the mid-nineteenth century to 1940 reveals that land prices or land rents rose with respect to wages. In other words, trends in relative factor prices during the period moved in favor of transplanting.

Available evidence during 1890-1910 shows that there were widespread land disputes on the young delta, especially in Rangsit, where the majority of cultivators were landowners. This led to uncertainty in land ownership. As a result, landowners turned to a short planning horizon and broadcasting became the optimal technique. The existence of a large number of small owner-operators in Rangsit during 1890-1910 also confirms that uncertainty in land ownership influenced the choice of broadcasting. After 1900 the system of private land ownership was improved. This contributed to a more peaceful situation on the young delta in 1910. After 1910 there is some evidence of the shift back to transplanting of small owner-operators. This confirms that the choice of broadcasting during 1890-1910 was the result of land ownership uncertainty.

After 1910 the pattern of land ownership in Rangsit changed. Most of the land in the area was owned by large landowners who did not farm the land themselves but rented it tc tenants. The majority of cultivators in Rangsit became tenants. Because of this change, not all cultivators switched back to transplanting. Tenants continued to use the broadcasting technique until the 1930s.

A time series analysis of rice prices for the period 1864-1941 shows that prices during 1864-1890 fluctuated but were predictable. However, prices during 1890-1941 were subject to a considerable degree of uncertainty. In addition, the cultivation on the young delta, particularly in the Rangsit area became dominated by large landowners, tenancy, and large tenants. Short-term lease, which was the main form of tenure in the area, was found to serve the need for flexibility on the part of landowners and tenants. It does not appear to cause underinvestment in agricultural improvements. Evidence regarding the effect of price uncertainty on the demand for rented rice land and wage labor also supports the proposition that large landowners and large tenants needed a flexible technique like broadcasting to adjust their production plans. Therefore, the choice of broadcasting on the young delta during 1910-1941 was the result of price uncertainty. The choice was, indeed, optimal under such economic conditions.

In conclusion, empirical evidence is consistent with these hypotheses and support the applicability of the model. Two main points have been presented in this study. The first is that external demand for rice and internal economic changes brought about by increased trade affected firms'choice of technique. This study illustrates how firms, as economic decision-making agents, optimized their opportunity set by using broadcasting in the face of

uncertainty. A second, more general point is that theory and empirical evidence examined during the course of this study suggest that the practice of broadcasting in Thailand during the period 1890-1940 is an optimal choice. That is, firms facing uncertainty act rationally regarding their choice of production technique.

## APPENDIX

### Appendix Table 1

### Quantity, Price, and Value of Rice Exports, 1857-1941

| Year | Quantity (metric ton) | 5-year--moving average | Export price (baht per metric ton) | 5-year--moving average | Value (millions of baht) | 5-year--moving average |
|---|---|---|---|---|---|---|
| 1857 | 54,432 | | 20.0[a] | | 1.6[a] | |
| 1858 | 63,504 | | - | | - | |
| 1859 | 45,306 | 73,109 | - | | - | |
| 1860 | 86,183 | 79,006 | - | | - | |
| 1861 | 116,121 | 85,175 | - | | - | |
| 1862 | 83,915 | 105,144 | - | | - | |
| 1863 | 94,348 | 88,512 | - | | - | |
| 1864 | 145,152 | 83,069 | 50.3 | | 7.3 | |
| 1865 | 3,024 | 88,421 | 72.8 | | 0.2 | |
| 1866 | 88,904 | 94,832 | 47.2 | 48 | 4.2 | 4.0 |
| 1867 | 110,678 | 98,582 | 31.7 | 45 | 3.5 | 3.6 |
| 1868 | 126,403 | 129,185 | 38.8 | 38 | 4.9[b] | 4.9 |
| 1869 | 163,901 | 133,903 | 32.9 | 39 | 5.4[b] | 5.2 |
| 1870 | 156,038 | 136,201 | 41.8 | 43 | 6.5 | 5.8 |
| 1871 | 112,493 | 121,444 | 51.1 | 43 | 5.8 | 5.2 |
| 1872 | 122,170 | 112,856 | 51.7 | 45 | 6.3 | 5.1 |
| 1873 | 52,618 | 129,065 | 39.5 | 45 | 2.1 | 5.8 |
| 1874 | 120,960 | 157,490 | 40.3 | 42 | 4.9 | 6.5 |
| 1875 | 237,082 | 170,675 | 41.0 | 42 | 9.7 | 7.3 |
| 1876 | 254,621 | 188,819 | 37.9 | 47 | 9.6 | 8.7 |
| 1877 | 188,093 | 213,374 | 53.0 | 49 | 10.0 | 10.1 |
| 1878 | 143,338 | 207,688 | 64.2 | 50 | 9.2 | 10.1 |
| 1879 | 243,734 | 201,882 | 49.2 | 51 | 12.0 | 10.2 |
| 1880 | 208,656 | 204,785 | 46.9 | 49 | 9.8 | 10.0 |
| 1881 | 225,590 | 208,051 | 41.8 | 46 | 10.1 | 9.6 |
| 1882 | 202,608 | 216,639 | 43.2 | 44 | 8.8 | 9.6 |
| 1883 | 159,667 | 219,663 | 47.2 | 43 | 7.5 | 9.6 |

[a] Value of the year 1850.

[b] Estimated using the mean export volume for the period 1864-1889.

Appendix Table 1 (Continued)

| Year | Quantity (metric ton) | 5-year--moving average | Export price (baht per metric ton) | 5-year--moving average | Value (millions of baht) | 5-year--moving average |
|---|---|---|---|---|---|---|
| 1884 | 286,675 | 218,454 | 41.4 | 45 | 11.9 | 9.8 |
| 1885 | 223,776 | 258,128 | 43.8 | 46 | 9.8 | 11.9 |
| 1886 | 219,542 | 317,641 | 49.6 | 46 | 10.9 | 14.6 |
| 1887 | 400,982 | 321,874 | 47.9 | 47 | 19.2 | 15.1 |
| 1888 | 457,229 | 374,976 | 46.0 | 48 | 21.1 | 18.1 |
| 1889 | 307,843 | 377,032 | 46.9 | 48 | 14.4 | 18.3 |
| 1890 | 489,283 | 340,019 | 51.3 | 50 | 25.1 | 16.8 |
| 1891 | 229,824 | 409,450 | 50.2 | 51 | 11.5 | 21.1 |
| 1892 | 215,914 | 454,689 | 54.3 | 52 | 11.7 | 23.9 |
| 1893 | 804,384 | 455,052 | 53.2 | 52 | 42.8 | 23.9 |
| 1894 | 534,038 | 506,339 | 53.3 | 57 | 28.5 | 28.7 |
| 1895 | 491,098 | 584,116 | 50.8 | 59 | 24.9 | 34.3 |
| 1896 | 486,259 | 541,369 | 73.5 | 65 | 35.8 | 35.1 |
| 1897 | 604,800 | 527,096 | 65.7 | 71 | 39.7 | 37.2 |
| 1898 | 590,650 | 513,185 | 83.1 | 79 | 46.6 | 39.7 |
| 1899 | 462,672 | 555,159 | 84.0 | 82 | 38.9 | 44.6 |
| 1900 | 421,546 | 596,527 | 89.0 | 86 | 37.5 | 50.6 |
| 1901 | 696,125 | 597,301 | 86.6 | 88 | 60.3 | 52.6 |
| 1902 | 811,642 | 676,529 | 86.1 | 90 | 69.9 | 61.1 |
| 1903 | 594,518 | 767,975 | 95.3 | 91 | 56.7 | 70.2 |
| 1904 | 858,816 | 803,416 | 94.4 | 93 | 81.1 | 74.5 |
| 1905 | 878,773 | 802,811 | 94.6 | 94 | 83.1 | 75.7 |
| 1906 | 873,331 | 870,549 | 93.8 | 92 | 81.9 | 80.2 |
| 1907 | 808,618 | 892,443 | 93.5 | 91 | 75.6 | 81.0 |
| 1908 | 933,206 | 929,457 | 85.1 | 89 | 79.4 | 82.6 |
| 1909 | 968,285 | 882,282 | 87.9 | 91 | 85.1 | 79.4 |
| 1910 | 1,063,843 | 840,067 | 85.6 | 94 | 91.1 | 77.3 |
| 1911 | 637,459 | 891,959 | 103.3 | 94 | 65.8 | 81.2 |
| 1912 | 597,542 | 920,747 | 109.2 | 92 | 65.3 | 81.3 |
| 1913 | 1,192,666 | 935,263 | 82.8 | 90 | 98.7 | 80.6 |
| 1914 | 1,112,227 | 1,047,030 | 76.7 | 86 | 85.4 | 87.4 |
| 1915 | 1,136,419 | 1,154,321 | 77.2 | 81 | 87.7 | 93.9 |
| 1916 | 1,196,294 | 1,087,551 | 83.6 | 96 | 100.0 | 100.6 |
| 1917 | 1,134,000 | 954,737 | 86.3 | 135 | 97.9 | 108.1 |
| 1918 | 858,816 | 784,426 | 153.8 | 140 | 132.1 | 96.4 |
| 1919 | 448,157 | 806,198 | 274.6 | 145 | 123.1 | 104.6 |

Appendix Table 1 (Continued)

| Year | Quantity (metric ton) | 5-year--moving average | Export price (baht per metric ton) | 5-year--moving average | Value (millions of baht) | 5-year--moving average |
|---|---|---|---|---|---|---|
| 1920 | 284,861 | 838,495 | 102.6 | 148 | 29.2 | 110.7 |
| 1921 | 1,305,158 | 935,868 | 108.0 | 138 | 141.0 | 113.1 |
| 1922 | 1,295,482 | 1,080,778 | 99.0 | 107 | 128.2 | 116.4 |
| 1923 | 1,345,680 | 1,301,167 | 106.9 | 111 | 143.8 | 144.0 |
| 1924 | 1,172,707 | 1,303,828 | 119.1 | 114 | 139.6 | 148.9 |
| 1925 | 1,386,806 | 1,391,524 | 120.7 | 118 | 167.4 | 163.5 |
| 1926 | 1,318,464 | 1,420,796 | 125.3 | 120 | 165.2 | 169.7 |
| 1927 | 1,733,962 | 1,414,385 | 116.0 | 120 | 201.2 | 169.6 |
| 1928 | 1,492,042 | 1,343,987 | 117.4 | 116 | 175.1 | 156.7 |
| 1929 | 1,140,653 | 1,348,825 | 121.9 | 103 | 139.1 | 139.2 |
| 1930 | 1,034,813 | 1,339,148 | 99.6 | 91 | 103.1 | 117.8 |
| 1931 | 1,342,656 | 1,376,041 | 57.7 | 77 | 77.5 | 99.4 |
| 1932 | 1,685,578 | 1,555,546 | 55.9 | 62 | 94.2 | 91.2 |
| 1933 | 1,676,506 | 1,651,346 | 49.5 | 54 | 83.0 | 88.8 |
| 1934 | 2,038,176 | 1,697,069 | 48.3 | 55 | 98.4 | 92.5 |
| 1935 | 1,513,814 | 1,582,157 | 60.0 | 57 | 90.8 | 88.7 |
| 1936 | 1,571,270 | 1,560,263 | 61.1 | 60 | 95.9 | 91.6 |
| 1937 | 1,111,018 | 1,534,136 | 67.8 | 62 | 75.3 | 94.6 |
| 1938 | 1,567,037 | 1,475,228 | 62.2 | 65 | 97.4 | 95.1 |
| 1939 | 1,907,539 | 1,395,637 | 59.4 | 79 | 113.3 | 105.7 |
| 1940 | 1,219,277 | | 76.7 | | 93.6 | |
| 1941 | 1,173,312 | | 126.8 | | 148.8 | |

Sources: This series of data was compiled by Ingram (1964: 120-2) and Feeny (1982:128-9). Data for 1857-1863 are taken from van de Heide (1906: 82); data for 1864-1890 are taken from Great Britain (1854-1900); data for 1901-1941 are taken from Central Statistical Office; vols. 1-19.

Appendix Table 2

Urban Unskilled and Rural Wages, 1820 to 1938

| Year | Nominal unskilled Bangkok wage (baht per day) | Rural or agricultural wage (baht) | Source |
|---|---|---|---|
| 1850 | 0.33-0.50 | | Ingram 1964: 115 |
| 1864 | 0.60-0.80 | | Ingram 1964: 115 |
| 1889 | 0.75 | 8 per month, Petchaburi | A. R5. KS. 3.1/1 |
| 1890s-1900s | | 80 per season, Central Plain | Johnson 1976: 41 |
| 1890 | 0.75 | | Ingram 1964: 115 |
| 1892 | | 60 per crop season | Child 1892: 143 |
| 1895 | 1.25 | | Holm 1977: 92 |
| 1896 | 0.50 | | Ingram 1964: 115 |
| 1898 | 0.50 | | Smyth 1898, 1: 228 |
| 1899 | 0.63 | | Holm 1977: 92 |
| 1901 | 0.83 | | Royal Survey Dept. 1901-1902: 48 |
| 1902 | 0.75-1.0 | | Ingram 1964: 115, van der Heide 1903: 116 |
| 1903 | | 19 per month for Lao in the Central Plain. | Royal Survey Dept. 1903-1904: 55 |
| | | 10 per month for Bangkok silk farm workers. | Toyama 1903: 5 |
| 1905 | 0.5 | | Holm 1977: 118 |
| | | 85.75 for the season plus 4.3 per month for board | Thompson 1910: 196 |
| 1906 | | 20 per month, livestock | A. R5. KS. 7/4 |
| 1907 | | 0.25 per day to work off tax debt | A. R5. KS. 3.2/35 |
| 1908 | | 25-30 per month in rice mill | Stiven 1908: 149 |

Appendix Table 2 (Continued)

| Year | Nominal unskilled Bangkok wage (baht per day) | Rural or agricultural wage (baht) | Source |
|---|---|---|---|
| 1910 | | 21 per month plus board for land survey | Rural Survey Dept. 1910-11: 15 |
| 1911 | | 80-120 for 9 months plus board | Yai S. Sanitwongse 1911: 4 |
| 1912 | 0.75-1.0 | Ingram 1964:115 | |
| 1914-15 | 0.75 | | Central Statistical Office, No.20 |
| 1915-16 | 0.75 | | Central Statistical Office, No.5 |
| 1916-17 through 1923-24 | 1.0 | | Central Statistical Office, Nos.5-11 |
| 1924-25 | 1.12 | | Central Statistical Office, No. 11 |
| 1925-26 | 1.0 | 85 per season | Central Statistical Office, No.11; Tardt 1930: 127 |
| 1926-27 | 1.0 | 81 per season | Central Statistical Office, Nos. 20, 39; Tardt 1930: 127 |
| 1927-28 | 1.0 | 85 per season | Central Statistical Office, No. 20; Tardt 1930: 127 |
| 1928-29 | 1.0 | 85 per season | Central Statistical Office, No. 20; Tardt 1930: 127 |
| 1929-30 | 1.0 | 25 per month, | A. R7. KS. 8/3 |
| 1930-31 | 1.0 | | Central Statistical Office, No.20 |

Appendix Table 2 (Continued)

| Year | Nominal unskilled Bangkok wage (baht per day) | Rural or agricultural wage (baht) | Source |
|---|---|---|---|
| 1931-32 | 0.8 | Angthong: was 60-80 per season; now 30-50<br>Pitsanulok: was 80 per season; now 40<br>Lopburi: was 60-100 per season; now 40-60 | A. R7. P. 13/5 |
| 1932-33 through 1938-39 | 0.6 | | Central Statistical Office, No. 20 |

Note: This series of information was compiled by Feeny (1982: 132-3).

Appendix Table 3

Observations on Paddy Land Prices and Rents for the Central Plain of Thailand, 1880-1948

| Year | Land price (baht/rai) | Land rent per Year (baht/rai) | Location and comments | Source |
|---|---|---|---|---|
| 1880 | 1 | | Rangsit | Johnston 1975: 121 |
| 1889 | 5 | | Bangkok | R5. KS. 3.1/3 |
| 1890 | 4.3 | | Rangsit | Johnston 1975: 121 |
| 1891 | 4 | | Ayuthya, canal project proposal | A. R5. KS. 3.1/7 |
| 1890s | | 1-2 | Rangsit, uncleared land | Tanabe 1978: 66 |
| | | 4.6 | Rangsit, paddy land | Tanabe 1978: 66 |
| 1892 | 5.3 | | Rangsit | Johnston 1975: 121 |
| 1894 | 4.8 | | Rangsit | Johnston 1975: 121 |
| 1896 | 6.3 | | Rangsit | Johnston 1975: 121 |
| 1897 | 5 to 8 to 10 | | Rangsit, SCLIC's sale price | A. R5. KS. 9.4 k/35 |
| 1899 | 22.67 | | Rangsit | Johnston 1975: 121 |
| 1900 | 20-50 | | Rangsit, SCLIC's sale price | A. R5. KS. 11/6 |
| 1901 | 35 | | Rangsit | Johnston 1975: 121 |
| | 13 | | Ayuthya | A. R5. KS. 4.2/3 |
| | 7.8 | | Ayuthya, mortgage | A. R5. KS. 4.2/3 |
| | 8.3 | | Ayuthya, mortgage | A. R5. KS. 4.2/3 |
| 1902 | 26.5 | | Rangsit | Johnston 1975: 121 |
| 1903 | 80 | 9-10 | Rangsit, lowland | van der Heide 1903: 30, 36 |
| | 20-50 | | Rangsit, average | van der Heide 1903: 30, 36 |
| | 10-20 | 1-2 | Rangsit, highland | van der Heide 1903: 30, 36 |
| | 35 | | Rangsit | Johnston 1975: 121 |
| | 25 | 4 | Nakornchaisri, good land | A. R5. KS. 10/1 |
| | 15 | | Nakornchaisri, medium land | A. R5. KS. 10/1 |
| | 10 | 1.5 | Nakornchaisri, poor land | A. R5. KS. 10/1 |

Appendix Table 3 (Continued)

| Year | Land price (baht/rai) | Land rent per year (baht/rai) | Location and comments | Source |
|---|---|---|---|---|
| 1904 | 37.5 | | Rangsit | Johnston 1975: 121 |
| | 25 | | central Thailand, West Bank project | van der Heide 1904: 22 |
| | 25 | | Rangsit, SCLIC's sale price | A. R5. KS. 9.4/14 |
| 1905 | 20 | | Rangsit | van der Heide 1905: 43 |
| | 40 | | Ayuthya | van der Heide 1905: 43 |
| | 33.8 | | central Thailand, good land | Thompson 1892: 195 |
| 1905 | | 4 | Ratburi | van der Heide 1905: 43 |
| 1905 | | 2 | Bangkhuad, Bangkok area | Kaufman 1960: 15 |
| 1906 | 20-30 | | Rangsit | A. R5. KS. 3.1/11 |
| 1907 | 35-40 | | Ratburi | Royal Survey Dept. 1907-8: 25 |
| 1908 | 72 | | San Saeb canal, near Bangkok | A. R5. KS. 3.3/40 |
| 1915 | 16-24-32 | | Central-Pasak area | Royal Irrigation Dept. 1915, V. 2, appendix |
| 1925 | was 40-50; now 80-100 | | Saraburi Pasak project | A. R5-7. BL. 3/7 #8 |
| | 40-80 | | Pasak project area | FF. 18, #11 |
| | 40 | | on boundary of Pasak project area | FF. 18, #11 |
| | 25 | | outside Pasak project area | FF. 18, #11 |
| | was 40-50; now 80-100 | | Rangsit, Pasak project | A. R5-7 BL. 3/7 #8 |
| | 40 | | Ayuthya, Pasak project area | A. R5-7 BL. 3/7 #8 |
| 1925 | 25 | | Ayuthya, outside Pasak project | A. R5-7 BL. 3/7 #8 |

Table A-3 (Continued)

| Year | Land price (baht/rai) | Land rent per year (baht/rai) | Location and comments | Source |
|---|---|---|---|---|
| 1932 | | was 12; now 6 | Angthong, good land | A. R7. P.13/5 |
| | | was 8; now 3 | Angthong, medium quality land | A. R7. P.13/5 |
| | | was 6; now 2.5 | Angthong, poor land | A. R7. P.13/5 |
| | | were 6-8, now 3-4 | Lopburi | A. R7. P.13/5 |
| | was 40, now 10 | | Pitsanulok | A. R7. P.13/5 |
| 1936 | 26 | | central Thailand, price for cooperative members | Report of FF. 1937-1938: 9 |
| 1942 | 52 | | central Thailand | Ladejinsky 1942: 169 |

Note: The series of information was compiled by Feeny (1982: 135-7).

Appendix Table 4

Ratios of Land Prices to Wages, 1880-1915

| Year | Land price (baht/ha) | Wage (baht/day) | Ratio of land price to wage |
|---|---|---|---|
| 1880 | 6.3 | 0.70 (1864)[a] | 8.9 |
| 1889 | 31.3 | 0.75 (1889) | 41.7 |
| 1890 | 26.9 | 0.75 (1890) | 35.8 |
| 1891 | 25 | 0.75 (1890) | 33.3 |
| 1892 | 33.1 | 0.75 (1890) | 44.2 |
| 1894 | 30 | 0.50 (1896) | 60.0 |
| 1896 | 39.4 | 0.50 (1896) | 78.8 |
| 1897 | 31.3, 50, 62.5 | 0.50 (1896) | 95.9 |
| 1899 | 141.7 | 0.50 (1896) | 283.4 |
| 1900 | 125-312.5 | 0.83 (1901) | 263.6 |
| 1901 | 81.5, 218.8 | 0.83 (1901) | 180.9 |
| 1902 | 165.6 | 0.83 (1901) | 199.5 |
| 1903 | 125-312.5 | 0.83 (1901) | 263.6 |
| 1904 | 234.4-156.3 | 0.50 (1905) | 390.7 |
| 1905 | 125-250 | 0.50 (1905) | 375.0 |
| 1906 | 125-187.5 | 0.50 (1905) | 312.5 |
| 1907 | 218.8-250 | 0.50 (1905) | 468.8 |
| 1908 | 450 | 0.88 (1915) | 511.0 |
| 1915 | 100, 150, 200 | 0.75 (1915) | 200.0 |

[a] Indicates the year for that wage rate.

Sources: Appendix Tables 2 and 3.

Appendix Table 5

Canal Construction and Area of Newly Opened Rice Lands on the Young Delta, 1861-1914

| Year | Canal | Area (ha) |
|---|---|---|
| 1861 | Mahasawat | 3,501 |
| 1867-1872 | Pasichareon | 7,936 |
| 1872 | Damnernsaduak | 8,064 |
| 1869-1870 | Premprachakorn | 16,269 |
| 1876-1877 | Nakornnuakate | 5,184 |
| 1878 | Taweewatana | 4,352 |
| 1878-1880 | Narapirom | 6,912 |
| 1878-1880 | Prawetburirom Branches | 12,570 |
| 1880 | Prawetburirom | 2,150 |
| 1889-1890 | Preng | 5,734 |
| 1888-1890 | Luangpang | 3,187 |
| 1886-1890 | Udomchonjorn & branches | 4,884 |
| 1891-1892 | Charoen | 5,400 |
| 1890-1898 | Prarachapimon | 3,335 |
| 1892-1899 | Prayabunlu | 888 |
| 1898-1901 | Bangpleeyai | 2,080 |
| 1903-1904 | Paisingtoe | 800 |
| 1899 | Niyomyatra | 1,600 |
| 1890-1904 | Rangsit & branches | 213,956 |
| 1904-1914 | West Bank Project | 112,000 |
| 1861-1880 | Total rice lands opened | 66,938 |
| 1889-1914 | Total rice lands opened | 353,864 |
| 1861-1914 | Total rice lands opened | 420,802 |

Source: Compiled from Wongsanuprapat (1941: 126-54).

Appendix Table 6

Rangsit Land Sales, Plot Size 10-1,000 Rai

Plot size 10-150 rai (62.5-25 ha)

| Plot size (rai) | No. of purchaser | Area sold (rai) |
|---|---|---|
| 10 | 2 | 20 |
| 20 | 12 | 240 |
| 30 | 17 | 510 |
| 35 | 1 | 35 |
| 45 | 135 | 6,075 |
| 50 | 83 | 4,150 |
| 55 | 1 | 55 |
| 60 | 103 | 6,180 |
| 65 | 1 | 65 |
| 70 | 3 | 210 |
| 75 | 18 | 1,350 |
| 80 | 4 | 320 |
| 90 | 99 | 8,910 |
| 100 | 275 | 27,500 |
| 105 | 127 | 13,335 |
| 115 | 3 | 345 |
| 120 | 60 | 7,200 |
| 135 | 2 | 270 |
| 150 | 40 | 6,000 |
| Total | 986 | 82,770 |
| Average | 84 | |

Appendix Table 6 (Continued)

Plot size 150-600 rai (24.1-96 ha)

| Plot size (rai) | No. of purchaser | Area sold (rai) |
|---|---|---|
| 151 | 1 | 151 |
| 165 | 2 | 330 |
| 180 | 24 | 4,320 |
| 185 | 2 | 370 |
| 200 | 210 | 42,000 |
| 210 | 15 | 3,150 |
| 215 | 1 | 215 |
| 225 | 3 | 675 |
| 230 | 3 | 690 |
| 240 | 34 | 8,160 |
| 250 | 8 | 2,000 |
| 255 | 4 | 1,020 |
| 260 | 2 | 520 |
| 270 | 6 | 1,620 |
| 280 | 11 | 3,080 |
| 300 | 93 | 27,900 |
| 310 | 2 | 620 |
| 315 | 6 | 1,890 |
| 320 | 9 | 2,880 |
| 330 | 4 | 1,320 |
| 345 | 14 | 4,830 |
| 350 | 1 | 350 |
| 360 | 12 | 4,320 |
| 390 | 9 | 3,510 |
| 400 | 77 | 30,800 |
| 420 | 3 | 1,260 |
| 435 | 3 | 1,305 |
| 480 | 3 | 1,440 |
| 500 | 28 | 14,000 |
| 520 | 4 | 2,080 |
| 550 | 4 | 2,200 |
| 570 | 1 | 570 |
| 600 | 15 | 9,000 |
| Total | 614 | 178,576 |
| Average | 291 | |

Appendix Table 6 (Continued)

Plot size 610-1,000 rai (97.6-160 ha)

| Plot size (rai) | No. of purchaser | Area sold (rai) |
|---|---|---|
| 610 | 1 | 610 |
| 615 | 1 | 615 |
| 685 | 1 | 685 |
| 690 | 4 | 2,760 |
| 700 | 1 | 700 |
| 710 | 1 | 710 |
| 720 | 1 | 720 |
| 750 | 4 | 3,000 |
| 810 | 3 | 2,430 |
| 900 | 3 | 2,700 |
| 1000 | 5 | 5,000 |
| Total | 25 | 19,930 |
| Average | 797 | |

Sources: Compiled from A. KS. 10/37, A. KS. 10/203, and A. KS. 10/200.

Appendix Table 7

Rangsit Land Sales, Plot Size 1,050-25,325 Rai
(168-4,056 ha)

| No. | Purchaser | Area (rai) |
|---|---|---|
| 1 | Krommoon Thiwakorn | 25,349 |
| 2 | SCLIC | 14,832 |
| 3 | Kromluang Pichit | 13,195 |
| 4 | Krommoon Narathip | 10,845 |
| 5 | Phraya Surenthorn | 7,405 |
| 6 | Luang Khettanuruks | 7,298 |
| 7 | Lamsai Company | 5,641 |
| 8 | M.R. Yai S. Sanitwongse | 5,485 |
| 9 | Kromoon Sommot | 4,750 |
| 10 | Phra Surasamdaeng | 4,460 |
| 11 | Krommoon Suppasastrsuppakit | 4,100 |
| 12 | Nai La | 4,056 |
| 13 | Chao Phraya Surasakmontri | 3,700 |
| 14 | Krommoon Burapongse | 3,658 |
| 15 | Mr. James Young | 3,650 |
| 16 | Chommanda (Pae) | 3,401 |
| 17 | Roitho Nai Puang | 3,184 |
| 18 | Luang Praphaspranot | 3,000 |
| 19 | Luang Wiphaspranot | 3,000 |
| 20 | Luang Prachakitworachukr | 3,000 |
| 21 | Than Maichene | 2,814 |
| 22 | Phraongchao Akornkiettiwongse | 2,742 |
| 23 | Siam Adkridtural Company | 2,700 |
| 24 | Krommoon Adisornudomdeth | 2,670 |
| 25 | Mom Aim | 2,556 |
| 26 | Yeehoo Ngeetae | 2,554 |
| 27 | Phraongchao Suapaktrwilaipan | 2,548 |
| 28 | Nai Tomya | 2,520 |
| 29 | M.H. Sangangam | 2,450 |
| 30 | Nai Chit Humpair | 2,335 |
| 31 | Khun Thepkosa | 2,100 |
| 32 | Than Lak | 2,100 |
| 33 | Phra Ratrongmoung | 2,057 |
| 34 | Chene Ngae | 1,991 |
| 35 | Phra Piphatsali | 2,017 |
| 36 | Luang Intramontri | 1,929 |
| 37 | Luang Wisetsali | 1,925 |

Appendix Table 7 (Continued)

| No. | Purchaser | Area (rai) |
|---|---|---|
| 38 | Khun Puam | 1,870 |
| 39 | Khun Thepkosa | 1,807 |
| 40 | Krommoon Pittayakorn | 1,800 |
| 41 | Nai Chan | 1,705 |
| 42 | Phraya Srisunthornwohan | 1,500 |
| 43 | Than Kien | 1,450 |
| 44 | M.R. Sathan | 1,404 |
| 45 | Than Jorn | 1,340 |
| 46 | Phra Worasum | 1,281 |
| 47 | Nai Pia | 1,265 |
| 48 | Phra Pratibatnaiyoung | 1,243 |
| 49 | Chene Yongiengsong | 1,200 |
| 50 | Phra BoriboonKosa | 2,400 |
| 51 | M.H. Chaweewilai | 1,170 |
| 52 | Mae Tomya | 1,160 |
| 53 | Nai Sung | 1,100 |
| 54 | Nai Young | 1,100 |
| 55 | Phraya Sriharachrongmuong | 1,051 |
| Total area sold | | 199,863 |
| Average | | 3,634 |

Sources: Compiled from A. KS. 10/37, A. KS. 10/203, and A. KS. 10/200.

Appendix Table 8

Canal Construction and Land Development in Rangsit, 1890-1905

| Year | Length of canal constructed (sen) | Area developed (rai) |
|---|---|---|
| 1111 | 22,878 | 1,372,794 |
| 1890 | 165 | 9,917 |
| 1891 | 263 | 15,805 |
| 1892 | 870 | 52,184 |
| 1893 | 718 | 43,099 |
| 1894 | 1,051 | 63,072 |
| 1895 | 991 | 59,449 |
| 1896 | 661 | 39,652 |
| 1897 | 957 | 57,427 |
| 1898 | 1,315 | 78,898 |
| 1899 | 1,327 | 79,643 |
| 1900 | 1,034 | 62,064 |
| 1901 | 3,011 | 180,671 |
| 1902 | 3,064 | 183,835 |
| 1903 | 3,788 | 227,299 |
| 1904 | 2,890 | 173,385 |
| 1905 | 773 | 46,394 |
| Total | 22,878 | 1,372,794 |

Source: A. R5. KS. 34/791 (Canal Department).

Appendix Table 9

Location and Area of Royal Rice Lands, 1900s

| No. | Monthon/village | Area (rai) | Comment |
|---|---|---|---|
| 1 | Monthon Krungkao | | |
| 1.1 | Sakae and Khanomchin | 67,500 | Proposed royal grant to Prince Wachirawut |
| 1.2 | Bang jitho | 1,509 | |
| 1.3 | Latnga | 61 | |
| 1.4 | Du mon | 341 | |
| 1.5 | Wat worachet | 141 | |
| 1.6 | Atso | 264 | |
| 1.7 | Chaochet | 160 | |
| 1.8 | Wat yom | 84 | |
| 1.9 | Pak kran | 414 | |
| 1.10 | Khomnomchin | 917 | |
| 1.11 | Khlo | 199 | |
| 1.12 | Changlek | 500 | |
| 1.13 | Phrao | 315 | In Pathumthani town |
| 1.14 | 7 villages | 20,158 | Uncultivated rice land |
| 1.15 | Ban phrao | 170 | Owned by Rama V |
| 1.16 | Ban phrao | 189 | Owned by Rama V |
| 2 | Monthon Prachinburi | | |
| 2.1 | 2 villages | 9,963 | In Prachinburi |
| | | (9,674) | Surveyed area in 1900 |
| 2.2 | Bang khanak | 5,000 | In Chachoengsao |
| 2.3 | Sala daeng | 3,388 | In Chachoengsao |
| 2.4 | West bank of the Preng Canal | 19,358 | Granted to Luang Praeng, a canal executer |
| 3 | Monthon Nakornchaisri | 16,200 | Rama IV granted to his princes and princeses in 1861 |
| | (Mahasawat Canal) | 21,882 | |
| 4 | Monthon Krungthep | | |
| 4.1 | Sisamak | 1,700 | |
| 4.2 | Klong chan | | |
| 4.3 | Bang khen | | |
| 4.4 | Sa pratumwan | | |

Appendix Table 9 (Continued)

| No. | Monthon/village | Area (rai) | Comment |
|---|---|---|---|
| 4.5 | Wat bampheng | | |
| 4.6 | Huaphai | 1,208 | |
| 4.7 | Luam oo | 370 | |
| 4.8 | Bang bon | 1,100 | |
| 4.9 | Saen saep in Minburi | 546 | Owned by Rama V |
| | Saen saep in Minburi | 1,636 | |
| 4.10 | Bang chan in Minburi | 468 | Owned by Rama V |
| 4.11 | Bang chan in | 160 | Owned by Rama V |
| 4.12 | Minburi | | |
| 4.13 | Thanyaburi | 551 | Owned by Rama V |
| 4.14 | Thanyaburi | 407 | Owned by Rama V |
| 4.15 | Thanyaburi | 509 | Owned by Rama V |
| 4.16 | Thanyaburi | 439 | Owned by Rama V |
| 4.17 | Thanyaburi | 2,352 | Owned by Rama V |
| 4.18 | Thanyaburi | 1,007 | Owned by Rama V |
| 4.19 | Thanyaburi | 1,600 | Owned by Rama V |
| 4.20 | Thanyaburi | 1,600 | Owned by Rama V |
| 4.21 | Thanyaburi | 2,567 | Owned by Rama V |
| 4.22 | Thanyaburi | 1,233 | |
| 4.23 | Krungthep | 1,453 | |
| 4.24 | Nontaburi | 661 | |
| 4.25 | Prathumthani | 620 | |
| 4.26 | Nakhonkhounkhun | 96 | |

Sources: This series of information was compiled by Tanabe (1978-75-7) and updated by the author. Data for 1.1 are taken from A. KS. 3.3/2 and A. KS. 9.2/2. The rest of the data are taken from A. KS. 3.3/5, A. KS. 1/2, A. R5. KS. 3.3/11, A. R5. KS. 3.3/31, and A. KS. 3.3/26.

Appendix Table 10

Location and Area of Royal Rice Lands Granted to the Thai Government, 1975

| Location | Area (ha) |
|---|---|
| Ayuthya | 2,176 |
| Chachoengsao | 2,395 |
| Nakornpratom | 533 |
| Petchaburi | 97 |
| Suphanburi | 2 |
| Patumthani | 2,692 |
| Saraburi | 192 |
| Nakornnayok | 502 |
| Total | 8,590 |

Note: These royal rice lands were granted by King Phumiphol to the Agricultural Land Reform Office in 1975.

Source: Office of Agricultural Land Reform (1977).

Appendix Table 11

Autocorrelation of Rice Prices (Yt), 1864-1941

| k | @1864-1941 | @1864-1890 | @1890-1941 |
|---|---|---|---|
| 1 | -0.69 | -0.32 | -0.55 |
| 1 | 0.69 | 0.32 | 0.55 |
| 2 | 0.53 | -0.22 | 0.31 |
| 3 | 0.47 | -0.26 | 0.22 |
| 4 | 0.43 | -0.27 | 0.15 |
| 5 | 0.42 | -0.14 | 0.13 |
| 6 | 0.42 | 0.21 | 0.12 |
| 7 | 0.44 | 0.23 | 0.15 |
| 8 | 0.37 | -0.03 | 0.06 |
| 9 | 0.31 | -0.16 | -0.02 |
| 10 | 0.29 | -0.15 | -0.03 |
| 11 | 0.26 | -0.13 | -0.06 |
| 12 | 0.20 | 0.13 | -0.15 |
| 13 | 0.16 | 0.12 | -0.18 |
| 14 | 0.14 | 0.11 | -0.17 |
| 15 | 0.14 | 0.07 | -0.16 |
| 16 | 0.15 | -0.06 | -0.11 |
| 17 | 0.13 | -0.05 | -0.09 |
| 18 | 0.13 | 0.02 | -0.07 |
| 19 | 0.10 | -0.05 | -0.09 |
| 20 | 0.08 | -0.07 | -0.11 |
| 21 | 0.07 | 0.01 | -0.09 |
| 22 | 0.12 | 0.01 | 0.03 |
| 23 | 0.04 | -0.04 | -0.02 |
| 24 | -0.05 | 0.01 | -0.13 |
| 25 | -0.07 | 0.02 | -0.15 |
| 26 | -0.10 | 0.01 | -0.18 |
| 27 | -0.13 | 0.00 | -0.21 |
| 28 | -0.15 | | -0.23 |
| 29 | -0.17 | | -0.18 |
| 30 | -0.20 | | -0.09 |
| 31 | -0.23 | | -0.11 |
| 32 | -0.25 | | -0.11 |
| 33 | -0.25 | | -0.11 |
| 34 | -0.27 | | -0.09 |
| 35 | -0.27 | | -0.07 |
| 36 | -0.26 | | -0.03 |

Appendix Table 11 (Continued)

| k | @1864-1941 | @1864-1890 | @1890-1941 |
|---|---|---|---|
| 37 | -0.26 | | 0.01 |
| 38 | -0.25 | | 0.04 |
| 39 | -0.23 | | 0.07 |
| 40 | -0.21 | | 0.11 |
| 41 | -0.18 | | 0.13 |
| 42 | -0.20 | | 0.12 |
| 43 | -0.23 | | 0.11 |
| 44 | -0.22 | | 0.09 |
| 45 | -0.21 | | 0.07 |
| 46 | -0.20 | | 0.04 |
| 47 | -0.17 | | 0.03 |
| 48 | -0.18 | | 0.02 |
| 49 | -0.19 | | 0.00 |
| 50 | -0.20 | | -0.02 |
| 51 | -0.20 | | -0.02 |
| 52 | -0.21 | | 0.00 |
| 53 | -0.17 | | |
| 54 | -0.13 | | |
| 55 | -0.15 | | |
| 56 | -0.10 | | |
| 57 | -0.09 | | |
| 58 | -0.07 | | |
| 59 | -0.07 | | |
| 60 | -0.06 | | |
| 61 | -0.04 | | |
| 62 | -0.02 | | |
| 63 | 0.01 | | |
| 64 | 0.02 | | |
| 65 | 0.02 | | |
| 66 | 0.02 | | |
| 67 | 0.02 | | |
| 68 | 0.01 | | |
| 69 | 0.02 | | |
| 70 | 0.01 | | |
| 71 | 0.00 | | |

Note: These series of autocorrelation are estimated using Shazam, an econometrics computer program (version 6.0). DIF1= autocorrelation of $\Delta Y_t$, DIF2 = autocorrelation of $\Delta^2 Y_t$, DIF3 = autocorrelation of $\Delta^3 Y_t$.

## Appendix Table 12

### Autocorrelation of the Differenced Rice Prices, 1864-1941

| k | DIF1: 64-41 | DIF1: 64-89 | DIF1: 90-41 | DIF2: 64-41 | DIF2: 64-89 | DIF2: 90-41 | DIF3: 64-41 | DIF3: 64-89 | DIF3: 90-41 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.21 | -0.14 | -0.21 | -0.51 | -0.25 | -0.52 | -0.66 | 0.32 | -0.67 |
| 2 | -0.16 | -0.33 | -0.16 | -0.03 | -0.33 | -0.02 | 0.13 | -0.22 | 0.14 |
| 3 | -0.03 | 0.07 | -0.04 | 0.07 | 0.26 | 0.06 | 0.06 | -0.27 | 0.06 |
| 4 | -0.06 | -0.28 | -0.06 | -0.04 | -0.21 | -0.03 | -0.05 | -0.38 | -0.05 |
| 5 | -0.02 | -0.07 | -0.01 | 0.02 | -0.12 | 0.02 | 0.05 | -0.13 | 0.05 |
| 6 | -0.01 | 0.25 | -0.02 | -0.07 | 0.19 | -0.08 | -0.10 | 0.23 | -0.11 |
| 7 | 0.15 | 0.18 | 0.14 | 0.14 | 0.13 | 0.14 | 0.13 | 0.23 | 0.13 |
| 8 | -0.01 | -0.10 | -0.01 | -0.03 | -0.12 | -0.03 | -0.04 | -0.03 | -0.04 |
| 9 | -0.08 | 0.00 | -0.08 | -0.07 | 0.02 | -0.08 | -0.06 | -0.15 | -0.06 |
| 10 | 0.02 | -0.07 | 0.01 | 0.05 | 0.07 | 0.05 | 0.05 | -0.25 | 0.05 |
| 11 | 0.02 | -0.27 | 0.04 | 0.04 | -0.28 | 0.05 | 0.03 | -0.26 | 0.04 |
| 12 | -0.07 | 0.14 | -0.08 | -0.08 | 0.08 | -0.08 | -0.08 | -0.09 | -0.08 |
| 13 | -0.02 | 0.21 | -0.03 | 0.03 | 0.20 | 0.02 | 0.03 | 0.26 | 0.03 |
| 14 | -0.02 | -0.09 | -0.02 | 0.01 | -0.12 | 0.02 | 0.02 | 0.13 | 0.03 |
| 15 | -0.04 | 0.09 | -0.04 | -0.05 | 0.12 | -0.05 | -0.06 | 0.08 | -0.06 |
| 16 | 0.04 | -0.10 | 0.04 | 0.06 | -0.12 | 0.06 | 0.08 | -0.04 | 0.08 |
| 17 | -0.02 | -0.01 | -0.02 | -0.07 | -0.04 | -0.06 | -0.09 | -0.03 | -0.08 |
| 18 | 0.06 | 0.10 | 0.06 | 0.06 | 0.14 | 0.05 | 0.06 | 0.00 | 0.05 |
| 19 | 0.00 | -0.11 | 0.01 | 0.01 | -0.09 | 0.02 | -0.01 | -0.10 | 0.00 |
| 20 | -0.06 | -0.04 | -0.06 | -0.02 | -0.06 | -0.02 | -0.03 | -0.06 | -0.03 |
| 21 | -0.08 | 0.08 | -0.09 | -0.01 | 0.08 | -0.02 | 0.05 | 0.04 | 0.05 |
| 22 | 0.07 | 0.00 | 0.07 | -0.06 | 0.00 | -0.06 | -0.10 | 0.03 | -0.11 |
| 23 | 0.12 | -0.03 | 0.13 | 0.12 | -0.03 | 0.13 | 0.13 | 0.00 | 0.14 |
| 24 | -0.07 | 0.01 | -0.07 | -0.10 | 0.00 | -0.10 | -0.12 | 0.01 | -0.12 |
| 25 | 0.03 | | 0.02 | 0.05 | | 0.05 | 0.06 | | 0.06 |
| 26 | 0.01 | | 0.00 | 0.01 | | 0.00 | -0.01 | | -0.02 |
| 27 | -0.01 | | -0.01 | 0.00 | | 0.01 | 0.00 | | 0.01 |
| 28 | -0.03 | | -0.03 | -0.02 | | -0.03 | -0.01 | | -0.02 |
| 29 | 0.02 | | 0.02 | 0.02 | | 0.02 | 0.02 | | 0.02 |
| 30 | -0.01 | | 0.01 | -0.02 | | 0.00 | -0.02 | | -0.01 |
| 31 | -0.01 | | -0.01 | 0.00 | | 0.00 | 0.00 | | 0.00 |
| 32 | -0.01 | | -0.01 | 0.00 | | 0.00 | 0.00 | | 0.00 |
| 33 | 0.01 | | -0.02 | 0.02 | | -0.01 | 0.01 | | |
| 34 | -0.01 | | 0.00 | 0.00 | | -0.01 | 0.00 | | |
| 35 | -0.03 | | -0.02 | -0.03 | | -0.01 | -0.03 | | |
| 36 | 0.01 | | 0.00 | 0.03 | | 0.01 | 0.04 | | |
| 37 | -0.02 | | | -0.02 | | 0.00 | -0.02 | | |
| 38 | -0.01 | | | 0.00 | | | 0.00 | | |
| 39 | 0.00 | | | 0.01 | | | 0.02 | | |

Appendix Table 12 (Continued)

| k | DIF1: 64-41 | DIF1: 64-89 | DIF1: 90-41 | DIF2: 64-41 | DIF2: 64-89 | DIF2: 90-41 | DIF3: 64-41 | DIF3: 64-89 | DIF3: 90-41 |
|---|---|---|---|---|---|---|---|---|---|
| 40 | -0.01 | | | -0.05 | | | -0.06 | | |
| 41 | 0.09 | | | 0.08 | | | 0.08 | | |
| 42 | -0.01 | | | -0.03 | | | -0.03 | | |
| 43 | -0.04 | | | -0.04 | | | -0.03 | | |
| 44 | 0.01 | | | 0.04 | | | 0.05 | | |
| 45 | -0.02 | | | -0.02 | | | -0.02 | | |
| 46 | -0.01 | | | -0.02 | | | -0.03 | | |
| 47 | 0.07 | | | 0.05 | | | 0.04 | | |
| 48 | 0.02 | | | 0.00 | | | -0.01 | | |
| 49 | -0.01 | | | -0.01 | | | 0.00 | | |
| 50 | -0.03 | | | -0.03 | | | -0.04 | | |
| 51 | 0.02 | | | 0.06 | | | 0.07 | | |
| 52 | -0.07 | | | -0.07 | | | -0.05 | | |
| 53 | 0.01 | | | -0.02 | | | -0.03 | | |
| 54 | 0.11 | | | 0.11 | | | 0.06 | | |
| 55 | -0.06 | | | -0.05 | | | -0.02 | | |
| 56 | 0.00 | | | 0.00 | | | 0.00 | | |
| 57 | -0.01 | | | -0.01 | | | | | |
| 58 | 0.01 | | | 0.01 | | | | | |
| 59 | 0.00 | | | 0.00 | | | | | |
| 60 | -0.01 | | | 0.00 | | | | | |
| 61 | -0.01 | | | 0.00 | | | | | |
| 62 | -0.02 | | | -0.01 | | | | | |
| 63 | 0.01 | | | -0.01 | | | | | |
| 64 | 0.03 | | | 0.02 | | | | | |
| 65 | 0.01 | | | 0.01 | | | | | |
| 66 | -0.01 | | | -0.01 | | | | | |
| 67 | 0.00 | | | 0.01 | | | | | |
| 68 | -0.02 | | | -0.01 | | | | | |
| 69 | 0.00 | | | 0.00 | | | | | |

Note: These series of autocorrelation are estimated using Shazam, an econometrics computer program (version 6.0). DIF1= autocorrelation of $\Delta Y_t$, DIF2 = autocorrelation of $\Delta^2 Y_t$, DIF3 = autocorrelation of $\Delta^3 Y_t$.

## ENDNOTES

### NOTES TO CHAPTER I

1. Traditionally, no water regulation was required with broadcasting. No bunds were built on the broadcasted rice fields except for small low boundary bunds between different owners' fields. In the 1960s, lowland broadcasting was improved with the use of chemical herbicides, artificial fertilizers, new varieties of rice, and irrigation systems. Bunding is required on the new broadcasting rice field because sprouted seed is broadcasted on puddled soil (Rice Research Institute 1986: 147-51, Gisselquist 1976: 90). Yields from the new broadcasting technique are higher than those from the traditional broadcasting technique because it is a more intensive technique. The broadcasting method discussed throughout this study refers to the traditional one, i.e., the one without water regulation.

2. This experimental data is difficult to obtain, if not impossible.

3. See details of the physiography and hydrology of the Chaophraya delta in Takaya (1987).

4. The author confirmed this pattern of farm alignment with elderly farmers in Rangsit in August 1987. The names and addresses of these farmers are: (1) Nai Yib Banboaprom, age 73 (address: 33 Mu 3, Klong 2, Amphoe Klongluang, Prathumthani); (2) Nai Chian Srisai, age 69 (address: 24, Klong 2, Amphoe Klongluang, Prathumthani); (3) Nai Suchin Mudubon, age 67 (address: 10 Klong 6, Mu 5, Amphoe Klongluang, Prathumthani); (4) Nai Mean Sangplung, age 64 (address: 11 Mu 15, Klong 1, Amphoe Klongluang, Prathumthani); (5) Nai Pai Bangchuad, age 71 (address: 30 Kong 5, Mu 8, Amphoe Klongluang, Prathumthani ).

5. See Grist (1986: Part 3), Cheng (1968: 32-6), Wickizer and Bennett (1941: 240-4), and Grant (1933: 11). Wickizer and Bennett also note that whenever the practice of transplanting is uncommon in the Asian regions, it is economic rather than physical limitations that operate against it (pp. 243-4).

6. See detailed descriptions in Wright and Breakspear (1908: 144), Thompson (1910: 188), Yai S. Sanitwongse (1911: 3-5), Graham (1924: 9), Wongsanupraphat (1941), Bangkok Calendar (1870: 142), Child (1892), Pugh (1929: 11), Ministry of Commerce and Communications (1930: 204-16), Annuman Rajadhon (1961), Pendleton (1962), Behrman (1968), Moerman (1962: 161), Gisselquist (1976), Kaufman (1976), A. KS. 13/229, A. KS. 15.2/30, A. KS. 13/229, and A. KS. 1/1005.

7. This book is regarded as the finest work on seventeenth century Thailand (see de La Loubere [1969: viii]).

8. This broadcasting method of growing rice in Ayuthya was also recorded in a seventeenth century Japanese document about Siam (see Ishii [1970: 170]).

9. See Yai S. Sanitwongse (1924), Wongsanupraphat (1941: 295-9), Ministry of Commerce and Communications (1930: 207-8), and Behrman (1968: 109).

10. A monetary unit equal to 1/4 baht.

11. The area planted to paddy may not have changed much between 1854 and 1864 because the population grew slowly and the country was just opened to international trade. The estimates of the average annual percent rates of growth of population in Thailand is 0.47 for the period 1850-1860 and 0.58 for the period 1860-1870 (Feeny 1982: 22). Both quantitative data and qualitative information on rice exports in Thailand point to a significant growth after 1864, especially during 1890-1900 (see Chapter 3).

12. For an account of this problem, see A. R5. KS. 3.2/2, A. R5. KS. 3.2/4, A. R5. KS. 3.2/7, A. R5. KS. 3.2/10, A. R5. KS. 3.2/31, and A. R5. KS. 3.2/2.

13. See also A. KS. 13/229.

14. The traditional administration system of Thailand at the time is, in descending order, province (*moung* later *changwat*), district (*khwaeng* later *amphoe*), commune (*tambon*), and village (*muban*).

15. See Johnston (1975: 198-246), Wongsanupraphat (1941: 298), Yai S. Sanitwongse (1911: 4-5), A. R5. K. 5.10.1/2, A. R5-7. B.1. 3/7 #8, and A. R7-8. 2/2378.

16. See for examples A. KS. 13/294, A. KS. 5/15, A. KS. 1.2/663, A. KS. 1.2/259, A. KS. 1/294, A. KS. 1/2154, A. KS. 1.2/367, A. KS. 1.2/389, A. N 3.1.1/9, A. KS. 1/2827, A. SB 2.47/118, A. R5. KS. 10.1/2, A. R5. KS. 3.1/11, A. R5. KS. 1/12, A. KS. 5/9, A. R6. KS. 1/6, A. KS. 13/583, A. R6. N. 13.1/4, A. R6. N. 13.6/4, and A. KS. 1.2/282.

17. See any annual reports of rice cultivation from the Department of Rice and the Department of Agricultural Economics.

18. See A. KS. 1/3226, A. SB. 2.7/7, A. KS. 1.2/88, A. KS. 1.2/398, A. KS. 15.2/30, A. KS. 1/1892, A. KS. 1.2/1894, A. KS. 1/1851, A. R6. KS. 4/7, and A. R7-R8. 2/2378.

19. The implicit assumption of perfect competition used here is a reasonable one, since there is evidence of a high degree of competition in rice markets and the rice trade dominated the economy, especially the Central Plain (see Feeny [1982: 165], Ingram [1971: 249], and Zimmerman [1931: 176-83]).

## NOTES TO CHAPTER II

1. This is equivalent to the short-run problem defined by Marshall (1920: 374).

2. For more detail of inputs used in the traditional Thai rice production and ] their importance see Young (1907: 200-17), Wright and Breakspear (1908: 146), Yai S. Sanitwongse (1911), Graham (1912: 322-4, 1924: 32-6), Annuman Rajadhon (1961), Pendleton (1963: 139-41), and Janlekha 1957: 93-9).

3. If a = 0, there is no difference in the slopes of the two marginal cost curves. Expected profits will not change despite the existence of price variability. This is equivalent to the situation where the firm has no choice of less capital intensive techniques.

## NOTES TO CHAPTER III

1. See Ingram (1964, 1971), Feeny (1982), and Birnberg and Resnick (1975). For other references on the importance of commercial rice production in the Central Plain of Thailand during the period, see Board of Commercial Development (any No.), Watanabe 1978, A. R5. KS. 3.1/1, and A. R5. KS. 3.1/8.

2. The response of rice cultivation to the increase in rice prices during the period is a characteristic of most rice growing Asian countries. For an account of this response see Owen (1971), Cheng (1968: 73, 241-3), Thompson (1941: 134-5), and Grant (1933: 1-4).

3. Supanee and Wagner (1969: 30) reveal that rice represented about 73 percent of the physical weight of total food consumed and 85 percent of the total caloric consumption for the whole country.

4. For an account of the shortage of Lao labor in Rangsit, see A. N. 41.1/214, A. R5. N. 3.2 k/63, A. R5. N. 3.2 k/116, A. R5. N. 41.1/214, A. KS. 1.2/663, A. P. 13/5, and A. P. 7/10.

## NOTES TO CHAPTER IV

1. See references cited in Note 9, Chapter 1.

2. This figure is the estimate of the Ministry of Agriculture, see Feeny (1981: Table A1-12).

3. See details of these land laws in A. R5/1 N. 41.4/1, A. N. 41.4/2, A. R6. KS. 5/10, and Sathian Laiyalak et al. (12: 18-20).

4. See Sathian Laiyalak et al. (11: 237-44, 12: 18-20, 215-24, 13: 8-12, 14: 172-6).

5. For information regarding the weakness of the traditional system of land laws and administrations, see A. R5. K. 3.3/10, A. R5. K. 4/7, Graham (1912: 287) and Siamwalla (1972).

6. See an account of this problem in A. R5. KS. 9.4 k/17, A. R5. KS. 4/1281, A. R4. KS. 3.2/10, and A. KS. 4/877.

7. See the government's concerns regarding land disputes during this period in A. KS. 1/158, A. R5. KS. 3.3/24, A. KS. 3.3/1. For details of land disputes in various areas on the young delta, see A. R5. KS. 3.3/10, A. KS. R5. 3.3/12, A. R5. Y. 11/16, A. KS. 4/1800-1801, A. KS. 85/3816, A. KS. 4/1794, A. R5. N. 41.4/46, A. Y. 13.10/7-25, A. KS. 4/2120-2123, A. KS. 4/3615-3616, A. R5. KS. 4.4/5, A. R5. KS. 4.4/7, A. R5-6. N. 15.2 c, A. R5. Y. 11/70, A. R5. Y. 11/87, A. KS. 3.2/31, A. N. R5. M1/21, A. N. R5. M. 1/23, A. R5. KS. 3.3/31, A. R5. KS. 3.3/33, A. R5. K. 4.2/49-50, A. R5. Y. 13.10/38, A. N. 3.4 k/89, A. N. 3.4 k/52, A. KS. 4/2119. A. KS. 6/2926, A. K. 6/3161, and A. KS. 6/4972. See also A. R5. N. 3.3 y/1-292, A. R5. N. 3.4 y/1-446, A. R5. N. 3.5 y/1-73, A. R5. N. 3.7. y/1-174, A. R5. N. 18.2/1-258, A. R5. K. 4.2/47, A. R5. N. 18.2 h/1-371, A. R5. N. 18.3/1-108, A. R5. N. 18.3 c/1-103, A. R5. Y. 13.10/12-15, and A. R5. KS. 9.2/11.

8. See these proposals in A. R5. KS. 9.2/2, A. R5. KS. 9.2/4, A. R5. KS. 9.2/6-7, A. KS. 4/3801, A. R5. KS. 9.2/11, A. R5. KS. 9.2/14-18, A. R5. KS. 9.2/20, R5. KS. 9.2/22-25, R5. KS. 9.2/28, R5. KS. 9.2/30, A. KS. 4/3825, A. KS. 4/3801, A. KS. 4/3812, A. R5. KS. 3.1/7, A. R5. KS. 4.4/8, A. R5. KS. 2/1, and

A. N. 40.2/11. See also A. KS. 10/394-1210 for details regarding land pre-emption during this period of rice boom.

9. See details in A. KS. 10/49, A. KS. 4/3822, and A. KS. 10/15.

10. See A. R6. KS. 5/4 and Sathian Laiyalak et al. (5: 374-8).

11. See A. R5. KS. 3.1/7, A. R5. KS. 2/10, A. R5. KS. 85/3812, and A. R5. KS. 9.2/11.

12. See also A. R5. KS. 3.3/12 and A. KS. 1/1.

13. See the company's announcement on the areas to be sold and the terms on which land could be purchased from the company in A. KS. 10/12.

14. The descriptions on Rangsit land disputes in this section are based on historical records of the Rangsit land development project. For details see A. N. R5. KS. 2-20, A. KS. 10/2-44, A. R5. KS. 3.3/10, A. KS. 4/2483, A. R5. KS. 9.4 k/22, A. R5. Y. 11/94, A. KS. 1/202, A. N. 3.2 k/39, A. R5. N. 41.4/1-84, A. KS. 4/3834, A. KS. 86/3836, A. KS. 86/3839, A. KS. 86/3841, A. KS. 86/3846, A. KS. 27/1223, A. KT 2/37, A. R5/1 N. 41.4/11, A. R5/1 N. 41.4/47, A. R5. KS. 9.4 k/25, A. R5. KS. 5/4, A. R5. KS. 5/10, A. R5. KS. 9.4/1, A. KS. 9.4/9, A. R6. KS. 5/5 (Appendix 2), and A. R5. KS. 9.4 k/7- 14, A. R5. 9.4 k/17-18, A. R5. K.S. 9.4 k/35, and Sathian Laiyalak et al. (17: 590-3).

15. See A. KS. 9.4 k/25, A. R5. KS. 9.4 k/35, A. R5. KS. 9.4 k/17-18, A. R5/1 N 41.4/47, and A. R5. KS. 5/10.

16. See A. R5/1 N. 41.4/11, A. KS. 9.4 k/17, A. KS. 5/4, A. R5. KS. 9.4/1, A. KS. 9.4/9, A. KT. 2/37, A. R5/1 N. 41.4/47, A. R6. KS. 5/5 (Appendix 2), A. R5. KS. 3.3/10, A. R5. KS. 9.4 k/9-14, A. KS. 10/4, and Sathian Laiyalak et al. (17: 590-93).

17. See Wright and Breakspear (1908: 124-7), Graham (1911: 288-9), and Wongsanupraphat (1960: 45-7, 87-107).

18. Indicated by names and addresses that appear in SCLIC's land sale records.

19. The figure for the total developed area is used because the figure for the total paddy area in Rangsit is unavailable.

20. See also Wright and Breakspear (1908), Graham (1912, 1: 288-9), and Wongsanupraphat (1960: 45-7, 87-107).

21. See also A. N. 31.3/70, A. N. 10.4/5, Graham 1924: 15, Siamwalla (1972: 28), and Thompson (1941: 173).

## NOTES TO CHAPTER V

1. In time series analysis, a spectral density function or periodogram can also be used to analyze the randomness of a series, usually by using a series of residuals after fitting a particular model. The device was first introduced by Schuster in 1898. For an introduction to this topic see Box and Jenkins (1976).

2. Box and Jenkins (1976: 33) note that in practice, to obtain a useful estimate of the autocorrelation function, at least fifty observations are needed.

3. There exist certain conditions that must hold for an autocorrelation function of a stationary process. However, the number of conditions that must hold becomes quite large as the number of observations become large. The derivation of these conditions is therefore complicated. Furthermore, the conditions themselves are cumbersome and of limited usefulness. It is, therefore, more common to judge stationarity from a visual examination of both the series itself and a sample autocorrelation function. For the purpose here, it is sufficient if $k > 0$ and $-1 < @k < 1$. See Pindyck and Rubinfeld (1976: 449-51) for the derivation of the conditions.

4. See Thompson (1941: 318), Siamwalla (1972: 27-8), Graham (1924), Ingram (1971: 66), Tanabe (1977, 1978), Battye (1974), Zimmerman (1931: 19), Andrews (1935: 102-3), Tomosugi (1980: 124-32), Feeny (1982: 61-2), A. R5. KS. 3.1/11, A. KS. 5/4, and A. R6. KS. 1/6.

5. See A. K. 12.2/8, A. KS. 4/3803, A. KS. 1/2, A. R5. KS. 3.3/6, and Sathian Laiyalak et al. (6: 273-4, 1220-4).

6. See A. R4. KS. 10/3, A. R5. KS. 12.4, A. R5. KS. 2/2, A. KS. 6/2926, A. R6. N. 10.5 k/25, A. KS. 5/5, A. R5. KS. 9/5, Sathian Laiyalak et al. (9: 202-4), and references cited in Appendix Table 9.

7. See references cited in Chapter 4 regarding areas of land disputes.

8. See Sathian Laiyalak et al. (9: 202-4) and A. KS. 20/8.

9. See Sathian Laiyalak et al. (47: 570-96), Rachakitchanubeksa 18: 370-2, A. KS. 2/1, A. KS. 20/8, Land Act 1908 and 1936.

10. See references cited in Appendix Tables 9 and 10.

11. See A. KS. 5/15, A. KS. 31.3/70, A. KS. 3.1/11, A. N. 10.4/5, and A. SB. 2.7/8.

12. See original contracts in A. KS. 4/1691, A. KS. 10/14, A. N. 41.41, A. N. 41.44, A. R5. N.18.3 k/1 (one for the period 1899-1900 and one for the

period 1901-03), A. SB. 2.47/189 (one for the period 1930-1932 and one for the year 1929). The scarcity of contracts may be due to the provisions of the 1901 Land Law, which required landlords and tenants to register their rental agreements only if the lease duration exceeded three years. Short-term leases (three years and under) were regarded as legally effective without registration.

13. See Akin (1969) for details on the Thai system of patron-client in the middle of the nineteenth century.

14. See A. R4. KS. 3.2/19, A. R5. K. 4.1/6, and A. KS. 4/1775.

15. See R.5. KS. 3.1/11, R5. KS. 3.2/28, A. N. 18.2 kh/4, and A. N. 10.4/5.

16. See Ricardo (1903), Mill (1899), and Marshall (1920).

17. For examples of this inference see Foster (1847: 405-6) and Pim (1848: 56).

18. See Mokyr (1983: 103-9) for a simple model of a predatory landlord.

19. See A. KS. 13/319. This document represented a petition from farmers and landlords to the Ministry of Agriculture.

20. Calculated from data on rice prices in Appendix Table 1.

21. For more details, see A. R7. Ph. 13/5, A. RL. 20/194, and A. RL. 20/198.

22. See A. R5. N. 3.2 k/63, A. R5. N. 3.2 k/116, A. R5. N. 41.1/214, A. KS. 1.2/663, and A. R5. N. 3.2 k/36.

23. See A. KS. 5/9, A. R5. KS. 3.1/11, A. KS. 1/1832, A. KS. 13/334, A. P. 7/10, and A. P. 13/15.

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- KS. Ministry of Agriculture
- KT. Ministry of Foreign Affairs
- K. Ministry of Finance
- MT. Ministry of Interior
- N. Ministry of Town
- P. Ministry of Commerce
- Y. Ministry of Justice
- SB. Damrong Papers
- FF. Files of Financial Advisor

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