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Joint Determination of Demand for Inputs and Choice of Rice Varieties: A Meta-Production Function Approach

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JOINT DETERMINATION OF
DEMAND FOR INPUTS AND CHOICE OF RICE VARIETIES:
A META-PRODUCTION FUNCTION APPROACH

SANZIDUR RAHMAN

A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

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ABSTRACT

Fierce competition in the already thin world rice market for low quality rice exports raised concerns on the future of rice production in Thailand for its increasing labor wages and production costs and its exporting competitors' lower cost of production. Over the past decade, high growth rate was observed for planted area of Khao Dawk Mali with fluctuating production and yield in northern Thailand. Khao Dawk Mali can be conceived as an alternative crop as Thailand enjoys a duopolistic competition in high quality rice market. Joint determination of farmers' responses to variable input price changes and rice variety choice at the farm-level would assist in exploring the potential of Khao Dawk Mali expansion as well as for predicting the impact of alternative policy instruments to assist the rice production sector. Ignoring the possibility of seed variety switching leads to underestimates of input demand elasticities. In addition, estimation with samples reflecting a single rice variety may involve serious selection bias. As such, a Two-Stage Switching Regression procedure which adjusts for selectivity bias is used to estimate the normalized restricted translog profit function model. The plot-level crop production data for the wet season, crop year 1992, were collected from six districts (*amphoe*) of Chiang Mai Province.

Estimated results for the elasticities of probability of planting Khao Dawk Mali from the first stage probit model revealed that seed selection is quite responsive to the fertilizer/rice price ratio as expected. The elasticity of probability with respect to land area suggests that land is positively related with Khao Dawk Mali adoption.

The second stage estimation of the normalized restricted translog profit function jointly estimated with three factor share equations using Seemingly Unrelated Regression Estimator method revealed that there was significant selectivity bias in estimating equations from a subsample of cultivators in Khao Dawk Mali regime, hence supporting the hypothesis of the study.

All own-price elasticities were inelastic and the inputs were complements. The total own-price elasticity of demand after allowing for the seed switching adjustments for fertilizer, labor and tractor power were estimated at -0.81, -0.69 and -0.37, respectively. The

impact of seed switching adjustments were about 9, 40 and 17 percent for fertilizer, labor and tractor power respectively. The output supply elasticity was estimated at 0.31. The output supply with respect to farm area and value of fixed farm assets were estimated at 0.90 and 0.04, respectively.

A 10 percent reduction in tractor power price is suggested from the ranking of fifteen policy alternatives according to their cost-effectiveness for Chiang Mai province, that would yield a net benefit of 26 baht/rai to rice farmers and a net return of 18.7 percent to the country. On the other hand, a rice (output) price subsidy of 10 percent would yield substantially higher net benefit of 274 baht/rai to farmers and a net return of 16.7 percent to the country (ranked two). For the combined policy alternatives, tractor power and rice subsidy would yield a net benefit of 300 baht/rai to farmers and a net return of 16.2 percent to the country (ranked three). Therefore, in order to increase rice production and raise farm income for Chiang Mai province, policy makers should focus on rice prices and tractor power prices.

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CHAPTER I
INTRODUCTION

Rice is the most important food crop in terms of planted area, value of production as well as source of foreign exchange earnings in Thailand. Unlike many developing countries that incur large bills for import of rice, Thailand is earning substantial foreign exchange by exporting its rice.

Over the last two decades the Thai agriculture grew at the remarkable rate of 4.5 percent per year (Puapanichya and Panayotou, 1985). Thailand is self-sufficient in food and a major food exporter in the world. However, most of the growth was accomplished through expansion of planted area with little contribution of increase in productivity. The average annual growth rate in rice area increased from 1.70 percent during 1911-1940 period to 2.18 percent during 1946-1980 and then lowered to mere 0.26 percent during 1981-1990 period (Table 1). Correspondingly, the growth rate of rice production for these three periods were 2.14, 3.40 and 1.78 percent, respectively. However, during the entire period, the yield level remained almost stagnant ranging from 1.32 to 2.02 mt per ha and is among the lowest in the world (Table 1).

Moreover, there is a widespread unequal distribution of income across regions. About 40 percent of the farmers, especially those in the Northeast and parts of the North, are still below the `*poverty line*', despite decades of agricultural growth. Therefore, the two major issues concerning agricultural sector are : (1) *how can Thailand increase further its agricultural production* *through raising yields*; and, (2) *how can farmers' income be raised without becoming uncompetitive in the world market owing to high production costs* ?

Table 1. Rice production performance in Thailand, 1907-1990.

Period	Area planted ('000 ha.)		Total Production ('000 mt paddy)		Yield (mt/ha)
1907-1910 [a]	1,461		2,737		1.74
1911-1920	1,906		3,248		1.37
1921-1930	2,515		4,448		1.61
1931-1940	2,912		4,546		1.56
Average annual growth rate 1911-20 to 1931-40 (%)		**1.70**		**2.14**	
1946-1955	4,970		6,546		1.32
1956-1965	5,634		8,177		1.44
1966-1975	7,478		13,182		1.76
1976-1980	8,990		16,400		1.82
Average annual growth rate 1946-55 to 1976-80 (%)		**2.18**		**3.40**	
1981-1990 [b]	8,904		19,181		2.02
Average annual growth rate 1981-90 (%)		**0.26**		**1.78**	

Source: [a]Selected from *The Rice Economy of Asia* (1985). (Tables 4.8, 4.9, 4.11, 4.12 and 4.13).
[b]Office of Agricultural Economics, *Agricultural Statistics of Thailand, Crop Year 1987/88 and 1989/90.*

It is worth noting that, Thailand enjoys a duopolistic competition with United States as the only opponent in the international market for high quality rice. Since, the world rice market is becoming highly competitive, exploring the possibility of promoting production of high quality rice for exports is essential. In addition, given the slow rate of adoption of high yielding varieties coupled with poor performance owing to various constraints, both physical and institutional, the urgency for diversion to high income crops is clear.

1.1 Government Policies

1.1.1 Rice Policy

In the post-World War II period Thailand has ranked as one of the world's largest rice exporters. The share of Thai rice exports in the international market is around 20 to 25 percent (Tolley *et al.*, 1982). This dependence on rice exports, however, has also posed problems because of the highly unstable and widely fluctuating rice prices in world market. Since rice constitutes a high percentage of the national income of Thailand and is also the main staple for consumption, the government has tried to intervene through taxation of rice exports which could serve as an instrument for stabilizing domestic price of rice in the face of world price fluctuations[1]. It is worth noting that, whatever is the theoretical superiority of the rice export policy, the prices paid to producers in Thailand have traditionally been below world levels. The farm level price of rice as a percentage of world price remained at 71 percent in 1961-1965, 55 percent in 1966-1970, 62 percent in 1971-75 and 70 percent in 1976-80, respectively (Barker *et al.*, 1985).

[1] A tax on a commodity generates revenue to the government, but its burden has to be borne by buyer in the form of high price received. Thus, an export tax results in a rise in price paid by the foreign buyer or a fall in the domestic price of the commodity in the country imposing the tax. One important determinant of the size of the net gain or loss is the extent to which the tax is passed on to foreign buyers which in turn depends on how responsive foreign demand is to changes in the price charged by the exporting country. Assuming Thailand is a price taker in the world rice market, the export tax would then be reflected entirely by a fall in the domestic price which implies burden to the producer (Tolley *et al.*, 1982).

There has been much debate on whether Thailand can influence international prices to some extent. Tolley *et al.* (1982) estimated the foreign elasticity of demand for Thai rice to be -4.00 for the short run and argues that in the long run it could conceivably be higher as substitution takes place and as present market relations and buyers' preference break down though it would still not approach infinity unless international trade were fully liberalized. And further suggested that, an optimal tax can be justified with its rate depending on the magnitude of the long-run and short-run foreign demand elasticities (Tolley *et al.*, 1982).

1.1.2 Rice Policy and Adoption of New Technology

Attempt of depressing domestic rice prices may hinder the adoption of new inputs in rice production[2]. Reasons often cited for the slow rate of adoption of high yielding varieties include lack of water control and accompanying inputs which increase the profitability of these varieties, the quality oriented nature of rice research in Thailand to meet standards in the export market, and the heavy indebtedness of farmers in the Central Plains, which prevents the adoption of a technology requiring capital and credit. An IRRI study postulated that, "labor and fertilizer costs are higher for high yielding varieties than for traditional varieties, and these costs rise with the

[2] A farmer tend to use an input - say, fertilizer - until the last unit employed contributes to the value of output an amount just equal to its cost. For a single farmer the price he pays for fertilizer and the price he receives for paddy sold can be taken as given. The contribution of fertilizer to output is expected to fall, however, as more and more of it is used. Thus, when paddy price is made artificially low, farmers would tend to cut down their fertilizer consumption; if in addition the fertilizer price is kept high, its use could be curtailed further. Such price distortions led to inefficiencies in production and higher costs (Tolley *et al.*, 1982).

degree of water control .... despite significant differences in net return and variable cost per hectare, variable cost per unit of output for high yielding varieties is not significantly different from that of traditional varieties. There is thus little gain in cost efficiency with the new technology .... This suggests that the profitability of adopting modern inputs depends as much on the future of world prices as on the price incentive used" (Tolley *et al.*, 1982).

1.1.3 Fertilizer Policy

It is believed that the key to significantly higher yields is a combination of fertilizer in appropriate quantities, irrigation, and improved seed varieties. Unfortunately, a combination of policies encouraging monopolies in the production and import of fertilizer in the past has led to unduly high fertilizer prices, which when combined with the rice pricing policies resulted in very unfavorable fertilizer/rice price ratios which ranges from 5.0 in 1955 to 2.9 in 1977 (Hayami and Ruttan, 1985). It is worthy to note that, Thai farmers have been among the lowest fertilizer users in Asia ranging from 2.4 kg per ha to 17.0 kg per ha for the period 1964-1981 (Puapanichya and Panayotou, 1985). Figure 1 presents the fertilizer use in Thailand for the period 1967-1990. The quantity used in agriculture increased steadily for the period, but the use of fertilizer in rice production fluctuated considerably.

Figure 1.Trends in fertilizer use in Thailand, 1967 to 1990

Source:*Food Policy Analysis* (1985) and *Agricultural Statistics of Thailand, Crop Year 1987/88 and 1989/90.*

Average application rate for rice was about 5.2 kg of material per rai in the 1973/74 crop year and increased to 6.4 kg of material per rai in the crop year 1978/79. However, for the second rice crop, the rate increased significantly from about 9 kg of material per rai in 1973/74 to about 42 kg of material per rai in 1978/79 crop year (Puapanichya and Panayotou, 1985).

Various policies concerning chemical fertilizers were implemented since 1963. In response to the oil-crisis of 1973, the government declared fertilizer to be a competitive industry. In 1975, a fund of 500 million baht were allocated to the Marketing Organization of Farmers (MOF) for fertilizer purchase at competitive bidding. Another policy was the imposition of an import tax at a rate of 20 percent of the CIF. However, the impacts of these policies have been mixed.

1.2 High Quality Rice of Thailand

1.2.1 Meaning and Importance

In setting rice standards, rice growers and exporters establish certain criteria to grade their commodities. The most common criteria involve physical properties such as length of kernel, degree of milling, percentage of broken, proportion of damaged grain, colored grain, moisture level and impurities (Kaosaard and Juliano, 1989). For understanding consumers' preferred rice quality, the criteria lie in the tastes and preferences of the consumers with respect to the cooking quality. It also depends on the historical and socio-cultural factors of the country in question. The chemical properties represent a first approximation of the preferred cooking qualities.

Kaosaard and Juliano (1989) postulated that, as income of rice consuming countries rise, grain quality becomes more and more important for both traditional exporters and importers. Particularly, for the traditional exporters, grain quality is essential in sustaining traditional markets and penetrating into high income and high technology-requirement markets. Improving the grain quality does not only improve welfare to consumers but also provides an assurance that emergent surpluses will find a rewarding market. Also, substantial price difference between different qualities implied non-perfect substitution and hence technological changes that improve the quality of rice may yield high gross return. In particular, improving quality characteristics related to genetic sources or varieties may reduce processing cost and directly raise returns to farmers (Kaosaard and Juliano, 1989).

1.2.2 Khao Dawk Mali: The Thai High Quality Rice

Khao Dawk Mali, a non-glutinous fragrant variety, is considered as the top quality rice in Thailand and has a high demand in world rice market. Grown in the main wet season, Khao Dawk Mali constituted 18.4 percent of all rice area for the year 1990/91 (Fig. 2).

Figure 2.Area planted and production of rice by varieties for wet rice season in Thailand, 1990/91.

Source:Department of Agricultural Extension, *Rice Data Classified by Rice Varieties*, Thailand, 1991.

During the past decade (1980-1991), Khao Dawk Mali production grew at a remarkable rate of 16.13 percent per year in twelve major growing areas concentrated in the Northeast and Northern regions of Thailand, while during the same period, the overall rice production grew only at the rate of 1.78 percent per year (Fig. 3).

Figure 3.Index of area planted and production of Khao Dawk Mali and total rice crop in Thailand, 1981 to 1990.

Source:Bank of Agriculture and Cooperative, Department of Domestic Trade and *Agricultural Statistics of Thailand*, 1987/88, 1989/90.

1.2.3 Share of Thai High Quality Rice in World Market

The world rice market is a thin one where only four percent of global production is traded. Moreover, if further classification of rice standards are made, the market size become more smaller. This small, residual and fragmented market combined with inadequate and inaccurate production forecast in most producing countries make the market of rice relatively volatile compared to other primary commodities (Kaosaard and Juliano, 1989).

Hong Kong, a traditionally rice consuming but non-producing economy, has been a traditional market of Thai rice. The market share has been as high as 64.5 percent in 1962 which fell sharply during 1963 when there was an acute production shortage in Thailand. Gradually Thailand regained the position of largest supplier in 1986 when her share accounted for 49.9 percent. The other two major suppliers were China and Australia. In the Hong Kong market, the share of fragrant Thai rice rose from 20 percent of total rice export in 1960 to about 80 percent at present (Kaosaard and Juliano, 1989).

The export volume of Khao Dawk Mali increased almost six folds from 148.5 thousand tons in 1988 to 823.1 thousand tons in 1991 (Fig. 4). Asia alone imports about 60 percent of the total export. The major customers of high quality rice are Hong Kong, Singapore, Middle East and USA.

Figure 4.Quantity of Khao Dawk Mali exported from Thailand to rest of the world.

Source:Private Rice Section, Department of Cereal Trade, Ministry of Agriculture and Cooperatives.

With respect to price level, Khao Dawk Mali enjoys advantage in the domestic market over RD 15 (a non-glutinous variety developed from Khao Dawk Mali for higher yield) and local varieties (mainly glutinous traditional cultivars) (Fig. 5). However, in the later period there seems to be a downward pressure in Khao Dawk Mali price. Examining the stability of export earnings and unit value of exports of Thai rice of different grades between 1957-1987, Purgsiganont (1989) revealed that high standard rice (better or equal to 5% broken) tended to be more stable than the medium (between 10-20% broken) and lower standard rice. The Coppock's instability index estimates indicated that, the export earning and price for high standard Thai rice are generally lower than the medium and lower standards (Table 2).

Figure 5. Domestic price of Khao Dawk Mali, RD 15 and the local variety rice in major growing areas of Thailand, 1989 to 1991.

Source: Bank of Agriculture and Cooperatives and Department of Domestic Trade.

Table 2. Coppock's instability index for Thai rice

Period	Price			Export earning		
	High quality	Medium quality	Low quality	High quality	Medium quality	Low quality
1957-1962	7.08	9.67	12.26	11.84	24.28	193.97
1963-1968	11.08	10.87	14.11	7.57	103.10	62.97
1969-1974	48.14	66.71	76.78	74.18	145.08	242.69
1975-1980	22.66	22.34	22.52	22.49	93.64	218.97
1981-1986	13.23	17.15	13.13	14.41	35.44	51.01

Source: Adapted from Purgsiganont (1989)

More importantly, high quality rice market is very close to a duopolistic market type with the United States and Thailand as the two major actors. Hence prices in this markets are very much affected by both the Thai export and the United States' agricultural policy. The Thai export premium policy which tended to place higher premium on higher standard rice with incremental premiums during production booms introduces distortions in the prices of high standard rice in the international markets.

1.3 Rationale

From the above analysis, it is evident that, in order to maintain the stability of rice export earnings in the long-run, Thailand should seek the opportunity to boost up the export of high quality rice. This consideration is important because, some of the Asian nations, such as, Vietnam, Cambodia who are moving towards a market oriented economy, potentially have the advantage to offer low quality rice at a very competitive price in the world market owing to their cheap labor cost. Thailand, whose economy is growing fast and is accompanied by rising labor wages is likely to lose in competition in the near future. This will force the farming population to switch from growing low priced subsistence crops to high valued cash or market oriented crops in the long run.

Since, there exists an opportunity of duopolistic market with the United States in the high quality rice market with little chance for other countries to enter in the near future, Thai government should explore the possibility of promoting production of high quality rice for exports. Moreover, as income level of Thai people are rising, there seems to be a potential tendency to move towards the consumption of high quality rice.

Over the past decade, Khao Dawk Mali production steadily expanded from 36.4 thousand rai in 1980/81 to 98.8 thousand rai in 1987/88 and then declined in the subsequent years and dropped to 85.7 thousand rai in 1990/91 in the Chiang Mai province. However, on the contrary, the yield level boosted up from a mere 380 kg per rai in 1980/81 to 655 kg per rai in 1990/91 (Table A3 in the Appendix). This implies that farmers in this province switch varieties in order to maximize profit as well as fulfill their own consumption need of glutinous rice, since the drop in expansion is consistent with the drop in output prices in the same period. Therefore, undertaking demand study for inputs at the farm-level would facilitate in understanding the current situation and the nature of farmers' responses to input prices changes jointly considering the possibility of seed variety changes, and also the impact of economic incentives introduced by alternative policy instruments.

1.3.1 Demand Studies for Rice in Thailand

Various researches on rice production has been done in Thailand. So far, to our knowledge, very few studies used the analytical framework of normalized restricted profit function to analyze demand relationships in Thai agriculture. Adulavidhaya *et al.* (1979) and Puapanichya and Panayotou (1985) used normalized restricted Cobb-Douglas profit function to analyze farm-level data of agricultural crops including rice and Sriboonchitta (1983) used single product translog cost function for agricultural output in Chiang Mai Valley. However, none of the previous studies considered the possibility that cultivators can respond to price changes not only by adjusting their use of variable inputs but also by switching to different varieties, so as to maximize with respect to a *meta-production function* (the envelope containing the production surfaces of all potential seed varieties). Input demand models that do not consider the possibility of seed variety switching would underestimate response to price and hence introduce bias in estimation (Pitt, 1983).

The present study, is thus, an attempt in this line and uses the Two-Stage Switching Regression procedure utilizing normalized restricted translog profit functions for both Khao Dawk Mali and glutinous rice varieties.

1.4 Objectives

The broad objective of this study is to jointly determine the demand for variable inputs and choice of rice varieties at farm-level in Chiang Mai province. The specific objectives are :

a)Present the input-output descriptions of Khao Dawk Mali and other glutinous rice varieties.

b)Estimate the average costs and returns for Khao Dawk Mali and other glutinous rice varieties.

c)Analyze the farmers' decision making process with respect to changes in variable input prices as well as switching between rice varieties.

d)Estimate the variable input demand and output supply elasticities jointly determined with rice seed variety choice by profit maximizing farmers.

1.5 Literature Review

1.5.1 Estimation Methods

Joint estimation of the normalized profit function and factor shares has been a popular method for obtaining indirect estimates of input demand elasticities as early as 1971. Normalized restricted Cobb-Douglas profit functions were employed by Lau and Yotopoulos (1972) for cross sectional study of farms in India. The results suggested that, the indirect elasticity estimates obtained for labor and land were more efficient than the direct estimation from production functions due to the existence of simultaneous equations bias in the production function (Lau and Yotopoulos, 1972).

Similar claims were made by Yotopoulos *et al.* (1976) from their study of cross sectional farm household data in Taiwan. They employed the same method of analysis with two distinct features added: (1) increase in the number of variable inputs from one to four, (2) and incorporating the test of hypothesis of structural change between successive cross section.

Sidhu and Baanante (1981) used the normalized restricted translog profit function to estimate farm-level input demand for Mexican wheat variety in Indian Punjab and claimed that it allowed a more disaggregated analysis of the farm production structure compared to Cobb-Douglas formulation. The increased flexibility permitted measurement of different impacts that exogenous variables have within and across input demands and output supply functions. Four variable inputs and seven fixed factors were specified in their model (Sidhu and Baanante, 1981).

Lopez (1984) asserted that he was able to derive all the relevant information with respect to the structure of production of an industry using the knowledge of only a profit function for Canadian agriculture.

Adulavidhaya *et al.* (1979) used normalized restricted Cobb-Douglas profit function to estimate input demand and output supply elasticities of Thai agriculture. Agricultural output, four variable inputs (labor, animal, mechanical, and seeds-fertilizer), and two fixed factors (fixed assets and land) were included in the function (Adulavidhaya *et al.*, 1979). Their results indicated that, the output supply and the factor demands were highly sensitive to changes in output price.

Puapanichya and Panayotou (1985) used normalized Cobb-Douglas profit function to validate profit maximization behavior and constant returns to scale for irrigated and non-irrigated rice area in Thailand. Agricultural output (rice, maize, cassava, and sugarcane), three variable inputs (seed, fertilizer, labor) and two fixed factors (land and fixed farm assets) were included in the function. The results suggested that, farmers in both areas are profit maximizers and the constant returns to scale exists in Thai rice agriculture. Also, the own-price elasticity of supply of irrigated rice was found to be higher than non-irrigated rice (0.649 vs 0.508) (Puapanichya and Panayotou, 1985).

Sriboonchitta (1983) used single product translog cost function to analyze the relative share of labor and estimate input demand elasticities, elasticities of substitution for Chiang Mai Valley. The results suggested that, demand for inputs are inelastic and mixed relationships (both complementary and supplementary) exists between inputs across two farming techniques, the animal power farming and the tractor power farming technique (Sriboonchitta, 1983).

1.5.2 Estimation Utilizing Meta-Production Function Approach

Few studies has been conducted using the conceptual framework that farmers could response to a price change by manipulating the variable input use as well as switching to different seed varieties. Studies conducted by Pitt (1983) and Sumodiningrat (1982)[3] are major two studies that were specifically designed to test the model of Figure 6. Pitt (1983) conducted the study on the response of traditional and modern rice cultivators to differences in the prices of variable and fixed inputs in Java, Indonesia. He stressed that, "fertilizer demand models which do not jointly consider seed variety choice and fertilizer demand will underestimate response to price" (Pitt, 1983). In addition, he argued that, there is another problem in variety specific fertilizer demand and profit/cost function studies. "In these studies, farmers who plant seed varieties other than those investigated are systematically excluded from the sample. The reason is simply that the profit to be obtained from planting Mexican wheat varieties, for example, is not observed from cultivators who plant other varieties. Hence, the least squares estimation may be selectivity biased. The bias comes about because cultivators who would obtain lower-than-average high yielding variety (HYV) profit, given prices and fixed factors select traditional variety (TV) seeds thus truncating the observed HYV profit distribution" (Pitt, 1983). His model differs from the other attempts that, it allows for the analysis of the choice of seed variety

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[3] Gunawan Sumodiningrat, "Varietal Choice and Input Demand in Rice Production in Indonesia", Ph.D Dissertation, University of Minnesota (1982). This reference was cited in Yujiro Hayami and Vernon W. Ruttan, *Agricultural Development: An International Perspective* (1985), John Hopkins University Press, Baltimore.

and the demand for variable input in a simultaneous equation framework using two stage estimation procedure adjusted for selectivity bias as well.

His estimates indicated that, the elasticity of fertilizer demand for traditional varieties was -0.400 and for modern varieties was -1.561. But the elasticity along the meta-production function which takes into account the shift from traditional to modern varieties, increases the elasticity by about 11 percent from -1.042 to -1.155 (Pitt, 1983). He concluded that, this shift in the response function, associated with a change in varieties, sharply increased the opportunity for Indonesian rice producers to expand rice production by substituting fertilizer for land (in Hayami and Ruttan, 1985).

Sumodiningrat (1982) also drew on data on the response of traditional and modern rice varieties to differences in the prices of variable and fixed inputs in Indonesia. He found that, the failure in taking into account the effect of variety shifts tended to underestimate the elasticity of demand for several other factor inputs (in Hayami and Ruttan, 1985).

CHAPTER II
METHODOLOGY

2.1 The Meta-Production Function

Hayami and Ruttan (1985) asserted that, a requisite for agricultural productivity growth is the capacity of the agricultural sector to adapt to a new set of factor and product prices. And this adaptation involves not only the movement along a fixed production surface but also the build up of a new production surface that is optimal for the new set of prices. For instance, the use of fertilizer, "even if fertilizer prices decline relative to the prices of land and farm products, increases in the use of fertilizer may be limited unless new crop varieties are developed which are more responsive to high levels of biological and chemical inputs than are traditional varieties" (Hayami and Ruttan, 1985).

Stated in simpler terms, it implies that, "changes in the relative price of fertilizer will induce cultivators to switch to seed varieties of differing fertilizer intensiveness so as to maximize profits with respect to a meta-production function. The meta-production function is the envelope containing the production surfaces of all potential seed varieties, irrigation system and cultivation techniques" (Pitt, 1983). The concept can be best illustrated as follows.

Figure 6 illustrates a conceptual meta-fertilizer response surface U, representing the locus of technically efficient fertilizer-output combinations for a particular agro-climatic environment and fixed level of other factors such as irrigation. It should be noted that, different types of meta-fertilizer response function is associated with each different combination of agro-climatic environment and factor inputs. The fertilizer response surface for the traditional varieties and the modern varieties can be drawn as U_0 and U_1 (Fig. 6a). The meta-fertilizer response surface U, which is the envelope of many such response surfaces encompasses the individual seed variety fertilizer response functions U_0 and U_1, each characterized by a different degree of fertilizer-responsiveness. UAP and UMP, a_0 and m_0, a_1 and m_1, in Fig. 6b, are the average and marginal product curves corresponding, respectively, to U, U_0 and U_1.

U_0 represents the optimal (profit maximizing) variety for the fertilizer/rice price ratio, P_0; and U_1 represents an optimum for P_1. With the fertilizer/rice price ratio of P_0, the profit-maximizing farmer would be at A (or D) on the meta-response function using variety 1. Now, when the fertilizer/rice price ratio declines from P_0 to P_1, and if the individual farmer is not allowed for switching (that is, not permitting movement along the meta-response surface) will result in an increase in the use of fertilizer at C (or F), which is a point inside the meta-production surface. When allowed for seed variety switching, this problem is eliminated, since the new fertilizer-output combination will be at B (or E) with variety type 2 - on the meta-response surface.

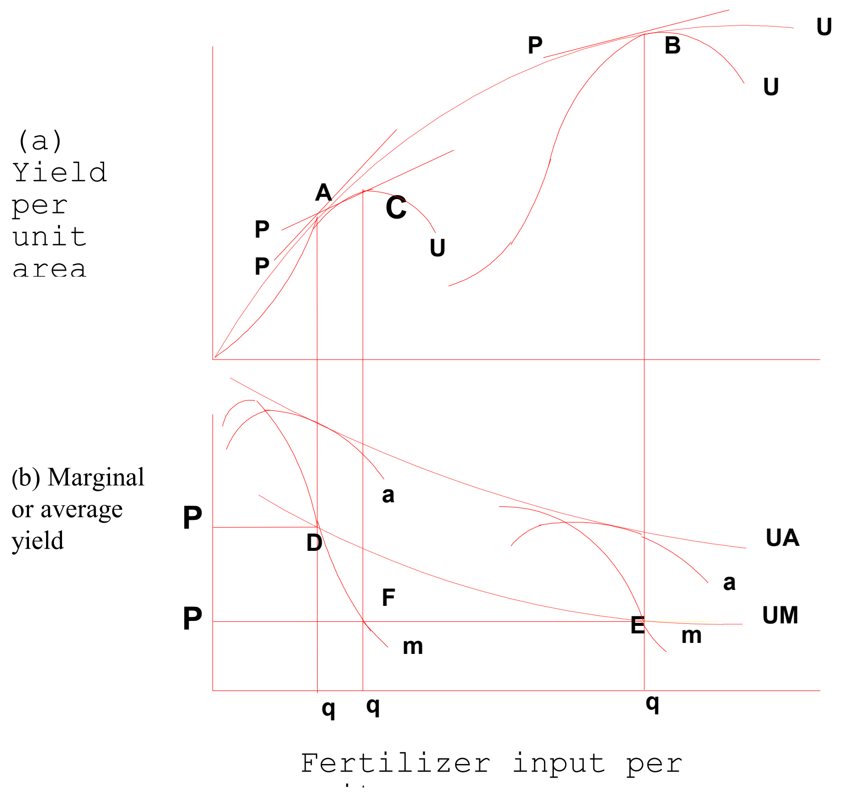

Figure 6.Fertilizer response on a meta-production surface

Source:Adapted from Hayami and Ruttan (1985).

Point C represents an equilibrium for a response surface U_0 if undertaken by farmers, but a disequilibrium in terms of potential alternatives described by the meta-production function U. It is worthy to note that fertilizer response to price is larger for movements along the meta-response surface thaHxalong the seed variety specific surface (Hayami and Ruttan, 1985 and Pitt, 1983).

2.2 Scope and Limitation

The present study will focus for the non-glutinous high quality rice, Khao Dawk Mali, which is mainly produced for export and other glutinous rice varieties, such as RD 6, RD 10, Neaw San Pa Tong (NSPT) etc., mainly used for consumption. Confining the scope to only glutinous rice varieties is reasonable as large percentage of farmers grow only glutinous rice in the wet season. On the other hand, apart from Khao Dawk Mali, few other non-glutinous varieties are grown in Chiang Mai valley area in the same season. For example, only 7 percent of total area were under other non-glutinous rice, such as RD 15, RD 21, RD 23 and Basmati in northern Thailand (DAE, 1991). Therefore, the study will concentrate on the issue of cultivators' response to price changes by adjusting their main variable inputs, such as fertilizer, labor, and tractor power, as well as by switching between Khao Dawk Mali and other glutinous rice varieties. The selection of these varieties is justified on the basis of two major policy issues and the subsequent analysis presented above.

2.3 Data Collection

Crop input-output data were collected from a sample of individual farm plots of wet rice from six districts of Northern Thailand. Multi-stage sampling was used for selection of farm-plots implying that; firstly a purposive selection of districts where Khao Dawk Mali and other glutinous varieties are predominantly cultivated in the northern region of Thailand was made. Also, the land type, production environment and income distribution of farmers was considered as much as possible.

Based on various literatures on rice studies, particularly on a recent survey conducted by the Department of Agricultural Extension (DAE), six districts, namely, Phrao, San Kam Phaeng, San Sai, Doi Saket, San Pa Tong and Mae Rim from Chiang Mai province were chosen in the first stage.

The next stage was a random sampling of fifteen sub-districts (Tambon) from the above districts. Then, a cluster of twenty two villages were chosen for primary data collection, emphasizing wider scatter of farm-plots. The major guideline in this sampling process came from the provincial, district and sub-district level agricultural extension officials.

2.4 Data Collected

This study considers only two distinct categories of rice, the high quality traditional variety, Khao Dawk Mali, and the other glutinous varieties grouped as one, as the focal issue. The data gathered include the following attributes:

Input-output data at farm-level - area cultivated, rice varieties planted, input used, yield, volume marketed, etc.

Socio-economic Profile - farm size, tenurial status, factor endowments (land, labor, etc.), age and education of household head, family size, number of dependents, farm income, off-farm income, cropping patterns, etc.

Access to Infrastructure - water control facilities, electricity, transport facilities, marketing channels, credit availability etc.

2.5 Specification of the Model

Farmers are assumed to choose between high quality rice, Khao Dawk Mali and other glutinous rice varieties (GV) so as to maximize profits. With every combination of fixed factors and variable factor prices, there is an associated variable profit for the two seed varieties. Farmers will choose to plant Khao Dawk Mali seeds if the variable profit obtained by doing so exceeds that obtained by planting other glutinous rice varieties grouped as one.

The general model consists of two regimes described by the simultaneous equations,

$$\pi_{qi} = P_i\beta_q + Z_i\gamma_q + \varepsilon_{qi} \qquad (1)$$

$$I'_i = (\pi_{qi} - \pi_{gi})\lambda + \varepsilon_i \qquad (3)$$

$$\pi_{gi} = P_i\beta_g + Z_i\gamma_g + \varepsilon_{gi} \qquad (2)$$

where P_i is a vector of variable factors and output prices; Z_i is a vector of fixed factors; π_{qi} and π_{gi} represent variable profits under the Khao Dawk Mali and glutinous variety regime, respectively; i = 1, 2, .. N; β_q, β_g, γ_q, γ_g, and λ are vector of parameters; and

$$\varepsilon_q \sim N(0, \sigma_q^2),\ \varepsilon_g \sim N(0, \sigma_g^2),\ \varepsilon_i \sim N(0, \sigma_\varepsilon^2)$$

Equations (1) and (2) are variable profit functions. Equation (3) is the selection criterion function, and I' is an unobservable variable. A dummy variable, I_i is observed. It takes the value of 1 if a plot is planted with Khao Dawk Mali, 0 otherwise: i.e.,

$$I_i = 1,\ iff\ I_i\ 0 \qquad = 0,\ otherwise \tag{4}$$

Since Khao Dawk Mali and glutinous varieties are mutually exclusive, planting of both varieties cannot be observed simultaneously on any one plot. Thus, observed variable profit π_i takes the values

$$\pi_i = \pi_{qi},\ iff\ I_i = 1$$
$$\pi_i = \pi_{gi},\ iff\ I_i = 0 \tag{5}$$

Heckman (1976) indicated that, all of the models in the literature developed for limited dependent variables and sample selection bias may be interpreted within a missing data framework. Suppose that we seek to estimate equation (1), but that for some observations from a larger random sample data are missing on π_q. But, there is a sample of N_1 complete observations.

The population regression function for equation (1) may be written as

$$E(\pi_{qi} \text{½} P_i, Z_i) = P_i \beta_{qi} + Z_i \gamma_{qi}, \quad i = 1, \ldots. N \tag{6}$$

This function could be estimated without bias from a random sample of the population of paddy cultivators. The regression function for the incomplete sample (Khao Dawk Mali cultivators only) may be written as

Error!

$$E(\pi_{qi} \text{½} P_i, Z_i,\ sample\ selection\ rule) \tag{7}$$

where without loss of generality the first N_1 observations are assumed to contain data on π_q. If the conditional expectation of ε_{qi} is zero, a regression on the incomplete sample will provide unbiased estimates of β_{qi} and γ_{qi}. Regression estimates of (1) fitted on a selected sample directly, omit the final term, i.e., the conditional mean of ε_{qi}, shown on the right hand side of equation (7). Thus the bias, that arises from using least squares to fit models for limited dependent variables or models with truncation arises solely because the conditional mean of ε_{qi} is not included as a regressor. Therefore, the bias that arises from selection may be interpreted as arising from an ordinary specification error with the conditional mean deleted as an explanatory variable (Heckman, 1976).

However, it is not likely that both

$$E(\varepsilon_{qi} | I_i = 1) = 0, \quad E(\varepsilon_{gi} | I_i = 0) = 0 \qquad (8)$$

This would occur only in very special situations (Lee, 1978). In the model, suppose that $\lambda > 0$, then it is likely that an observation of $I_i = 1$ will be associated with a positive value of ε_{qi} or negative value ε_{gi}. That is, random factors associated with high Khao Dawk Mali profit are likely to be associated with observed adoption.

2.6 Estimation

The variable profit functions of (1) and (2) are represented by Transcendental Logarithmic (translog) functions. The translog form is much less restrictive than the Cobb-Douglas form. It does not maintain additivity or unitary Hicks-Allen elasticities of substitution (Pitt, 1983). The translog variable profit function can be written as

$$\ln\pi' = \alpha_0 + \alpha_i \Sigma_i \ln P_i' + \frac{1}{2}\Sigma_i \Sigma_h \gamma_{ih} \ln P_i' \ln P_h' + \Sigma_i \Sigma_k \delta_{ik} \ln P_i' \ln Z_k$$
$$+ \Sigma_k \beta_k \ln Z_k + \frac{1}{2}\Sigma_k \Sigma_j \psi_{kj} \ln Z_k \ln Z_j \qquad (9)$$

where $\gamma_{ih} = \gamma_{hi}$ for all h, i, and the function is homogenous of degree one in prices of all variable inputs and output. The definition of the variables and the notation used are as follows: π' is the restricted variable profit - total revenue less total variable input costs - normalized by P_y, the price of output;

P_i' is the price of variable input X_i, normalized by P_y, the price of output; Z_k is the quantity of the *k*<u>th</u> fixed factors; $i = h = 1, 2, 3, ..., n + k = j = 1, 2, 3, ..., m$; *ln* is the natural logarithm; the parameters α_0, α_i, γ_{ij}, β_k, δ_{ik} and ψ_{kj} are to be estimated.

From the profit function (9), the following equation can be derived for a variable input (Diewert, 1974 and Sidhu and Baanante, 1981)

$$S_i = -\frac{P_i' X_i}{\pi'} = \frac{\partial \ln\pi'}{\partial \ln P_i'} = \alpha_i + \Sigma_h \gamma_{ih} \ln P_h' + \Sigma_k \delta_{ik} \ln Z_k \qquad (10)$$

where S_i is the ratio of variable expenditures for the *i*<u>th</u> input to variable profit. Profits and variable input demands are determined simultaneously. Under price-taking behavior of the farms, the normalized input prices and quantities of fixed factors are considered to be the exogenous variables.

Estimation of the variable profit functions (7) with selected samples can be accomplished with the Two-stage Switching Regression method described by Lee (1978) and Heckman (1976). The objective is to find an expression that adjusts the profit function error terms so that they have zero means. A reduced-form seed selection equation is obtained by substituting the profit functions (1) and (2) into the seed selection equation (3).

$$I_i' = \theta_0 + P_i\theta_1 + Z_i\theta_2 - \varepsilon_i' \quad (11)$$

By estimating (11) as a typical probit equation, it is possible to compute the probability that any plot has missing data on π_{qi} or π_{gi}. The probit reduced form itself shows how prices and fixed factors affect the probability of adopting Khao Dawk Mali. If the joint density of ε_{qi}, ε_{gi} and ε_i is multivariate normal, then the conditional expectation on the right-hand side of (7) is

$$E(\varepsilon_{qi} ½ I_i{=}0) = \sigma_{1\varepsilon'} \left(\frac{-f(\varphi_i)}{F(\varphi_i)}\right) \quad (12)$$

where F is the cumulative normal distribution and *f* is its density function, both evaluated at φ_i. $F(\varphi_i)$ is the probability that π_{qi} is observed.

The two-stage procedure uses $-f(\varphi_i)/F(\varphi_i)$ and $f(\varphi_i)/[1 - F(\varphi_i)]$ as regressors in the Khao Dawk Mali and glutinous variety profit function, respectively, to purge them of bias. Estimates of φ_i are just $\theta\_0 + P_i\theta\_1 + Z_i\theta\_2$, obtained from the estimated probit reduced-form equation (11).

We get estimates θ_0, θ_1, and θ_2 using the probit Maximum Likelihood (ML) method. Then, conditional on selection status, the variable profit equation for Khao Dawk Mali is,

$$\pi_{qi} = P_i\beta_q + Z_i\gamma_q + \sigma_{1_\varepsilon'} \left(\frac{-f(\varphi_i)}{F(\varphi_i)}\right) + \xi_q \qquad (13)$$

where f is the density function and F the distribution function of the standard normal, $\varphi_i = \theta_0 + P_i\beta_q + Z_i\gamma_q$, and $\sigma_{1\varepsilon'} = Cov(\varepsilon_q, \varepsilon')$. Similarly, conditional on selection status, the variable profit equation for glutinous varieties is,

$$\pi_{gi} = P_i\beta_g + Z_i\gamma_g + \sigma_{2_\varepsilon'} \left(\frac{f(\varphi_i)}{1-F(\varphi_i)}\right) + \xi_g \qquad (14)$$

where $\sigma_{2\varepsilon'} = Cov(\varepsilon_g, \varepsilon')$. After getting φ_ from the probit estimates of θ_0, θ_1 and θ_2 and substituting it for φ_i in equations (13) and (14), these equations can be estimated by Ordinary Least Squares (OLS). However, a more efficient estimate would be obtained by estimating jointly the profit function and the share equations using Zellner's Seemingly Unrelated Regressions Estimator (SURE) (Heckman, 1976).

The coefficient estimates of the profit functions obtained from this two-stage procedure are consistent (Lee, 1978). The correct asymptotic covariance matrix is very complicated. The formula used in calculating the asymptotic variance is discussed in Lee *et al.* (1980).

The vectors of explanatory variables used are the variable input prices, fertilizer, labor and tractor power, and the levels of fixed factors, land area and farm capital assets.

2.7 Input Demand Elasticities

After getting the parameter estimates of equations (9) and (10), one can get the elasticities of variable input demands and output supply with respect to all exogenous variables evaluated at averages of the S_i and at given levels of variable input prices and fixed factors which are linear transformations of the parameter estimates of the profit function. However, in order to allow for the seed switching options a further treatment would be necessary on these estimates discussed later in this chapter.

From (10) the demand equation for the *i*th variable input can be written as (Sidhu and Baanante, 1981)

$$X_i = \frac{\pi}{P_i}\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (15)$$

$$\ln X_i = \ln \pi - \ln P_i + \ln\left(-\frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (16)$$

The own-price elasticity of demand (η_{ii}) for X_i then becomes

$$\eta_{ii} = -S'_i - 1 - \frac{\gamma_{ii}}{S'_i} \qquad (17)$$

where S_i' is the simple average of S_i.

Similarly, from (16) the cross-price elasticity of demand (η_{ih}) for input *i* with respect to the price of the *h*th input can be obtained

$$\eta_{ih} = -S'_h - \frac{\gamma_{ih}}{S'_i} \qquad (18)$$

where $i \neq h$.

The elasticity of demand for input i (η_{iy}) with respect to output price, P_y, can also be obtained from (16),

$$\eta_{iy} = \Sigma_i S_i' + 1 + \Sigma_h \frac{\gamma_{ih}}{S_i'} \qquad (19)$$

where $i = 1, \ldots n, h = 1, \ldots , n$.

Finally the elasticity of demand (η_{ik}) for input *i* with respect to *k*th fixed factor Z_k is obtained from (16)

$$\eta_{ik} = \Sigma_i \delta_{ik} \ln P_i + \beta_k - \frac{\delta_{ik}}{S_i'} \qquad (20)$$

2.8 Output Supply Elasticities

Output supply elasticities with respect to output prices and variable inputs of production and quantities of fixed factors evaluated at averages of the S_i and at given levels of exogenous variables, can also be expressed as linear functions of parameters of the restricted profit function. From the duality theory (Lau and Yotopoulus, 1972) the equation for output supply V can be written as (Sidhu and Baanante, 1981)

$$V = \pi + \Sigma_i P_i X_i \qquad (21)$$

The various supply elasticity estimates can be derived from this equation. Rewriting (21) with the help of (15) as follows

$$\ln V = \ln \pi + \ln\left(1 - \Sigma_i \frac{\partial \ln \pi}{\partial \ln P_i}\right) \qquad (22)$$

Then the elasticity of supply (ε_{vi}) with respect to the price of the *i*th variable input is given by

$$\varepsilon_{vi} = -S'_i - \frac{\Sigma_h \gamma_{hi}}{1 + \Sigma_h S'_h} \qquad (23)$$

where $i = h = 1,.....,n$.

The own-price elasticity of supply (ε_{vv}) is given by

$$\varepsilon_{vv} = \Sigma_i S'_i + \frac{\Sigma_i \Sigma_h \gamma_{ih}}{1 + \Sigma_h S'_h} \qquad (24)$$

Finally, the elasticity of output supply (ε_{vk}) with respect to the fixed inputs Z_k is given by

$$\varepsilon_{vk} = \Sigma_i \delta_{ik} \ln P_i + \beta_k - \frac{\Sigma_i \delta_{ik}}{1 + \Sigma_h S'_h} \qquad (25)$$

2.9 Input Demand Elasticities After Allowing for Seed Switching

The price elasticity of demand for inputs allowing for seed switching can be readily calculated from the parameters of the probit see selection equation and the corresponding three sets of input demand equations or share equations.

The expected demand for variable input *i* by a representative cultivator having mean levels of fixed factors and facing mean prices is

$$E(X_i) = E(X_i | I=1)\,Prob(I=1) + E(X_i | I=0)\,Prob(I=0), \qquad (26)$$

where $E(X_i | I = 1)$ and $E(X_i | I = 0)$ are the demand for input *i* under a Khao Dawk Mali and a glutinous variety regime, respectively; and Prob (I = 1) and Prob (I = 0) are probabilities of observing a Khao Dawk Mali and a glutinous variety regime, respectively. The log derivative of this expectation with respect to the price of *i*th input is the total price elasticity of demand (η), which can be reduced to

$$\eta = \frac{\eta_q E(X_i | I=1)\,Prob(I=1)}{E(X_i)} + \frac{\eta_g E(X_i | I=0)\,Prob(I=0)}{E(X_i)} + \frac{\zeta_q [E(X_i | I=1) - E(X_i | I=0)]\,Prob(I=1)}{E(X_i)} \qquad (27)$$

where ζ_q is the elasticity of the probability of choosing Khao Dawk Mali variety with respect to the price of the *i*<u>th</u> input, and for estimating the total own price-elasticity of demand, η_q and η_g are given by

$$\eta_p = -S_i' - 1 - \frac{\gamma_{iip}}{S_i'} \; ..... \; p = \text{KDML, Glutinous variety} \qquad (28)$$

Similarly, the total cross-price elasticity of demand with respect to input prices and cross-price elasticities with respect to fixed factors can be obtained from the above expression (27) by replacing (28) with (16), (17) and (18) as required.

CHAPTER III

PRODUCTION ENVIRONMENT IN THE STUDY AREA

The study area covered six districts of the Chiang Mai Province namely, Phrao, Doi Saket, San Sai, Mae Rim, San Kam Phaeng and San Pa Tong. The first four districts are located in the northern and northwestern part of the Chiang Mai city (Fig. 7). San Pa Tong and San Kam Phaeng is located in the southeastern and eastern part of the city respectively. A national highway network stretches across all these six districts and supporting feeder roads also facilitates the access to city market. Phrao is relatively dry area with upland land types and is located 100 km north from the city. The nearest district is the San Kam Phaeng, about 20 km from the city. The intent of the present chapter is to describe the physical production environment and socio-economic information of the sample farms as well as some selected information on the sample villages as a whole.

3.1 The Production Environment

Agricultural production environment is determined by physical, climatic and also to some extent by socio-economic factors. The study area comprises of a mix of irrigated agriculture as well as rainfed agriculture, with wet season rice as the main crop in the system. Surface water irrigation systems from Mae Khong, Mae Kai and Mae Taeng is the major water supply source for these areas. However, few

Figure 7.Map of Chiang Mai province showing the study area.

Source :Adapted from Abamo (1992)

shallow tubewell irrigation systems used mainly for irrigating potato and other vegetables in the dry season were observed in San Sai. Phrao district is basically considered as out of the lowland agro-ecosystem of the Chiang Mai valley characterized with relatively poor infrastructure network, irrigation system and partially elevated land types. This was also reflected in the lower productivity of rice in the sample. The other five districts have a complex mix of intensive agriculture based systems to semi-industrialized and urban economic systems.

3.1.1 Cropping Systems

Chiang Mai Valley which stretches over the provincial area is endowed with favorable production environment for most of the economic crops. The main notable crops are rice, soybean, onion, garlic, chilly, various vegetables, tobacco and seasonal fruits. Rice based cropping system is the mainstay of the farmers except in upland areas, with little or no irrigation, where soybean based cropping system is dominant (Abamo, 1992).

Rice-soybean, rice-tobacco, rice-peanut are the dominant cropping systems in Phrao. Rice-garlic, rice-chilly, rice-onion-soybean are practiced in San Pa Tong and San Kam Phaeng. In San Sai, rice-potato, rice-tomato, rice-vegetables systems are the major patterns. The farmers of other three areas also practice rice-soybean, rice-garlic and rice-vegetables. Seasonal fruits, such as, longan, lychee are also produced by some farm families having land in the upland areas. Table 3 presents the cropping system followed by the sample farms in general.

Table 3.Second crops grown in general after wet rice in the study area

Area	Second crop growers (%)	Non-growers (%)	Crop types (weighted by number of farms growing)					
			Soybean	Spices	Potato	Tobacco	Peanut	Others
San Kam Phaeng	18.18	81.82	25.00	50.00	-	-	-	75.00
Doi Saket	44.44	55.56	68.75	43.75	-	-	12.50	6.25
Phrao	85.71	14.29	94.44	5.56	-	8.33	2.78	8.34
San Sai	96.77	3.23	70.00	-	26.66	-	-	10.00
Mae Rim	90.91	9.09	100.0	-	-	10.00	-	-
San Pa Tong	100.00	-	92.59	18.52	-	-	-	3.70
Total	73.89	26.11	83.46	11.28	6.02	3.76	2.26	8.28

Source: Survey

3.2 Agro-economic Characteristics of the Sample Villages

In this study, respondents were represented from about 22 villages. As such, a brief on some selected agro-economic features of the villages as a whole seems desirable. Table 4 presents some selected features of the sample villages aggregated as one for each area. Overall family size of the study areas ranges from 3.19 persons in Doi Saket to 4.38 persons in San Pa Tong. Topographically, villages in Phrao are of upland land type having slopes of about 1 to 15 percent and in some cases up to 35 percent, and the rest are on flat lands. The major proportion of soils are clay with a mix of loamy and sandy soils. In the wet season, Khao Dawk Mali area constituted more than half of the total rice area in Doi Saket, Phrao and San Sai, while glutinous rice production was dominant in Mae Rim, San Pa Tong and San Kam Phaeng covering more than two-third of the total rice area. This

Table 4. Agro-economic profile of the study villages in aggregates in six

districts

Attributes	San Kam Phaeng	Doi Saket	Phrao	San Pa Tong	San Sai	Mae Rim
Demographic						
Total village area (rai)	3809	1696	3164	1685	970	1030
No. of Households	829	376	254	528	309	343
Total population (persons)	3088	1200	954	2311	1280	1258
Family size	3.72	3.19	3.76	4.38	4.14	3.67
Topographic and climatic						
Rainfall (mm.)	905	866	910	785	843	928
Percent of precipitation during May-September	92.2	82.7	73.4	70.9	87.4	74.5
Agriculture						
Total cultivated area (rai)	2450	994	1138	1373	520	860
Total rice area (rai)	2296	805	1130	1228	520	860
KDML 105 (%)	39.9	71.9	53.5	33.0	67.7	17.1
RD 6 (%)	60.1	18.3	35.9	27.2	25.4	73.6
NSPT (%)	-	9.8	10.6	39.8	6.9	9.3
Other crops grown after wet rice[a]	P,C,V,	C—,O,G S,G,T		P,Ft, V,Dr	S,T, Dr,S	O,G,S,
Tenurial structure						
Owner operated HHs (%)	62.4	78.6	57.4	68.3	26.0	44.4
Tenant operated HHs (%)	37.6	21.4	42.6	31.7	74.0	55.6
Wage structure						
Cash with food (baht/day)	100-120	80	60	60-70	100	70
Cash contract (baht/rai)	350	350	300-350	350	-	350
Kind in paddy (kg/day)	20-30	20	10	10-15	-	20
Tractor rental (baht/rai)	350	350	300-350	350	250-350	350

[a]C = Chilly, O = Onion, G = Garlic, P = Peanut, Ft = Fruit tree, S = Soybean, T = Tobacco, V = Vegetable, Dr = Dry rice.

Source : Survey

reflects that the sample of this study was represented from areas where either Khao Dawk Mali or the glutinous varieties were dominant.

Share-tenancy was found to be dominant in San Sai and Mae Rim. A wide variation in wage rate is observed, ranging from 60 baht in Phrao (farthest from Chiang Mai city) to 120 baht per day in San Kam Phaeng (nearest to the city).

3.3 General Socio-economic Information of the Sample Farms

3.3.1 Family Size

The size of families varied from 3.64 persons in Mae Rim to 4.42 in San Sai (Table 5). However, the figures are not significantly different from each other.

3.3.2 Land Ownership and Tenancy

Average size of land owned per farm is highest in Phrao (13.38 rai per farm), a dry upland area and lowest in San Pa Tong (5.35 rai per farm), a well irrigated area which is currently under pressure of expanding urbanization (Table 5). The operation size also varies largely across areas in a similar pattern, ranging from 19.06 rai per farm in Phrao to only 7.68 rai per farm in San Pa Tong.

Table 5.General socio-economic information of the sample farms

Attributes	San Kam Phaeng	Doi Saket	Phrao Rim	Mae Sai	San Tong	San Pa Area	All
Demographic							
Family size (persons)	4.05	3.94	4.05	3.64	4.42	4.00	4.03
Farm and household Assets (baht/farm)	122,570	147,645	114,120	66,737	171,509	118,771	118,770
Land ownership[a] (rai/farm)							
Homestead area	0.71	1.08	0.95	0.84	0.94	0.62	0.88
Owned land	10.91	9.13	13.38	6.51	7.68	5.35	9.20
Size of rented-in land	2.41	4.53	6.62	3.23	4.85	2.94	4.42
Size of rented-out land	0.23	1.67	2.52	-	0.23	-	1.00
Operation size	12.66	12.83	19.06	8.72	11.68	7.68	12.79
Tenancy (percent)							
Owner operator	68.18	55.56	42.86	59.09	45.16	48.15	51.67
Pure tenant/landless	18.18	19.44	26.19	13.64	16.13	18.52	19.44
Part tenant	13.64	25.00	30.95	27.27	38.71	33.33	28.89
Prices							
Rice price (baht/kg)	3.78	3.86	3.63	3.93	3.92	3.50	3.78
Price of seed (baht/kg)	6.61	6.97	6.77	6.66	6.88	6.56	6.79
Wage rate (baht/day)	93.03	80.96	57.74	64.87	78.46	64.95	72.27
Tractor rate (baht/rai)	235.12	196.77	175.40	235.05	228.21	255.24	214.38
Farming experience (years)							
Overall farming	22.32	26.58	22.60	23.95	27.77	24.44	24.69
Growing Khao Dawk Mali	6.32	10.67	10.83	4.23	10.00	6.74	8.68
Growing glutinous rice	6.30	6.20	9.33	7.00	6.20	6.44	6.53

Source: Survey

Renting out land is not quite significant in any of the areas. On an average, about half of the farms are owner operated while about 20 percent farms are functionally landless and was farming under varied tenurial arrangements (Table 5). The rental arrangements vary from case to case, depending on whether a commercial or kinship relation dominates. The common practices include, (a) fifty-fifty crop output sharing with some input costs (such as fertilizer cost, half of the hired labor cost for harvesting and threshing) or no input costs sharing, (b) fixed rent in cash ranging from 400 to 1000 baht per rai per year, or (c) fixed rent in kind ranging from 100 to 200 kg of paddy per rai per year. One important point is to note that, the rent is paid only once in rice while the tenant is allowed to use the land for the whole year and grow as many crop as he/she desires. Similar pattern of rental arrangements were also reported by Zhang (1991) for San Sai area.

3.3.3 Input and Output Prices

The mean level of farm specific rice price received (ignoring varietal differences) for the crop year 1992 was 3.78 baht per kg (Table 5). The mean labor wage was 72.27 baht per day and mean tractor hiring rate (4-wheel and 2-wheel) was 214.38 baht per rai.

3.3.4 Farming Experience

The mean level of overall farming experience of the sample farms was about 25 years (Table 5). Khao Dawk Mali seems to be newly extended (less than 7 years) in the three pre-dominantly glutinous rice growing areas, Mae Rim, San Pa Tong and San Kam Phaeng. This newly expanded cultivation of Khao Dawk Mali might have contributed to its observed increasing growth rate at the national scale (see Table 5).

3.3.5 Farms and Household Assets

San Sai farms had the highest value of farm and household assets (171,509 baht per farm). Farm machinery and equipment, which include tractors and accessories, sprayer, water pump constituted about 14 percent of total value and was owned by about half of the sample farms (see item number 1 through 4, Table 6). Means of transport, pick-up trucks and motorcycles constituted the major share of the assets value (40 percent) and more than 90 percent of the farms owned at least one motorcycle. About three quarter of the farms had liquid assets, such as, bank savings, cooperative funds or gold ornaments, which constituted about 27 percent of the assets value.

Table 6.Percentage distribution of farm and household assets of sample farms

Area	Tractor and ac-cesorry	Genera-tor and thresher	Sprayer	Water pump	Pick-up truck	Motor-cycle	Live-stock and birds	Farm house	Liquid assets	House-hold assets	Total
San Kam	6.39	0.78	0.17	0.63	36.34	17.82	17.74	6.44	6.11	7.58	100.00
Phaeng	(54.55)	(9.09)	(54.55)	(59.09)	(22.73)	(100.0)	(72.73)	(68.18)	(63.64)	(100.0)[a]	
Doi	4.90	0.13	0.10	0.97	12.61	12.19	3.77	2.06	56.86	6.41	100.00
Saket	(47.22)	(5.56)	(41.67)	(58.33)	(11.11)	(88.89)	(52.78)	(38.89)	(69.44)	(100.0)	
Phrao	16.66	9.39	0.38	1.55	25.04	18.67	7.25	3.08	10.31	7.67	100.00
	(73.81)	(7.14)	(71.43)	(69.04)	(19.05)	(95.24)	(78.57)	(54.76)	(85.71)	(100.0)	100.00
Mae Rim	7.47	-	1.60	2.18	36.10	18.71	3.56	6.88	12.95	10.55	100.00
	(40.91)	-	(77.27)	(72.73)	(22.73)	(79.27)	(54.55)	(90.91)	(81.82)	(100.0)	
San Sai	9.75	0.15	0.66	0.93	29.10	10.20	4.49	9.07	31.18	4.47	100.00
	(35.48)	(6.45)	(77.42)	(70.97)	(32.26)	(83.57)	(64.52)	(83.87)	(74.19)	(100.0)	
San Pa	9.37	-	0.81	2.11	22.36	22.46	3.63	11.83	14.30	13.13	100.00
Tong	(51.85)	-	(77.78)	(77.78)	(11.11)	(100.0)	(66.67)	(62.96)	(81.48)	(100.0)	
All	9.48	2.27	0.47	1.23	24.92	15.16	6.46	5.74	27.06	7.21	100.00
Area	(51.11)	(5.00)	(68.33)	(68.33)	(19.44)	(91.11)	(66.11)	(63.89)	(76.67)	(100.0)	

[a]Figures in parenthesis are percentages of the farms that had those kind of farm and household assets as percent of total number of farms in each area.

Source : Survey

3.4 Economics of Rice Cultivation

This section analyzes the economics of cultivation of alternative rice varieties investigated. The objective is to highlight the implication of the adoption of high quality rice variety for costs of production, input requirements and profitability of cultivation. The larger the gains for farm households in the cultivation of Khao Dawk Mali rice relative to glutinous rice, the greater would be the possibility of diffusion of Khao Dawk Mali in northern region.

3.4.1 Yields

Land is a scarce resource in these Asian regions. As urbanization increases with consequent land value appreciation, agricultural production faces high competition and pressure to yield higher income which is feasible through intensification and increases in productivity of high valued crops.

At the sample means, significant yield differences (43 kg per rai) was observed between the two rice varieties ($P < 0.01$) (Table 7). Farm-level yield of Khao Dawk Mali was estimated at 643 kg per rai as compared to 600 kg per rai for glutinous varieties (80 percent of which is RD 6 alone, 15 percent Neaw San Pa Tong, and 5 percent RD 8 and RD 10). It should be noted that, no large variations was found among RD 6, RD 8, RD 10 and Neaw San Pa Tong with respect to yield levels, input uses and production practices. And as such, these varieties were grouped as one to represent as the glutinous variety.

Table 7.Average cost and profitability at farm specific prices of rice production, 1992

Variety/Area	Weight[a]	Yield (kg/rai)	Paddy price (baht/kg)	Gross value (baht/rai)	Variable cost (baht/rai)	Gross margin[b] (baht/rai)
San Kam Phaeng						
Khao Dawk Mali	0.671	676	4.28	2893.90	1143.75	1750.15
Glutinous rice	0.275	624	3.29	2056.30	1102.24	954.06
Doi Saket						
Khao Dawk Mali	0.811	650	4.16	2703.00	879.41	1823.59
Glutinous rice	0.189	647	3.29	2127.50	800.06	1327.44
Phrao						
Khao Dawk Mali	0.591	603	4.13	2488.60	732.29	1756.31
Glutinous rice	0.409	579	3.10	1814.70	799.08	1015.62
Mae Rim						
Khao Dawk Mali	0.339	751	4.18	3135.50	1040.22	2095.28
Glutinous rice	0.661	576	3.78	2179.10	866.07	1213.03
San Sai						
Khao Dawk Mali	0.744	643	4.07	2616.50	906.91	1709.59
Glutinous rice	0.256	690	3.64	2520.90	938.75	1582.15
San Pa Tong						
Khao Dawk Mali	0.373	594	3.88	2306.50	1042.65	1263.85
Glutinous rice	0.627	547	3.25	1775.80	1093.09	682.71
All Area						
Khao Dawk Mali	0.607	643	4.12	2652.50	917.27	1735.23
Glutinous rice	0.343	600	3.38	2029.00	917.74	1111.26
Mean difference		43	0.74	623.50	-	623.97
		(2.29)**	(16.90)***	(7.97)***	-	(7.31)***

Figures in parenthesis are approximate t-ratios

*** Significant at 1 percent level

** Significant at 5 percent level
[a] The proportion of total rice area
[b] Gross Margin =Gross value of production minus costs of seed, fertilizer, manure, irrigation, pesticides, hired labor, hired tractor price and imputed value of family and exchange labor and imputed value of tractor price.

Source: Survey

3.4.2 Material Inputs

The material inputs to be mentioned are seed, fertilizer, pesticides and irrigation.

3.4.2.1 Seeds

The amount of seed used per unit of land depends on whether the seed is broadcast, or a separate seed bed is prepared to grow seedlings which are then transplanted to the main field, the later being the common practice in these regions. Higher seed rate (7.82 kg per rai) was observed in glutinous rice production as compared to 6.90 kg per rai for Khao Dawk Mali (Table 8). The mean difference is about 0.92 kg of seeds per rai and is significant at 5 percent level.

3.4.2.2 Fertilizer and Pesticides

The fertilizer rate for Khao Dawk Mali and glutinous varieties were estimated at 17.12 kg and 16.32 kg of material per rai, respectively (Table 8). About 21 percent farms used manures in addition to low doses of chemical fertilizers.

In some areas of the northern region, widespread rice-blast disease were reported for the crop year 1992. Among the sample, few farms reported some damage in yield levels of both varieties. However, pesticides and herbicides were used by about 60 percent of the farmers as a precaution to imminent danger. It

Table 8. Material inputs in rice production

Variety/Area	Seed rate (kg/rai)	Fertilizer rate (kg/rai)	Pesticide rate (baht/rai)	Irrigation rate[a] (baht/rai)
San Kam Phaeng				
Khao Dawk Mali	6.10	25.12	41.56	6.64
Glutinous rice	8.90	30.04	30.46	7.55
Doi Saket				
Khao Dawk Mali	6.47	18.20	8.52	-
Glutinous rice	7.18	16.08	5.61	-
Phrao				
Khao Dawk Mali	6.21	13.52	30.06	3.00
Glutinous rice	6.54	14.67	41.56	6.64
Mae Rim				
Khao Dawk Mali	7.15	13.31	42.15	12.38
Glutinous rice	7.77	14.13	29.55	22.00
San Sai				
Khao Dawk Mali	6.82	16.26	23.45	8.63
Glutinous rice	7.52	17.46	20.12	6.00
San Pa Tong				
Khao Dawk Mali	10.08	18.59	72.54	6.00
Glutinous rice	9.52	18.95	79.97	7.38
All Area				

Khao Dawk Mali	6.90	17.12	26.70	5.00
Glutinous rice	7.82	16.32	36.00	8.00
Mean difference	-0.92	0.80	-9.30	-3.00
	(-2.159)**	(0.677)	(-1.446)	(-1.127)

Figures in parenthesis are approximate t-ratios
** Significant at 5 percent level
[a] Fertilizer rate is measured in kg of material per rai.
Source: Survey

should be noted that measurement of these inputs are complicated as farmers use various types of chemicals. A common measure of aggregation is to use the value of expenditure on pesticide and herbicide as a proxy. The mean expense incurred for such chemicals were 36.00 and 26.70 baht per rai for glutinous variety and Khao Dawk Mali, respectively (Table 8).

3.4.2.3 Irrigation

Surface water irrigation system is the dominant mode in the northern region. The Royal Irrigation Department (RID) constructs the weir and the main canal while the farmers receives water by paying a flat rate of 5.00 to 6.00 baht per rai for the growing season. Therefore, irrigation can be considered as a linear function of land size and frequency of irrigation and water control will vary from farm to farm depending on the stock of family labor. During the interview sessions, isolating the cost of irrigation came out to be very cumbersome. Only the flat water fee and in some cases fuel costs incurred to operate the water pumps were obtained and these values were aggregated to use as a proxy for irrigation expenses. The average expense per rai for irrigation was estimated at 5.00 baht and 8.00 baht for Khao Dawk Mali and glutinous varieties, respectively (Table 8).

3.4.3 Labor

Labor was classified into three groups; family labor, exchange labor and hired labor. Exchange labor means the host farmer calls in neighbors for farming operations, mainly for transplanting, harvesting and threshing, and make up the labor used in return by working himself for equivalent man-days in the neighbors' farms. However, during work, the host provides one light meal and drinks, the cost of which was estimated at about 10 to 20 baht per person per day.

Significant ($P < 0.01, 0.05$) differences were observed in the use of family and exchange labor and hence the total labor per day and per ton of paddy between Khao Dawk Mali and glutinous varieties (Table 9). Higher amount of labor being used in growing glutinous varieties. However, the proportion of hired labor as percentage of total labor was found to be 15 percent lower in case of glutinous rice farms. The labor days per ton of paddy produced were estimated at 17.67 and 23.40 persons for Khao Dawk Mali and glutinous varieties, respectively.

Table 9. Labor inputs in rice production

Variety/Area	Family labor	Ex-change labor	Hired labor	Total labor	Hired labor as % of total	Labor days per ton of paddy
	............(man-days/rai)..........					
San Kam Phaeng						
Khao Dawk Mali	2.30	2.33	7.32	11.95	61.26	17.69
Glutinous rice	4.42	4.33	4.75	13.50	35.19	21.63
Doi Saket						
Khao Dawk Mali	4.49	3.43	5.70	11.72	48.63	19.45
Glutinous rice	5.73	5.99	3.98	15.70	25.35	24.28
Phrao						
Khao Dawk Mali	2.59	3.43	5.70	11.72	48.63	19.45
Glutinous rice	3.97	7.85	5.29	14.03	40.27	24.24
Mae Rim						
Khao Dawk Mali	3.73	4.77	8.69	17.19	50.55	22.88
Glutinous rice	3.99	7.85	5.29	17.13	30.88	29.74
San Sai						
Khao Dawk Mali	3.15	5.25	5.62	14.02	40.08	21.80
Glutinous rice	3.71	5.45	6.95	16.11	43.14	23.34
San Pa Tong						
Khao Dawk Mali	5.41	5.53	6.89	17.83	38.64	30.00
Glutinous rice	3.64	5.14	7.65	16.43	46.56	30.05
All Area						
Khao Dawk Mali	2.44	2.43	6.24	11.11	56.17	17.67
Glutinous rice	3.33	4.62	5.70	13.62	41.85	23.40
Mean difference	-0.89	-2.19	0.54	-2.51	-	5.73
	(-2.31)**	(-3.21)***	(0.93)	(-3.27)***		(-3.99)***

Figures in parenthesis are approximate t-ratios

*** Significant at 1 percent level

** Significant at 5 percent level

Source: Survey

3.5 Average Cost and Profitability

The costs and gross returns have been estimated at actual prices paid and received by farmers. Land is an important fixed asset but the opportunity cost of the investment in land has not been included in the cost of production for owner operated farms. The justification is that land, unlike other fixed assets, land does not depreciate in value in land scarce countries (Hossain, 1991). Land rent for the tenant farmers were also not included in the calculation of farm operator's surplus because the rent for entire one year was paid in rice alone and as such inclusion of this item as a cost for only rice production will seriously overestimate the cost figures. Moreover, rent can also be treated as a fixed cost considering it as a linear function of the land size cultivated. Another cost element that has not been included is the rate of interest paid on working capital borrowed from outside, because of the short cycle of production and difficulty in apportioning the loan to various crops.

Family labor and exchange labor has been imputed at the entertainment cost incurred for exchange labor, as opportunity cost of family labor is unlikely to be same as the market wage rate. The opportunity cost of labor could vary across farms depending on the availability of family labor. Junankar (1989) criticized the use of same market wage rate for family and hired labor, (as well as male/female, child/adult labor) as a gross simplification, as it implies that labor market is perfect and the opportunity cost of family labor is the wage rate. Sevilla-Siero (1991) suggested an alternative view that farmers by segmenting the output and/or labor markets can turn a negative farm profit (computed at market prices) into a positive one.

In this view of production behavior, the farmer treats his family supply of labor and his family demand for output as *internal markets* which, under certain conditions, he may segment profitably from the `*external*', the market supply of labor to the farm, and the market demand for farm output. In his pursuit of profit in such cases, the farmer (i) sells part of farm output in the external market at the given market price, and the remainder in the internal (family) market at an endogenously determined price which is higher than the market price, and (ii) hires part of total labor requirements from the external labor market at the *given* wage rate, and the balance from the internal (family) market at an endogenous wage rate which is lower than the market wage. Thus profit maximization in the standard sense is a special case of a broader behavior rule involving profit maximization with market segmentation (Sevilla-Siero, 1991).

Owner operated tractors were imputed by the daily hiring rate of machines (different from the common hiring rate of 250 to 350 baht per rai), plus one day hired labor cost plus actual fuel costs spent for farm operation. This method was used mainly because, more than 50 percent of the sample farms own tractors reflecting that imputing this input by market rate will overestimate the cost figures, assuming that the farmers follows market segmentation strategies.

The items included in the estimation of different variables are as follows:

Material Input Costs =Seeds (own supplied and purchased), manure, fertilizer, pesticides, irrigation charges.

Purchased Input Costs =Material inputs plus hired labor and hired machine power services.

Total Cost =Purchased inputs plus imputed value of family labor and tractor power supplied from the household.

Profit	=Gross value of production minus total cost.
Farm Family Income	=Gross value of production minus purchased input costs.
Value Added	=Gross value of production minus the material input costs.

The farm specific prices of paddy received for Khao Dawk Mali (4.12 baht per kg) is significantly ($P < 0.01$) higher than the price of glutinous rice (3.38 baht per kg) (Table 7). Coupled with higher yield and higher farm-specific prices of paddy, the gross value of production per rai of Khao Dawk Mali was also found to be significantly higher ($P < 0.01$).

However, no difference in variable cost per rai of rice production was observed between varieties at the sample means, though at a disaggregated level, the material costs were found to be higher for the glutinous varieties which was offset by lower total labor costs as a consequence of using less hired labor. As such the gross margin was estimated at 1,735 baht per rai for Khao Dawk Mali and 1,111 baht per rai for glutinous variety, resulting in a significant ($P < 0.01$) mean difference of 624 baht per rai.

The comparative positions of factor shares are analyzed in Table 10. Family supplied material inputs and labor were estimated to be significantly higher for glutinous rice production than for Khao Dawk Mali. The higher family supplied labor and input usage for glutinous rice production implicitly supports the assumption of market segmentation strategy explained above. Since, family supplied inputs do not involve cash expenses, these are used more in glutinous rice production Table 10. Factor shares in rice production

	Khao Dawk Mali	Glutinous variety	Mean difference

Factors	Baht per rai	% of Gross value of prod.	Baht per rai	% of Gross value	Baht per rai	t-Ratio
Material inputs	190.67	7.19	210.99	10.40	-20.32	-1.42[a]
Family supplied	20.72	0.79	36.11	1.78	-15.39	-2.36**
Purchased	169.95	6.40	174.88	8.62	-4.93	-0.43
Human labor	526.98	19.87	477.93	23.55	49.05	1.29[a]
Family	67.03	2.53	81.07	3.99	-14.04	-1.65*
Hired	459.95	17.34	396.86	19.56	63.09	1.54[a]
Tractor power	199.62	7.52	228.81	11.28	-29.19	-2.28**
Family supplied	54.64	2.06	49.73	2.45	4.92	0.68
Hired	144.98	5.46	179.08	8.83	-34.10	1.93*
Profit[b]	1735.20	65.42	1111.30	54.77	623.97	7.31***
Gross value of production[c]	2652.50	100.00	2029.00	100.00	623.50	7.97***
Farm family income	1856.90	70.01	1242.10	61.22	614.80	7.92***

*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level
[a] Significant at 20 percent level
[b] Profit =Gross value of production minus total cost.
[c] Farm Family Income =Gross value of production minus purchased input costs.

Source: Survey

wherein consumption motive is a primary consideration and which yields significantly lower profits. On the other hand, lower labor input usage in Khao Dawk Mali production might be due to better and carefully managed allocation of proportionately higher hired labor and may not necessarily be the differences in labor intensiveness between varieties. The mean tractor power rate was found to be significantly higher in glutinous rice production because of higher hiring rate prevailing in San Pa Tong and Mae Rim districts.

The returns to family resources (farm family income) is about 9 percent higher for Khao Dawk Mali. The average labor productivity, estimated as value added per day of labor, was 222 baht and 133 baht for Khao Dawk Mali and glutinous rice varieties. The difference is about 60 percent.

3.6 Highlights

The production environment of the study area comprises of a mix of irrigated agriculture as well as rainfed agriculture with a rice based double cropping system. Khao Dawk Mali is more produced in Doi Saket, San Sai and Phrao, while glutinous varieties are dominant in San Pa Tong, San Kam Phaeng and Mae Rim. The average operation size was 12.79 rai and about half of the farms were owner operated while 20 percent were landless tenants.

Significantly higher yield was estimated for Khao Dawk Mali (643 kg per rai) as compared to glutinous varieties (600 kg per rai). Significant higher family and exchange labor use and hence the total labor use, and family supplied material inputs were also observed for the glutinous varieties as compared to Khao Dawk Mali.

Though on the whole no differences were observed in total variable costs, significantly higher profits were estimated for Khao Dawk Mali (1,735 baht) as compared to glutinous varieties (1,111 baht).

CHAPTER IV
DECISION MAKING AND CHOICE OF RICE VARIETIES

Decision making process is a complicated issue, dealing with which calls for substantial evidences to support the notions. In general, qualitative techniques, such as preference rankings, farmers' own perceptions and attitudes etc. facilitate our understanding of the decision making process. However, qualitative analysis alone cannot be considered as complete. Econometric techniques, on the other hand, reconfirms conclusions and enable us to predict on the farmers' responses, hence, their decision making with respect to economic variables through testing various hypotheses developed from *a priori* knowledge of the situation. Therefore, one strategy to analyze the issues is to use a combination of qualitative and quantitative methods. The present chapter attempted to highlight some qualitative features associated with the production and marketing of Khao Dawk Mali and glutinous varieties while the next chapter is devoted to quantitative analysis of the decision making process at the farm-level.

4.1 Factors Influencing Variety Selection Decision

Respondents were asked to rank among seven selected factors believed to influence the rice variety selection decision. The factors selected for questions were obtained from the questionnaire pre-test session conducted at Fang district in the upper northern Chiang Mai. These are, *high price and profit motive, ready market for the output, low cost of production, resistance to* *drought, short maturity period of the crop* (this might have implication on choice of second crop after wet rice), *resistance to insect and disease attack* (which have direct effect on profitability as well as food security), and *producing for consumption.* For analysis, respondents were grouped into three, those who grew only Khao Dawk Mali, those who grew only glutinous variety, and those who grew both. This was done in order to identify whether a variation in perception on these varieties exists between categories of growers.

Table 11 presents the farmers' ranking of the factors influencing variety selection decision. It was noted that, the single variety growers ranked only for the varieties they grew, and skipped answer for other varieties. High price and higher profits came up as the major influencing factor to chose Khao Dawk Mali, while ready marketability of the product is ranked second. It was believed that Khao Dawk Mali is a drought resistance variety and as such can be grown in relatively dry areas. The respondents also ranked drought resistance between third and fourth across categories of growers.

Glutinous varieties are grown mainly for consumption. However, profit motive of growing this variety was ranked second and resistance to disease and insect attack ranked third. The ranks for other factors are mixed among categories of growers.

Table 11. Ranking of factors influencing farmers' rice variety choice

Factors	Only KDML rice growers: Percentage of farmers responding according to rank (%)	Rank	Only glutinous rice growers: Percentage of farmers responding according to rank (%)	Rank	Both: Percentage of farmers responding according to rank for KDML (%)	Rank	Both: for glutinous (%)	Rank
High price and profit	89.74	1	39.89	2	80.00	1	29.52	2
Ready market	46.15	2	38.89	5	41.90	2	28.57	6
Low cost of production	30.77	5	44.44	4	41.90	6	27.62	7
Drought resistance	23.08	3	33.33	6	31.43	4	40.00	4
Short maturity	38.46	4	-	-	35.23	5	30.47	5
Disease resistance	25.64	6	47.22	3	18.09	3	29.52	3
For consumption	-	-	77.78	1	-	-	63.81	1
Multiple responses	n = 39		n = 36		n = 105			

Note: These percentages are computed on the basis of the number of times that a given factor was chosen for a corresponding rank across respondents

Source: Survey

4.2 Incidence of Changing Rice Varieties

The present study was intended to identify whether farmers response to prices by adjusting their variable inputs as well as switching seed varieties for a more optimal adjustment. One qualitative investigation would be to enquire whether the farmers had changed seed varieties over the production period of about 10 years. Fifty five percent of the farmers' were found to change varieties for at least one or more times over the past decade (Table 12).

Table 12.Farmers responses on changing varieties as well as sources for procuring seed in the past five years

Area	Percentage of farmers responding (%)			Percentage of farmers responding (%)		
	Changed variety	Did not change variety	Total	Changed seed source	Did not charge seed source	Total
San Kam Phaeng	54.55	45.45	100.00	59.09	40.91	100.00
Doi Saket	47.22	52.78	100.00	38.89	61.11	100.00
Phrao	35.71	64.29	100.00	45.24	54.76	100.00
Mae Rim	77.27	22.73	100.00	45.45	54.55	100.00
San Sai	58.66	41.94	100.00	35.48	64.52	100.00
San Pa Tong	74.08	25.92	100.00	33.33	66.67	100.00
All area	55.00	45.00	100.00	42.22	57.78	100.00

Source : Survey

The major direction of changes were from local varieties to Khao Dawk Mali and glutinous varieties to Khao Dawk Mali. Changes were also made from local varieties to glutinous varieties as well as among different glutinous varieties, such as RD 6, RD 8, RD 10, Neaw San Pa Tong (Table 13).

Enquiry on farmers' practices on recycling the seed source was also made. Changing seed source here refers to changing the supply source of the seed to be used, such as supplying from own production for three consecutive years and then using purchased seeds from the market. The rationale for changing source is that using the same source of seed depresses the corresponding yield levels and some 42 percent farmers' were found to be aware of this fact and reported that they use to recycle the seed source at least once in five years or every year (Table 12).

Table 13.Percentage distribution of changes in variety in the past five years, 1987 to 1992.

Changed from	Changed to			
	Khao Dawk Mali	Glutinous varieties	Local varieties	Row total
Khao Dawk Mali	-	100	-	100
Glutinous varieties	66	34	-	100
Local varieties	62	35	3	100
Total	60	39	1	100

Source: Survey

Problems encountered in Khao Dawk Mali production was found to be higher than glutinous variety production. Major problems reported was insect and disease attacks, and a combination of insect and disease attacks with lack of water for irrigation and sterility in seeds (Table 14). The response pattern for glutinous varieties were also similar but to a lesser extent.

Table 14. Farmers' responses on types of problems encountered in rice production

Problem categories	Percentage of farmers responding (%)	
	Khao Dawk Mali	Glutinous rice
Insect and disease attacks	27.22	18.33
Insect, disease and lack of water	9.44	7.78
Sterile seed and low production	4.44	5.56
Low and fluctuating price	8.33	3.33
Insect, disease and sterile seed	7.22	2.77
Insect, disease and fluctuating price	11.67	4.44
No problem	31.68	57.79
Total	100.00 n = 180	100.00 n = 180

Source: Survey

4.3 Rice Marketing Practices and Constraints

Apart from the national highway, a well developed feeder road network accessible in all seasons to every village provide adequate access for the farmers to the market for buying and selling operations. Rice marketing system is also facilitated by presence of middlemen who purchases the output at the farmgate and also acts as information dissemination sources for the farmers in some cases.

In the study areas, almost all (94.4 percent) farmers use to sell some or most of their rice crop (Table 15). Majority of them (65.88 percent) sell their paddy at the farmgate to the middlemen, which saves the costs of carrying and transportation to markets. As San Pa Tong hosts a large rice mill and also have favorable proximity to city market, about 96 percent of the farmers sell their paddy at the market (66.67 percent) and rice mill (29.16 percent) which is very different from the other areas. Since the middlemen purchase the products, the marketing costs are also borne by them (67 percent cases).

The average marketing costs (transportation, food, rental charges and carrying costs) was estimated at 124 baht per ton of paddy in cases where the farmer undertakes the marketing operations. This estimate should be taken with caution as the incidence of marketing by farmers themselves is quite small, and the volume marketed is also not very substantial. However, as an indication, this estimate suffice to the need.

Table 15.Rice marketing practices and the average marketing cost of the sample farms

Area	Percentage of farmers selling rice (%)	% of farmers selling at			Who pays for marketing costs (%)		Average marketing cost per ton of paddy sale (baht/ton)
		Farm-gate	Rice-mill	Market	Farmer	Middlemen	
San Kam Phaeng	90.91	70.00	10.00	20.00	20.00	80.00	96.61
Doi Saket	100.00	97.22	2.78	-	11.11	88.89	204.56
Phrao	95.24	57.50	17.50	25.00	35.00	65.00	134.65
Mae Rim	86.36	78.94	10.53	10.53	10.53	89.47	100.00
San Sai	100.00	70.97	12.90	16.13	32.25	67.74	78.71
San Pa Tong	88.89	4.17	29.16	66.67	91.67	8.33	130.29
All area	94.44	65.88	13.53	20.59	32.94	67.06	124.14

Source: Survey

An open question was placed to the farmers to react on any problems encountered in the marketing process. Low output price and lack of bargaining power was the main problem of the farmers (21 percent) in these areas (Table 16). However, 58 percent of the farmers seems to be quite satisfied with the existing marketing systems, as they felt there were no problem. Cheating in measurement was another problem, so was the low quality of rice (i.e., high moisture level, low grain weight, sterile grain etc.).

Table 16. Farmers responses on types of problems encountered in rice marketing

Problem categories	Percentage of farmers responding (%)						
	San Kam Phaeng	Doi Saket	Phrao	Mae Rim	San Sai	San Pa Tong	All area
Bargain in price	22.74	25.00	11.90	13.64	32.26	22.22	21.11
Cheating in measurement	13.64	2.78	9.53	4.54	3.23	11.11	7.78
Low quality of rice	9.09	2.78	7.14	4.54	3.23	11.11	6.11
Bargain in price and low quality	4.54	5.55	9.53	4.54	12.90	3.70	7.22
No problem	49.99	63.89	61.90	59.10	48.38	51.86	57.78
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	n = 22	n = 36	n = 42	n = 22	n = 31	n = 27	n = 180

Source: Survey

4.4 Farmers' Perception on Input Use

Manipulation of the levels of variable inputs in response to price changes leads to the economic optimization. Fertilizer is one of the major input that contributes to increased productivity for fertilizer responsive varieties coupled with adequate water control. Therefore, knowledge of farmers' perception on the use levels of this particular input as well as purchasing practices and problems encountered in input markets seems desirable.

Table 17.Input purchasing practices and perception of the sample farmers on the extent of fertilizer use

Grower category	Percentage of farmers responding (%)					
	Use enough fertilizer	Do not use enough fert.	Total	Buy inputs collectively	Do not buy collectively	Total
Only Khao Dawk Mali growers (n = 39)	56.41	43.59	100.00	48.72	51.28	100.00
Only glutinous rice growers (n = 36)	61.11	38.89	100.00	47.72	52.78	100.00
Both variety growers (n = 105)	51.43	48.57	100.00	44.76	55.24	100.00
Total (n = 180)	54.44	45.56	100.00	46.11	53.89	100.00

Source: Survey

About 54 percent of the farmers perceive that their present fertilizer application rate (17.12 kg and 16.32 kg of material per rai for Khao Dawk Mali and glutinous variety at the sample means, respectively) is sufficient (Table 17). The rest 46 percent considers the present rate to be not enough. The reasons cited by the both groups as a whole were, consequent increase in the cost of production at higher level of use, fear of increasing toxicity to the soil, positive residual affects from previous soybean crop (under rice-soybean system), use of manures, rice straw and soybean by-product for mulching. It was found that 21 percent of the farmers used manures and majority of the farms used straw and other residues in addition to fertilizer for mulch. Only, less than five percent of the farms did not use fertilizers.

About 46 percent of the farmers use to purchase fertilizer and other inputs collectively (Table 17). The main reasons cited were, cheaper transportation costs, and membership obligation in agricultural groups. As more purchases were made in the cooperatives, the farmers ultimately reap the benefits of higher dividend at the year-end.

4.5 Farm Indebtedness

Sixty percent of the farmers are in debt (Table 18). Institutional source, particularly the Bank of Agriculture and Agricultural Cooperatives (BAAC), was the major source of loan. Only 6.11 percent of borrowers borrowed from non-institutional sources. Incidence of being indebted to both sources were negligible (about 1 percent). Between category of growers, about half of the Khao Dawk Mali growers are in debt as compared to 64 percent in the remaining two categories. Across tenancy status, no large difference in indebtedness of farms was observed. Distribution across areas reveals that, about 87 percent of farmers in San Kam Phaeng (nearest to the city centre) are indebted followed by 74 percent in Phrao (farthest from the city centre with inadequate infrustructure and low productivity).

Table 18.Percentage distribution of farmers who were indebted in crop year, 1992

Variety/ Area/ Tenancy	Non-indebted (%)	Indebted to institutional lenders (%)	Indebted to non-institutional lenders (%)	Total
By variety				
Only KDML growers	51.28	41.03	7.69	100.00
Only glut. growers	36.11	55.56	8.33	100.00
Both	36.19	57.14	6.67	100.00
By tenancy status				
Owner operators	43.01	52.69	4.30	100.00
Tenants	37.93	54.02	8.05	100.00
By area				
San Kam Phaeng	13.64	68.18	18.18	100.00
Doi Saket	55.55	38.89	5.58	100.00
Phrao	26.19	64.29	9.52	100.00
Mae Rim	40.91	50.00	9.09	100.00
San Sai	61.29	38.71	-	100.00
San Pa Tong	33.33	66.67	-	100.00
All Area	39.44	54.45	6.11	100.00

Source : Survey

The mean level of indebtedness was estimated at 11,336 baht per farm of which 95 percent (10, 793 baht) was from institutional source (Table 19). However, when tenancy status was considered, the discrepancy in amount indebted was found to be very large. The average level of indebtedness of owner operators (14,270 baht per farm) was 74 percent higher than the tenant operators (8,196 baht per farm). This might be because of the opportunity to provide more collateral by the owner operators as compared to the tenants.

Table 19.Average level of indebtedness of rice farms by area and tenancy

Area/Tenancy	Institutional source (baht/farm)	Non-institutional source (baht/farm)	Total (baht/farm)
San Kam Phaeng	15,664	1,792	17,456
Owner operated	18,940	1,828	20,768
Tenant operated[a]	8,644	1,714	10,358
Doi Saket	6,722	209	6,931
Owner operated	9,250	-	9,250
Tenant operated	3,563	471	4,034
Phrao	12,833	1,119	13,952
Owner operated	19,778	-	19,778
Tenant operated	7,625	1,958	9,583
Mae Rim	10,250	164	10,414
Owner operated	12,269	46	12,315
Tenant operated	7,333	334	7,667
San Sai	7,258	-	7,258
Owner operated	10,357	-	10,357
Tenant operated	4,706	-	4,706
San Pa Tong	13,576	-	13,576
Owner operated	13,042	-	13,042
Tenant operated	14,071	-	14,071
All area	10,793	542	11,314
Owner operated	13,969	301	14,720
Tenant operated	7,397	799	8,196

[a] Tenant includes both pure tenant and part tenant operators.
Source: Survey

However, the pattern of indebtedness is largely a reflection of the characteristics of the rice farmers drawn in the sample and may not necessarily be as a consequence of growing glutinous rice or Khao Dawk Mali rice.

4.6 Incidence of Extension Support

Factors such as education and agricultural extension are considered as important determinants of seed variety choice (Pitt, 1983). Investigation was made in order to understand the farmers' perception on various technology and relative contribution of technological information from different sources. As such, farmers were asked to rank between three selected sources of information and the type of information received from them. The sources are, co-farmer, agricultural extension officials (both at district and subdistrict levels) and mass media. These selections were made from the result of questionnaire pre-test sessions. Enquiry was also made on whether the farmer received any agricultural training over the past periods (as long as he/she can recall) and, if any, the types and duration of them.

Table 20 presents the ranking of the technological information sources by the farmers. As a whole, agricultural extension officials were ranked as the most important source of technological information, such as fertilizer use, choice of seed varieties, planting methods, weed and water control, land management, and general agriculture other than rice. For insect and disease control measures, co-farmers or neighbors were ranked first followed by the agricultural extension officials. It was interesting to note that, the mass media played a very rudimentary role in technological information dissemination except for providing the prices and market information of various crops (ranked first) and some general agricultural news (ranked second).

Table 20.Ranking of the sources for technological information received

Type of technology	Co-farmer		Kaset official		Mass media		
	Percentage of farmers responding according to rank		Percentage of farmers responding according to rank		Percentage of farmers responding according to rank		
	(%)	Rank	(%)	Rank	(%)	Rank	
Insect and disease control	19.86	1	33.56	2	46.58	3	n = 146
Fertilizer Use	40.84	2	32.39	1	26.77	3	n = 71
Rice Variety	37.25	2	29.41	1	33.34	3	n = 51
Planting method, land, water and weed management	41.07	2	28.57	1	30.36	3	n = 103
Price and market information	53.85	2	-	-	46.15	1	n = 13
General agriculture	29.63	3	15.79	1	50.53	2	n = 95

Note: These percentages are computed on the basis of the number of times that a given factor was chosen for a corresponding rank across respondents

Source: Survey

Majority of the farmers did not receive any training (Table 21). Only 17 percent farmers received some training on planting techniques and input usage in rice production and fisheries development ranging from one to three days duration conducted by relevant government agencies.

Table 21.Incidence of training in agricultural production technology of sample farms

Option	San Kam Phaeng	Doi Saket	Phrao Rim	Mae Sai	San Tong	San Pa	All area
Received training (%)	18.18	13.89	16.67	18.18	16.13	18.52	16.67
Did not receive training (%)	81.82	86.11	83.33	81.82	83.87	81.48	83.33
Total	100.00 n = 22	100.00 n = 36	100.00 n = 42	100.00 n = 22	100.00 n = 31	100.00 n = 27	100.00 n = 180

Source: Survey

About 78 percent of the farmers had affiliation in at least one social organization (Table 22). The majority (57.44 percent) were the members of the BAAC, from where they borrowed credit and purchased fertilizer and other chemicals.

Table 22. Membership in social organizations

Area	Percentage of farmers (%)		Membership in (% of all members)		
	Having membership	Not having membership	BAAC	Agricultural cooperatives	Agril. Group and others
San Kam Phaeng	77.27	22.73	82.35	11.76	41.18
Doi Saket	80.56	19.44	41.67	33.33	8.33
Phrao	85.71	14.29	66.67	19.44	33.33
Mae Rim	59.09	40.91	76.92	23.08	-
San Sai	67.74	32.25	47.62	42.86	9.52
San Pa Tong	92.59	7.41	32.00	52.00	16.00
All area	78.33	21.67	57.44	32.62	26.95

Source : Survey

4.7 Highlights

From the ranking of factors influencing rice variety selection decision, high price and profit motive were reported as the main influencing factor for farmers to chose Khao Dawk Mali (ranked one) while glutinous variety is mainly produced for consumption (ranked one) followed by profit motive (ranked two). Over the past five years, the main direction in seed switching were directed to Khao Dawk Mali from other varieties.

Majority of the Khao Dawk Mali growers (70 percent) reported problems in production, mainly, insect and disease attack as compared to glutinous variety growers (43 percent). Almost all farmers sell some or all their rice crops, msajority (67 percent) selling them at the farmgate.

Fifty-five percent of the farmers reported that their present level of fertilizer application is satisfactory (17.12 kg and 16.32 kg for Khao Dawk Mali and glutinous variety, respectively). About 60 percent of the farmers are in debt. The average level of indebtedness of owner operators (14,270 baht per farm) was estimated at 70 percent higher than the tenant farms (8,196 baht per farm).

From the ranking of main source of technological information, agricultural officials were ranked one followed by co-farmer and mass media ranked two and three, respectively.

CHAPTER V
INPUT DEMAND AND OUTPUT SUPPLY ESTIMATIONS

Several studies on farm-level input demand estimations were made in the past decade. Demand relationships in these studies were typically estimated from a sample of farms in which a common variety of seed was planted. Such studies ignored the possibility that cultivators can respond to price changes not only by adjusting their use of variable inputs but also by switching to different seed varieties (Pitt, 1983). In a situation of rising costs of production and high competition in export market, Thai farmers would require to switch varieties that could bring higher profit. Evidence of switching varieties were also observed in the sample area (Chapter 4).

Therefore, in this study, input demand at farm-level is jointly determined with the possibility of seed switching using Two Stage Switching Regression procedure. The first stage is the Probit Maximum Likelihood Estimation of the reduced-form seed selection equation which will enable us to compute the probability that any farm has missing data on Khao Dawk Mali profit function (regime 1) or the glutinous variety profit function (regime 2). It also shows how prices and fixed factors affect the probability of choosing seed varieties.

The second stage is the joint estimation of the Translog Profit Function and Share Equations for the two separate regimes using the Zellner's Seemingly Unrelated Regression Estimator (SURE).

5.1 Model Specification

The generalized translog profit function model and the *i*th share equation was developed in Chapter 2. From the general function (9), the normalized restricted translog profit function for the farms can be specified in actual variables as:

$$\ln \pi' = \alpha_0 + \alpha_M \ln P'_M + \alpha_W \ln P'_W + \alpha_F \ln P'_F + \frac{1}{2}\gamma_{WW} \ln P'_W \ln P'_W + \frac{1}{2}\gamma_{FF} \ln P'_F \ln P'_F$$
$$+ \beta_A \ln Z_A + \delta_{WL} \ln P'_W \ln Z_L + \delta_{WA} \ln P'_W \ln Z_A + \delta_{FL} \ln P'_F \ln Z_L + \delta_{FA} \ln P'_F \ln Z_A$$
$$+ \delta_{ML} \ln P'_M \ln Z_L + \delta_{MA} \ln P'_M \ln Z_A + \frac{1}{2}\psi_{LL} \ln Z_L \ln Z_L + \frac{1}{2}\psi_{AA} \ln Z_A \ln Z_A \quad (29)$$
$$+ \frac{1}{2}\gamma_{MM} \ln P'_M \ln P'_M + \gamma_{WF} \ln P'_W \ln P'_F + \gamma_{WM} \ln p'_W \ln P'_M + \gamma_{FM} \ln P'_F \ln P'_M + \beta_L \ln Z_L$$

where π' is the restricted profit from rice production per farm: total revenue less total costs of labor, chemical fertilizer, manures, irrigation, pesticides, and tractor power normalized by the price of rice; P_W' is the money wage rate of labor per day normalized by the price of rice; P_F' is the money price per kg of fertilizer materials normalized by the price of rice; and P_M' is the money price of tractor power per rai normalized by the price of rice.

The definitions of the two fixed inputs included in the specification of the profit function, are, Z_L is the land input measured as rai of rice grown per farm; and Z_A is the quantity of farm equipment and machinery used for rice production per farm measured as baht of total stock value.

The parameters α_0, α, β,γ, δ, and ψ are to be estimated and subscripts W, F, and M stands for the variable inputs of production, labor, chemical fertilizer, and tractor power, respectively.

Following the development of (10), the S_i functions of labor, chemical fertilizer and tractor power is obtained by differentiating the normalized restricted translog profit function (29) as follows:

$$-\frac{P'_W \cdot X_W}{\pi'} = \alpha_W + \gamma_{WW}\ln P'_W + \gamma_{WF}\ln P'_F + \gamma_{WM}\ln P'_M + \delta_{WL}\ln Z_L + \delta_{WA}\ln Z_A \qquad (30)$$

$$-\frac{P'_F \cdot X_F}{\pi'} = \alpha_F + \gamma_{FW}\ln P'_W + \gamma_{FF}\ln P'_F + \gamma_{FM}\ln P'_M + \delta_{FL}\ln Z_L + \delta_{FA}\ln Z_A \qquad (31)$$

$$-\frac{P'_M \cdot X_M}{\pi'} = \alpha_M + \gamma_{MW}\ln P'_W + \gamma_{MF}\ln P'_F + \gamma_{MM}\ln P'_M + \delta_{ML}\ln Z_L + \delta_{MA}\ln Z_A \qquad (32)$$

where X_W, X_F, and X_M are the quantities of variable inputs of labor, chemical fertilizer and tractor power, respectively.

This sets of equations, (29), (30), (31), (32) will be jointly estimated for each regime in the second stage after incorporating the selectivity variable to be obtainable from the first stage probit estimation of the reduced-form seed selection equation.

5.2 The First Stage Estimation: Probit Maximum Likelihood Model

In order to adjust the selectivity bias in the final stage estimation of the profit functions and to see how prices and fixed factors affect the probability of choosing Khao Dawk Mali, we have to estimate the reduced-form seed selection equation

$$I'_i = \theta_0 + P_i\theta_1 + Z_i\theta_2 - \varepsilon'_i$$

as a typical probit equation because this is not directly observable. What we observe is a dummy variable which takes the value of 1 if a plot is planted with Khao Dawk Mali, 0 otherwise: that is

$I_i = 1 \; if \; I' \geq 0,$
$= 0 \; otherwise.$

$= 0 \; otherwise.$

The maximum likelihood estimates of the probit reduced-form seed selection equation are presented in Table 23. It should be noted that the right-hand side of the reduced form probit equation is the difference in the Khao Dawk Mali and glutinous variety profit functions. Since both profit functions have identical sets of regressors and parametric restrictions, conceptually, the coefficients on the reduced-form regressors can be regarded as the differences between the Khao Dawk Mali and glutinous variety profit function coefficients for the same regressors (Pitt, 1983).

Table 23.Probit reduced-form of seed selection equation

Exogenous Variables	Estimated Coefficients	Standard Error	t-Ratio
Intercept	66.2001	24.1700	2.739***
$\ln P_W'$	-29.9659	10.2897	-2.915***
$\ln P_F'$	2.8074	11.4600	0.245
$\ln P_M'$	-4.9247	4.7950	-1.027
$½(\ln P_W')^2$	7.3211	2.9960	2.444**
$½(\ln P_F')^2$	-4.6893	5.1180	-0.916
$½(\ln P_M')^2$	-0.1631	0.8086	-0.202
$\ln P_W'.\ln P_F'$	-0.7591	3.1770	-0.239
$\ln P_W'.\ln P_M'$	1.0927	1.0250	1.066
$\ln P_F'.\ln P_M'$	0.8733	1.3580	0.643
$\ln Z_L$	-4.0053	3.1200	-1.284
$\ln Z_A$	-1.0981	1.2970	-0.846
$\ln P_W'.\ln Z_L$	1.4900	0.7330	2.033**
$\ln P_W'.\ln Z_A$	0.0115	0.3159	0.036

$\ln P_F'.\ln Z_L$	-1.7091	0.9232	-1.851*
$\ln P_F'.\ln Z_A$	-0.2596	0.4503	-0.577
$\ln P_M'.\ln Z_L$	-0.0864	0.3518	-0.241
$\ln P_M'.\ln Z_A$	0.1546	0.1411	1.096
$\frac{1}{2}(\ln Z_L)^2$	0.2700	0.3129	0.863
$\frac{1}{2}(\ln Z_A)^2$	0.0405	0.0626	0.647
$\ln Z_L .\ln Z_A$	0.0645	0.1105	0.584

Accuracy of Prediction= 83.06 percent

McFadden R^2 = 36.56 percent

*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

McFadden $R^2 = 1 - \log L_{max}/\log L_0$

Source: Computed

Five of the estimated coefficients are statistically significant at 10 percent level at the least (Table 23). About 83 percent of the observations are accurately predicted and the McFadden's R-squared [4] was 0.366. The coefficients of Table 23 cannot directly reveal the sign or magnitude of the change in the probability of planting Khao Dawk Mali in response to changes in the exogenous variables. The probit estimation is used mainly to obtain the selectivity variable (or Mill's ratio) to be incorporated in the second stage of estimation and to check the accuracy of prediction. The information on the magnitude and direction of the factors affecting seed selection is provided as elasticities in Table 24.

The following procedures were used to obtain the probit elasticities: the derivatives of the probabilities with respect to a particular exogenous variable for the probit model is given by

$$\frac{\partial F(\varphi_i)}{\partial X_{ik}} = f(\varphi_i)\,\beta_k \qquad (33)$$

where F is the distribution function and f is the density of the standard normal; β_k is the coefficient attached to the exogenous variable X_{ik} (Maddala, 1987). Therefore, the elasticity of the probability of *i*th exogenous variable is:

$$\zeta_q = \frac{\partial F(\varphi_i)}{\partial X_{ik}} \cdot \frac{X_{ik}}{p_i} = f(\varphi_i)\,\beta_k \cdot \frac{X_{ik}}{p_i} \qquad (34)$$

4 McFadden's R^2 is not comparable to the R^2 in the OLS regression. McFadden's R^2 lies in the range of 0.20 to 0.40 in this type of model (Sonka *et al.*, 1989)

where p is the probability.

Two of the five elasticities (at the sample means) are significantly different from zero ($P < 0.01, 0.10$) suggesting that seed selection is quite responsive to changes in prices (Table 24).

Table 24.Elasticities of the probability of planting Khao Dawk Mali at sample means

Exogenous Variable	Estimates	t-Ratio
Price of Labor	-1.25550	-1.645*
Fertilizer Price	-0.17127	-5.205***
Tractor Power Price	-0.22914	-1.086
Area	0.15250	1.165
Farm Assets	0.13773	0.744

*** Significant at 1 percent level
* Significant at 10 percent level
Source: Computed

The elasticities of fertilizer price and labor price are significantly different from zero (at the sample means) suggesting that seed selection is quite responsive to the input/output price ratio as expected. The elasticity of probability with respect to land area is positive, though small, suggesting that plot size is positively related with Khao Dawk Mali production.

5.3 The Second Stage Estimation: Maximization of the Profit Function

From the first stage probit estimation, we defined the Mill's ratio or selectivity variable which are used as identifiability restriction to adjust the selectivity bias and force the separation of the translog profit function of the two regimes (1) and (2). One of the interesting properties of the Mill's ratio is that, the higher the value of the ratio, the lower is the probability that an observation is having data on $I_i = 1$ (Heckman, 1976).

The final specification of the reduced-form of the translog profit function with the inclusion of the selectivity variable, (equation 13 and 14) are restated as;

$$\pi_{qi} = P_i\beta_q + Z_i\gamma_q + \sigma_{1'_\varepsilon}\left(\frac{-f(\varphi_i)}{F(\varphi_i)}\right) + \xi_{qi} \qquad \text{for Khao Dawk Mali}$$

$$\pi_{gi} = P_i\beta_g + Z_i\gamma_g + \sigma_{2'_\varepsilon}\left(\frac{f(\varphi_i)}{1-F(\varphi_i)}\right) + \xi_{gi} \qquad \text{for Glutinous Variety}$$

These translog profit functions and the corresponding three share equations for each regimes were jointly estimated by using Zellner's Seemingly Unrelated Regressions Estimator.

Table 25 and 26 provides the joint restricted parameter estimates of the normalized restricted translog profit function and labor, fertilizer, and tractor power share equations adjusted for selectivity bias for Khao Dawk Mali and glutinous variety, respectively. Two formal statistical tests were conducted to test two sets of hypotheses. The first test was conducted to test the validity of the symmetry and parametric constraints across profit and S_i equations. The null hypothesis is that parameters of the S_i equations (30), (31) and (32) are equal to the corresponding same parameters in equation (29) and that $\gamma_{WF} = \gamma_{FW}$, $\gamma_{WM} = \gamma_{MW}$, and $\gamma_{FM} = \gamma_{MF}$. This is a joint hypothesis on the validity of imposing 18 restrictions (six restrictions for each S_i equations) to estimate jointly equations (29), (30), (31) and (32) for each of the two regimes. An *F*-test statistic with good asymptotic properties was conducted to test this hypothesis. For the seemingly unrelated regression procedure, estimated under the assumption that null-hypothesis $R\beta = r$ is true is

$$F = \frac{(r - R\beta_{seem})'[R(X'(\Sigma^{-1} \otimes I)X)^{-1}R'](r - R\beta_{seem})}{(y - X\beta)'(\Sigma^{-1} \otimes I)(y - X\beta)} \frac{MT-k}{J}$$

where M = number of equations, J is the number of restrictions. *F* is distributed as (1/J) $\chi^2_{(J)}$ (Theil, 1971). For the Khao Dawk Mali function, the computed $F_{0.05(18,504)}$ equals 1.905, and the critical $F_{0.05(18,504)}$ equals 1.975. For the glutinous rice function, the computed $F_{0.05(18,492)}$ equals 1.809, and the critical $F_{0.05(18,492)}$ equals 1.975. Thus, the null hypothesis (validity of the constraints) cannot be rejected at the 5 percent level of significance. This implies, among other things, that the sample farms, on an average, maximize profits with respect to normalized prices of the variable inputs, thus supporting empirically the assumption of profit maximization. Evidence of profit maximizing behavior of the Thai farmers were also found by Puapanichya and Panayotou (1985) and Adulavidhaya *et al.* (1979).

The second statistical test was carried out to test for the Cobb-Douglas (C-D) hypothesis. It should be noted that, for the profit function to be

Cobb-Douglas, coefficients of all second order terms in (29) should be zero (Sidhu and Baanante, 1981). An *F*-test was conducted to test the null hypothesis that all γ_{ij} equal 0 and all δ_{ik} equal 0. For the Khao Dawk Mali function, the computed $F_{(15,504)}$ equals 2.013, and the critical $F_{0.01(15,504)}$ equals 1.691. Thus, the hypothesis was rejected, and the translog representation appeared to be more suitable than the C-D in this case. On the other hand, for the glutinous rice function the computed $F_{(15,492)}$ equals 1.289 and the critical $F_{(0.01(15,492)}$ equals 1.692 and hence the hypothesis cannot be rejected implying that C-D function would not perform worse than translog. However, translog specification was maintained for both functions for our present analysis. This was done in order to maintain comparability between regimes and to avoid the weakness implicit in the C-D profit functional form as noted by Chand and Kaul (1986).

Nineteen and twenty-five coefficients of the total 40 coefficients in each set of functions are statistically significant at 10 percent level at the least (Tables 25 and 26).

At the bottom of the profit function in Tables 25 and 26, the coefficients and standard errors of the selectivity variables appear, $-f(\varphi_i)/F(\varphi_i)$ for the Khao Dawk Mali function and $f(\varphi_i)/[1 - F(\varphi_i)]$ for the glutinous variety function. The selection variable is significantly different from zero at the 10 percent level of significance in the Khao Dawk Mali profit function. This is the evidence of pronounced selection bias in estimating equations from a subsample of cultivators (Pitt, 1983). On the other hand, there appears to be no significant selection bias in the estimation of the glutinous variety function. Therefore, single stage estimation of this function from a subsample of glutinous variety cultivators should be unbiased[5].

Table 25.Joint estimation of the normalized profit function and factor share equations for variable inputs in Khao Dawk Mali, adjusted for selectivity bias

Exogenous Variables	Parameters	Estimated Coefficient	Standard Error	t-Ratio
Profit Function				
Intercept	α_0	5.209940	1.50400	3.464***
ln P_W'	α_W	1.185770	0.46370	2.557**
ln P_F'	α_F	0.147314	0.04985	2.955***
ln P_M'	α_M	0.530296	0.28450	1.864*
½(ln P_W')^2	γ_{WW}	-0.494342	0.09126	-5.417***
½(ln P_F')^2	γ_{FF}	-0.031796	0.01778	-1.789*
½(ln P_M')^2	γ_{MM}	-0.169857	0.03568	-4.760***
ln P_W'.ln P_F'	γ_{WF}	-0.055843	0.01202	-4.648***
ln P_W'.ln P_M'	γ_{WM}	-0.049073	0.04573	-1.073
ln P_F'.ln P_M'	γ_{FM}	-0.009452	0.00583	-1.620
ln Z_L	β_L	1.089270	0.32210	3.382***
ln Z_A	β_A	-0.261975	0.17530	-1.503
ln P_W'.ln Z_L	δ_{WL}	-0.043033	0.05021	-0.857
ln P_W'.ln Z_A	δ_{WA}	0.011110	0.02204	0.504
ln P_F'.ln Z_L	δ_{FL}	0.001869	0.00551	0.339
ln P_F'.ln Z_A	δ_{FA}	-0.001448	0.00255	-0.566
ln P_M'.ln Z_L	δ_{ML}	-0.040898	0.02979	-1.373
ln P_M'.ln Z_A	δ_{MA}	0.017678	0.01315	1.344
½(ln Z_L)^2	ψ_{LL}	0.044506	0.04281	1.040
½(ln Z_A)^2	ψ_{AA}	0.018621	0.01260	1.477
ln Z_L .ln Z_A	ψ_{LA}	0.004957	0.01790	0.277
Selectivity variable	σ_{1u}	0.100199	0.05931	1.689*

Table 25. (continued)

Exogenous Variables	Parameters	Estimated Coefficient	Standard Error	t-Ratio

[5] In general, the selectivity variable may be significant in any or both of the equations (Lee, 1978 and Pitt, 1983).

Labor Share Equation				
Intercept	α_W	1.185770	0.46370	2.557***
ln P_W'	γ_{WW}	-0.494342	0.09126	-5.417***
ln P_F'	γ_{WF}	-0.055843	0.01202	-4.648***
ln P_M'	γ_{WM}	-0.049073	0.04573	-1.073
ln Z_L	δ_{WL}	-0.043033	0.05021	-0.857
ln Z_A	δ_{WA}	0.011110	0.02204	0.504
Fertilizer Share Equation				
Intercept	α_F	0.147314	0.04985	2.955***
ln P_W'	γ_{FW}	-0.055843	0.01202	-4.648***
ln P_F'	γ_{FF}	-0.031796	0.01778	-1.789*
ln P_M'	γ_{FM}	-0.009452	0.00583	-1.620
ln Z_L	δ_{FL}	0.001869	0.00551	0.339
ln Z_A	δ_{FA}	-0.001448	0.00256	-0.566
Tractor Power Share Equation				
Intercept	α_M	0.530296	0.28450	1.864*
ln P_W'	γ_{MW}	-0.049073	0.04573	-1.073
ln P_F'	γ_{MF}	-0.009452	0.00583	-1.620
ln P_M'	γ_{MM}	-0.169857	0.03568	-4.760***
ln Z_L	δ_{ML}	-0.040898	0.02979	-1.373
ln Z_A	δ_{MA}	0.017678	0.01315	1.344

*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Selectivity Variable $= -f(\varphi_i)/F(\varphi_i)$

Source: Computed

Table 26. Joint estimation of the normalized profit function and factor share equations for variable inputs in glutinous rice, adjusted for selectivity bias

Exogenous Variables	Parameters	Estimated Coefficient	Standard Error	t-Ratio
Profit Function				
Intercept	α_0	-6.885170	4.01100	-1.716*
ln P_W'	α_W	4.451160	1.62600	2.737***
ln P_F'	α_F	0.987797	0.26260	3.762***
ln P_M'	α_M	2.892350	0.57420	5.037***
½(ln P_W')^2	γ_{WW}	-0.925564	0.38770	-2.387**
½(ln P_F')^2	γ_{FF}	-0.169621	0.05755	-2.948***
½(ln P_M')^2	γ_{MM}	-0.486116	0.05686	-8.549***
ln P_W'.ln P_F'	γ_{WF}	-0.244445	0.05931	-4.121***
ln P_W'.ln P_M'	γ_{WM}	-0.319976	0.11520	-2.777***
ln P_F'.ln P_M'	γ_{FM}	-0.079804	0.02766	-2.886***
ln Z_L	β_L	1.734012	0.64270	2.698***
ln Z_A	β_A	0.254821	0.25400	1.003
ln P_W'.ln Z_L	δ_{WL}	-0.375587	0.13230	-2.839***
ln P_W'.ln Z_A	δ_{WA}	-0.040154	0.04832	-0.831
ln P_F'.ln Z_L	δ_{FL}	0.012056	0.02512	0.480
ln P_F'.ln Z_A	δ_{FA}	0.001165	0.00986	0.118
ln P_M'.ln Z_L	δ_{ML}	-0.045749	0.05317	-0.860
ln P_M'.ln Z_A	δ_{MA}	-0.018905	0.02048	-0.923
½(ln Z_L)^2	ψ_{LL}	0.045069	0.10540	0.428
½(ln Z_A)^2	ψ_{AA}	-0.011204	0.01603	-0.699
ln Z_L .ln Z_A	ψ_{LA}	0.027214	0.02648	1.028
Selectivity variable	σ_{2u}	-0.069508	0.09883	-0.703
Labor Share Equation				
Intercept	α_W	4.451160	1.62600	2.737***
ln P_W'	γ_{WW}	-0.925564	0.38770	-2.387**
ln P_F'	γ_{WF}	-0.244445	0.05931	-4.121***
ln P_M'	γ_{WM}	-0.319976	0.11520	-2.777***
ln Z_L	δ_{WL}	-0.375587	0.13230	-2.839***
ln Z_A	δ_{WA}	-0.040154	0.04832	-0.831
Fertilizer Share Equation				
Intercept	α_F	0.987797	0.26260	3.762***
ln P_W'	γ_{FW}	-0.244445	0.05931	-4.121***
ln P_F'	γ_{FF}	-0.169621	0.57550	-2.948***
ln P_M'	γ_{FM}	-0.079805	0.02766	-2.886***

ln Z_L	δ_{FL}	0.012056	0.02512	0.480
ln Z_A	δ_{FA}	0.001165	0.00986	0.118

Table 26.(continued)

Exogenous Variables	Parameters	Estimated Coefficient	Standard Error	t-Ratio
Tractor Power Share Equation				
Intercept	α_M	2.892350	0.57420	5.037***
ln P_W'	γ_{MW}	-0.319976	0.11520	-2.777***
ln P_F'	γ_{MF}	-0.079805	0.02766	-2.886***
ln P_M'	γ_{MM}	-0.486116	0.05686	-8.549***
ln Z_L	δ_{ML}	-0.045749	0.05317	-0.860
ln Z_A	δ_{MA}	-0.018905	0.02048	-0.923

*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Selectivity Variable = $f(\varphi_i)/[1-F(\varphi_i)]$

Source: Computed

All γ_{ij} coefficients are of negative signs in both the regimes as expected. The negative cross-price coefficients imply a complementarity in inputs. Land coefficient (β_L) is positive and highly significant at both the profit functions consistent with the expectation. However, negative farm assets coefficient (β_A) in Khao Dawk Mali profit function implies that increase in capital endowment would reduce profitability. Since the coefficient is not significant, the affect might not be truely negative.

The coefficients are generally found to be larger in magnitude for glutinous function. This is because, the profitability in glutinous variety production is significantly lower as compared to Khao Dawk Mali (see Chapter

4), as such, variations in input prices and exogenous factors would lead to larger decreases in profitability in absolute terms. On the other hand, smaller coefficients in Khao Dawk Mali function implies that the extent on reduction would be lower, for an equivalent change in input prices and exogenous variable. However, firm conclusions can be drawn only from the elasticities to be computed using these profit function coefficients, factor demand functions and input prices.

5.4 Input Demand and Output Supply Elasticities

The estimates presented in Tables 25 and 26 form the basis for deriving elasticity estimates for rice supply and input demand for the variable inputs of labor, fertilizer, and tractor power. These elasticity estimates for individual varieties were first obtained by using equations (17), (18), (19), (20), (23), (24), and (25). As noted earlier, the elasticities are functions of variable input ratios, variable input prices, level of fixed inputs, and the parameter estimates of the translog profit function presented in Tables 25 and 26. These elasticities are evaluated at simple averages of the S_i, variable input prices and fixed inputs. This provides the basis of using equation (27), which uses these estimates from each regime plus the elasticities of the probabilities presented in Table 24. The elasticity estimates of individual varieties, and total elasticity of demand after allowing for seed switching adjustments (or permitting movements along the meta-response surfaces) are presented in Table 27.

In the translog function, unlike Cobb-Douglas function, the impact across variable input demand functions for labor, fertilizer, and animal power of a given change in any of the exogenous variables is not symmetric. It varies across demand equations, which is consistent with *a priori* theoretical expectations (Sidhu and Baanante, 1981).

Table 27.Derived elasticity estimates for rice supply and demand for variable inputs of rice

	Rice price	Fert. price	Labor price	Tractor price	Farm assets	Land
Elasticity of demand and supply for Khao Dawk Mali rice[a]						
Output supply	0.1942	-0.0108	-0.0773	-0.0386	0.0335	0.9449
Fert. demand	0.2490	-0.7002	-0.0443	-0.0614	0.0410	0.8685
Labor demand	0.2983	-0.0145	-0.2971	-0.0618	0.0436	0.9950
Tractor Demand	0.3705	-0.0239	-0.1538	-0.2028	0.0815	1.1300
Elasticity of demand and supply of glutinous rice[a]						
Output supply	0.6502	-0.0222	-0.2168	-0.1572	0.0591	0.0685
Fert. demand	0.2584	-0.4373	-0.0773	-0.1421	0.0223	0.0379
Labor demand	0.6808	-0.0139	-0.6572	-0.1096	0.0843	0.3728
Tractor demand	0.7814	-0.0610	-0.1743	-0.5472	0.0203	0.0431
Total elasticity of demand and supply (with seed switching adjustments)[b]						
Output supply	0.3128	-0.0146	-0.1160	-0.0678	0.0433	0.8981
Fert. demand	0.2827	-0.8056	-0.0568	-0.0860	0.0423	0.8068
Labor demand	0.4157	-0.0154	-0.6856	-0.0783	0.0510	0.9156
Tractor demand	0.5008	-0.0348	-0.1723	-0.3651	0.0743	0.9733

[a]Using equations (17), (18), (19), (20), (23), (24), (25) and simple averages of input S_i ratios.
[b]Using equations (17), (18), (19), (20), (23), (24), (25), (27) and simple averages of input S_i ratios.

Source: Computed

All the own-price elasticities are less than one indicating an inelastic response of factor utilization. A finding consistent with the estimates for Chiang Mai valley by Sriboonchitta (1983). The total own price elasticities for fertilizer was estimated at -0.73 and the seed switching adjustments increases the elasticity by about nine percent to -0.81. Pitt's (1983) estimates of fertilizer demand elasticity for Javanese rice with seed switching adjustment increased by about 11 percent from -1.042 to -1.155. The total own-price elasticity of tractor power after seed switching adjustments improved by about 17 percent from -0.30 to -0.37. The own-price elasticity of labor was estimated at -0.41 which then increased by about 40 percent to -0.69 after allowing for seed switching.

All the three variable inputs are complements, rather than substitutes, because cross-price elasticities between all these inputs were negative. Complementarity in inputs for Thai agriculture, including rice, were also validated by Puapanichya and Panayotou (1985) and Adulavidhaya *et al.* (1979) and Sriboonchitta (1983). The fixed inputs appear to be important in influencing rice supply. Their influence, however, is not uniform on labor, fertilizer and tractor power demand functions. The exogenous increases in land quantities and expansion in farm capital, in the form of implements and machinery, increase rice supply and demand for all variable inputs of production. The elasticities of output supply with respect to the value of fixed farm assets and land size were 0.04 and 0.90 respectively. This indicates that one percent increase in the value of fixed farm assets would increase output supply by 0.04 percent, while a one percent increase in land size would increase output supply by 0.90 percent.

All price effects are quite reasonable, and nonsymmetric nature of their impact, contrary to the Cobb-Douglas case, is as expected and more natural. The inelastic price elasticity of labor is consistent with the almost zero marginal value product of labor estimated by Abamo (1992), Zhang (1991) and Wiboonpongse (1983).

At an individual variety level, the own-price elasticity of fertilizer is relatively higher (-0.70) for Khao Dawk Mali consistent with the expectation. Also the supply and demand elasticities with respect to land area is much higher in Khao Dawk Mali function. This finding is consistent with the farmers' responses during the interview session, where they mentioned farm size being an important constraint in their plan to expand Khao Dawk Mali area. On the other hand, few farmers expressed interest to expand glutinous rice area as the existing level of production is enough for consumption and market opportunities for glutinous rice is uncertain. Price elasticities of labor and tractor power were higher in glutinous function. In Chapter 4 it was revealed that, relatively less hired labor was used in glutinous rice production implying farmers' responses would be higher to changes in labor price. Also, since the profit margin in glutinous rice was significantly lower as compared to Khao Dawk Mali, farmers tend to response actively to price increases because it would result in larger cuts in aboslute profit as compared to Khao Dawk Mali for an equivalent rise in prices. On the other hand, changes in output price have higher response in glutinous function as compared to Khao Dawk Mali because of its preference for consumption and could be inherent attachment to tradition, culture etc.

The cross-price effects for both regimes are not different from each other, due to the inelastic nature of overall response to price changes. Output supply and input demand elasticities with respect to fixed farm assets were also similar in both functions.

Table 28 presents the comparisons of selected elasticity estimates with other studies. Sriboonchitta (1983), in his cost function study revealed that, all input elasticities were inelastic in Chiang Mai valley. However, over the past decade, the parameters did not seem to be changed much. The labor elasticity however increased to a higher level because of sharp rise in labor price over the past decade.

Table 28.Comparisons of Selected Elasticity Estimates with Other Studies

	Present study (1993)	Sriboon-chitta[a] (1983)	Puapanichya and Panay-otou[b] (1985)	Adulavidhaya *et al.*[c] (1979)
Output supply	0.3128	-	0.6496	0.8980
Fertilizer demand	-0.8056	-0.8532	-1.1915	-1.1120
Labor demand	-0.6856	-0.1932	-1.4167	-1.5740
Tractor demand	-0.3651	-0.4819	-	-1.1230
Land[d]	0.8981	-	0.9894	0.5410
Farm assets[d]	0.0433	-	0.0106	0.4590

[a]Estimates for agricultural output in Chiang Mai Valley utilizing translog cost function with six input prices (equipment, animal/tractor, seed fertilizer, labor and land) and crop output.

[b]Estimates for irrigated rice utilizing Cobb-Douglas normalized restricted profit function with three variable inputs (seeds, fertilizer and labor) and two fixed factors (farm assets and land).

[c]Estimates for overall Thai agriculture utilizing Cobb-Douglas normalized restricted profit function with variable inputs (labor,animal,mechanical input, and seed-fertilizer), and two fixed factors (fixed assets and land).

[d]Output supply with respect to fixed inputs, land and farm assets.

It should be noted that, the various estimates presented in Table 28 are not strictly comparable to each other, because of the differences in model specification, location, and time lag between these studies. However, such comparison would assist in providing a picture of the response patterns of Thai farmers to economic incentives introduced over the past years.

CHAPTER VI
POLICY ANALYSIS

The ultimate purposes of such studies has been to identify cost-effective policy instruments for raising crop yields and income of the farm families which is also a central objective of the Thai agricultural policy. The impact of any policy instruments would have to work through the actions of the farmers and the agronomic characteristics of the crops. Therefore, in order to predict the impact of alternative policy instruments we need to know the quantitative response of farmers to economic incentives introduced by these instruments as well as the response of the crops to changes in input use consequent of the farmers' response to policy instruments (Puapanichya and Panayotou, 1985).

Fifteen policy alternatives are considered: four single instrument policies (fertilizer price, labor price, tractor power price and rice price); six two-instrument combinations; four three-instruments combinations; and, one four-instrument combination. For analysis, we consider the effect of a 10 percent reduction in input prices (i.e., fertilizer, labor subsidies and machinery subsidies) and a 10 percent increase in rice prices (output subsidy) both individually and in combination.

The procedure used to calculate the cost-effectiveness of the policy alternatives were utilized from Puapanichya and Panyotou (1985) : First, based on the elasticity estimates the percentage change in input use and crop production as a result of these subsidies were calculated (Table 29). Second, using these percentages and the estimated input and production data of the sample (Table 30), the absolute change in input use and crop production were calculated on a *per rai basis* (as a representative for Chiang Mai province as a whole) which were then converted to costs and value, respectively, using the corresponding post-subsidy prices.

Table 29.Effects of selected policies on wet season rice production in Chiang Mai province

Policy	Farmers' response (% effect on input and output)			
	Use of Fertilizer	Use of Labor	Use of Tractor	Rice Output
1. 10 % ↓ in fert. price	8.056	0.154	0.348	0.146
2. 10 % ↓ in wage rate	0.568	6.856	1.723	1.160
3. 10 % ↓ in trac. price	0.860	0.783	3.651	0.678
4. 10 % ↑ in rice price	2.827	4.157	5.008	3.128
5. (1) + (2)	8.624	7.010	2.071	1.306
6. (1) + (3)	8.916	0.937	3.999	0.824
7. (1) + (4)	10.883	4.311	5.356	3.274
8. (2) + (3)	1.428	7.639	5.374	1.838
9. (2) + (4)	3.395	11.013	6.731	4.288
10. (3) + (4)	3.687	4.940	8.659	3.806
11. (1) + (2) + (3)	9.484	7.793	5.722	1.984
12. (1) + (2) + (4)	11.451	11.167	7.079	4.434
13. (1) + (3) + (4)	11.743	5.094	9.007	3.952
14. (2) + (3) + (4)	4.255	11.796	10.382	4.966
15. (1) + (2) + (3) + (4)	12.311	11.950	10.730	5.112

Source: Computed

Table 30.Base-line data used for calculating costs and benefits of alternative inputs and output price policies

Fertilizer quantity (kg/rai)	16.79
Fertilizer price (baht/kg)	5.47
Labor amount (man-day/rai)	6.18
Wage rate (baht/man-day)	72.27
Tractor quantity (unit/rai)	1.00
Tractor rate (baht/rai)	214.38
Rice production (kg/rai)	602.12
Rice price (baht/kg)	3.78

Note:Estimated at the sample means for wet season rice production (varietal differences incorporated).
Source: Computed

The difference between the change in value and the change in costs is the benefit to the farmers from the subsidy-induced increase of production. To arrive at the total net benefit to the farmers from the subsidy, we have to add the savings in input cost and increase in output value from the pre-subsidy level of production (Puapanichya and Panayotou, 1985). The results of these steps are reported in Table A6 in the Appendix. Next step is to calculate the cost of subsidy to the government which equals the unit output subsidy multiplied by the post subsidy output plus the unit subsidy multiplied by the post subsidy input use. Finally, the difference between the total benefit to the farmers and the cost to the government gives the net social benefit of the subsidy (see Table A6). The various policy alternatives are ranked according to the ratio of their net social benefit to their cost on a per rai basis.

Table 31 summarize the results of these calculations. For rice production in Chiang Mai province, the most cost-effective policy appears to be a reduction in tractor power prices. A 22 baht subsidy per rai will give a net benefit of 26 baht per rai to farmer and 4 baht per rai to the country. This amounts to 18.7 percent return on the tractor power subsidy. An output price subsidy of 235 baht per rai, on the other hand, will give a substantially higher net benefit of 274 baht per rai to farmer and 39 baht per rai to the country. The rate of return being 16.7 percent (ranked two). For the combination policies, most cost-effective appears to be a combination of tractor power price and rice price subsidy. A total subsidy of 258 baht per rai would yield a net benefit of 300 baht per rai to farmer and 42 baht per rai to the country. The rate of return being 16.2 percent (ranked three).

It should be noted that, policy-makers do not choose policies based on only a single criterion of cost-effectiveness but also have distribution considerations. The latter criterion often complicates the policy prescriptions. If the government's distributional objectives is targetted to raise the income of the rice farmers, the output price subsidy policy or a combination of both rice price and tractor power price subsidy would yield substantially higher income to farmers. However, the cost-effectiveness of these two policy instruments are about 2 to 2.5 percent lower than the most cost-effective policy, the single tractor power price subsidy, which would generate very low income for the farmers in absolute terms.

Table 31.Cost-effectiveness of alternative policies for rice production

Policy Alternatives	Net benefit to farmers (baht/rai)	Government susidy (baht/rai)	Net impact of policy (baht/rai)	Cost effect-iveness (%)
1. 10% ↓ in fert. price	4.41	9.92	-5.51	-55.52
2. 10% ↓ in labor price	39.30	44.76	- 5.46	-12.20
3. 10% ↓ in trac. price	25.52	21.51	+4.02	+18.70
4. 10% ↑ in rice price	274.00	234.72	+39.28	+16.74
5. (1) + (2)	43.72	54.68	-10.97	-20.06
6. (1) + (3)	29.95	31.44	-1.49	-4.73
7. (1) + (4)	278.42	244.98	+33.44	+13.65
8. (2) + (3)	64.84	66.27	- 1.44	-2.17
9. (2) + (4)	313.30	282.12	+31.18	+11.05
10. (3) + (4)	299.54	257.78	+41.76	+16.20
11. (1) + (2) + (3)	69.25	76.20	-6.95	-9.12
12. (1) + (2) + (4)	317.72	292.38	+25.34	+8.67
13. (1) + (3) + (4)	303.95	268.03	+35.92	+13.40
14. (2) + (3) + (4)	338.84	305.18	+33.66	+11.03
15. (1) + (2) + (3) + (4)	343.25	315.43	+27.82	+ 8.82

Source: Computed

As providing a complete set of policies is beyond the scope of this study, it seems that price policies for raising rice yields and farm incomes in Chiang Mai province should focus on rice prices and tractor power prices. Reducing the cost of tractor in the Chiang Mai province may take two forms. In addition to reducing the rental cost of tractors, the actual cost of tractors could be reduced by encouraging assembling facilities and cutting tax on material imports, sales tax, providing cheap after sales services etc. As tractors and labor are complementary inputs, the reduction in the rental cost of tractors would also generate employment.

CHAPTER VII
SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Summary

The present study centered on examining the possibility of expanding Khao Dawk Mali, a high quality fragrant non-glutinous variety, in Chiang Mai province, as well as the estimation of the input demand and output supply elasticities for rice jointly determined with the choice of rice seed varieties at the farm-level. In other words, it focusses on estimating demand relationships by considering that farmers can response to price changes not only by manipulating their variable inputs alone, but also by moving along a meta-response surface, which is an envelope containing the production surfaces of all potential seed varieties. Normalized restricted translog profit functions for both Khao Dawk Mali and glutinous varieties were estimated utilizing the Two-Stage Switching Regression procedure.

The plot-level crop production data for the wet season, crop year 1992, were collected using multi-stage sampling from six districts of Chiang Mai province (San Kam Phaeng, San Sai, Doi Saket, Phrao, San Pa Tong, and Mae Rim) where either Khao Dawk Mali or the glutinous varieties are predominantly cultivated.

Rice-soybean, rice-garlic, rice-onion, and rice-potatoes were the main cropping systems of the sample farms. Average owned land is 9.20 rai and operation size is 12.79 rai. About half of the farms were owner operated and 20 percent were landless tenants farming under varied tenurial arrangements.

Yield of Khao Dawk Mali (643 kg per rai) was found to be significantly higher than the glutinous varieties (600 kg per rai). Significant differences in the family and exchange labor allocation and hence the total labor use, and family supplied material inputs were also observed between Khao Dawk Mali and glutinous varieties.

Though on the whole no differences were observed in total variable costs, significantly higher profits (gross margin) and returns to family resources per rai were estimated for Khao Dawk Mali production (1,735 and 1,857 baht, respectively) revealing a clear advantage over glutinous varieties (1,111 and 1,242 baht, respectively) when only economics of rice production is considered. Sixty percent higher average labor productivity, measured as value added per day of labor, were also estimated for Khao Dawk Mali (222 baht per day) production as compared to glutinous varieties (133 baht per day).

High price and profit motive were reported as the major influencing factor for farmers to choose Khao Dawk Mali (ranked one) while glutinous varieties were produced for consumption alone (ranked one) followed by profit motive (ranked two). However, about 70 percent of the Khao Dawk Mali growers reported various problems, mainly insect and disease attacks, as compared to 43 percent glutinous variety growers, revealing high profit is also associated with increased risk of yield.

Almost all farmers sell some or all of their rice crops of which majority (67 percent) sell their rice crop at the farmgate to the middlemen. About 43 percent of the farmers reported some problems in marketing, mainly lack of bargaining power, implying less bottlenecks in the marketing system of rice, except price fluctuations.

Fifty-five percent of the farmers seem to be satisfied at their present level of fertilizer application rate of 17.12 kg and 16.32 kg of material per rai for Khao Dawk Mali and glutinous varieties, respectively, while the rest feels that they should apply more in order to raise the productivity. Some farmers expressed concerns about increasing toxicity in soils as a consequence of increased use of fertilizer for higher production. Most farmers from rice-soybean system reported improvement in soil fertility from soybean residues and hence use less fertilizer. Collective purchase is a common feature in the input markets, particularly fertilizer, which helps in cutting the transportation costs.

About 60 percent of the sample farmers are in debt, where BAAC is the major source of lending. The average level of indebtedness of owner operators (14,270 baht per farm) was estimated at 70 percent higher than the tenant farms (8,196 baht per farm).

Agricultural extension officials were the main sources of technological information (ranked one) while co-farmers and neighbors were the next (ranked two). The role of mass media seems to be minimum in information dissemination (ranked three).

Estimation results of the elasticities of probability of planting Khao Dawk Mali from the first stage probit model revealed that seed selection is quite responsive to the fertilizer/rice price ratio as well as labor/rice price ratio. The positive elasticity of prabability with respect to land area suggests that plot size is positively related with Khao Dawk Mali adoption.

The second stage estimation of the normalized restricted translog profit function jointly estimated with three factor share equations using Seemingly Unrelated Regression Estimator method revealed that there were significant selectivity bias in estimating equations from a subsample of cultivators in Khao Dawk Mali regime, supporting the hypothesis of the study.

All the own-price elasticities were estimated to be inelastic. The total own-price elasticity of demand after allowing for the seed switching adjustments for fertilizer, labor and tractor power were estimated at -0.81, -0.69 and -0.37, respectively. The impact of seed switching adjustments were about 9, 40 and 17 percent for fertilizer, labor, and tractor power, respectively. This indicates, that allowance of farmers to move along the meta-response surface increased the opportunity of the farmers to raise income from rice production.

All variable inputs were found to be complements, rather than substitutes, because all the cross-price elasticities were negative. The output supply elasticity was estimated at 0.31 indicating a moderate response to output price changes. The output supply with respect to land area and value of fixed farm assets were 0.90 and 0.04 respectively. This indicates that, one percent change in land area will increase output supply by 0.90 percent and one percent improvement in the value of fixed capital will increase output supply by 0.04 percent.

A 10 percent reduction in tractor power price is suggested from the ranking of fifteen policy alternatives according to their cost-effectiveness for the Chiang Mai province calculated on a per rai basis. A 22 baht per rai subsidy for this policy will yield a net benefit of 26 baht per rai to farmer and 4 baht per rai to the country. The rate of return being 18.7 percent. On the other hand, a 10 percent increase in rice price would require a subsidy of 235 baht per rai and will give a substantially higher net benefit of 274 baht per rai to farmer and 39 baht per rai to the country. The yield rate on this output subsidy is 16.7 percent (ranked two). For the combined policy alternatives, tractor power price and rice price subsidy would yield a return of 300 baht per rai to farmers and 42 baht per rai or 16.2 percent to the country (ranked three).

7.2 Conclusion and Recommendation

Thailand being a food surplus country, faces a different set of food policy issues than other developing countries. Food, is the major source of export earnings in Thailand. For several decades Thailand has been a major world exporter of rice. However, in recent times, Thailand is facing high competition in the already thin world rice market owing to its increasing labor wage and production costs. It is worth noting that, Thailand enjoys a duopolistic competition in the high quality rice market with United States as the sole opponent. In 1992, an additional environmental limitation, that is, shortage of water for dry season rice (which is mainly grown for exports), is posing threat to the future of low quality rice exports. Therefore, exploring the possibilities of expanding high quality rice production seemed urgent. Khao Dawk Mali, a non-glutinous fragrant traditional variety, is considered as the top quality rice of Thailand and has a high demand in export markets as well.

The current results revealed that Khao Dawk Mali production demonstrated clear advantage over glutinous varieties when only economics of production is considered. With significantly higher yield, better price incentives and no differences in total variable costs, Khao Dawk Mali production accrued significantly higher profit over the glutinous varieties. The higher average labor productivity, measured as value added per day of labor, was also a positive factor in consideration. However, higher return is not devoid of risk. Higher incidence of insect and disease attacks in Khao Dawk Mali may hinder its rapid expansion in these major growing areas that was observed throughout the past 10 years. It is worth mentioning that, the observations for the present study were drawn mainly from areas not damaged by the widespread disease outbreak that occured in this region during the crop year 1992, though a few farmers reported some damage.

The bio-physical environment in the study areas appeared to be suitable for growing either varieties, thereby, offering more flexibility in switching varieties for farmers. In fact, in San Sai, Doi Saket and Phrao, Khao Dawk Mali has been grown in conjunction with glutinous varieties for many years. Therefore, in areas with inadequate irrigation and water control, expansion of Khao Dawk Mali can be considered because of its tolerance to drought conditions and relative economic advantage.

Based on the implications drawn from the economic and qualitative analyses and subject to the given condition of higher and more price certainty and favorable move towards increased consumption demand for high quality rice, it can be concluded that, Khao Dawk Mali offers a better alternative cash crop for the rice farmers in Chiang Mai province. However, a number of caveats are in order. Firstly, the disease susceptibility of Khao Dawk Mali should be given due consideration. Secondly, major concern lies in the acceptance of the quality standards of Khao Dawk Mali by the exporters. Finally, in order to balance between the consumption and higher income priorities, farmers could partly allocate their land to glutinous rice for consumption and partly to Khao Dawk Mali for the market.

For policy prescription purposes, cost-effectiveness analysis was performed to determine the effect of fifteen alternative policy instruments calculated on the basis of responses predicted by the estimated elasticites. From the viewpoint of both the cost-effectiveness and distributional considerations for the target beneficiaries, the rice farmers, it can be concluded that, price policies for raising rice yields and farm incomes in Chiang Mai province should focus on rice prices and tractor power prices.

From the above conclusions, it is hoped that these findings could provide some valuable inputs for a more detailed understanding of the farm-level production structure and dynamics of farmers actions and responses to variable input price changes in Chiang Mai province. However, policy makers should be cautioned that the results obtained in this study are a function of a sample of data. Therefore, the use of these results for a changed environment should be undertaken with caution. Moreover, in order to utilize the results and implications of this study, the following research limitation worth consideration.

Due to some logistic limitations, the scope of the study could not be expanded to northeastern region where Khao Dawk Mali is predominantly grown, which would have enabled us to draw policy recommendations for a larger area or the country as a whole.

7.3 Further Areas of Research

Controversies exists in determining the quality of the Khao Dawk Mali produced in northern Thailand for exports and hence its acceptance by the exporters. For drawing a conclusive policy implication on the potential of expansion of Khao Dawk Mali, a clear understanding of the marketing aspects and quality control is

desirable, which is however, beyond the scope of this study. Therefore, studies on marketing, quality as well as productivity of Khao Dawk Mali should be undertaken.

Moreover, as there are large differences in agro-climatic situation of northern region with the rest of the country, similar studies might be undertaken covering the greater north, northeast and central region to check magnitudes of the parameters and hence the farmers' response patterns.

With respect to methodology, qualitative variables such as marketing aspects, education, agricultural extension, drought and disease resistance of the varieties, etc., which can also be considered as important determinants of seed variety choice can be incorporated in the probit reduced-form seed selection equation for a possible better estimate. However, it should be noted that, the corresponding profit functions for the second stage estimation has to be respecified accordingly.

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APPENDIX

APPENDIX TABLES

Table A1.Area planted, total production and yield of selected rice varieties in Thailand, crop year 1990/91. (Major rice season only)

Variety	Region				All Country
	North	Northeast	Central	South	
All Varieties					
Area (rai)	13,049,873	31,639,413	10,536,161	2,979,219	58,204,666
% of all area	100.00	100.00	100.00	100.00	100.00
Production (ton)	4,030,558	7,744,744	2,400,613	726,508	14,902,423
Yield (kg/rai)	309	245	228	244	256
Local Variety					
Area (rai)	6,150,472	5,711,934	4,006,794	2,456,861	18,326,061
% of all area	47.13	18.05	38.03	82.47	31.49
Production (ton)	1,234,627	1,284,540	677,936	585,192	3,782,295
Yield (kg/rai)	201	225	169	238	206
RD 6					
Area (rai)	1,870,229	13,571,123	48,171	--	15,489,523
% of all area	14.33	42.89	0.46	--	26.61
Production (ton)	921,577	3,353,796	7,454	--	4,282,827
Yield (kg/rai)	493	247	155	--	276
Khao Dawk Mali					
Area (rai)	647,530	9,567,576	440,562	53,395	10,709,063
% of all area	4.96	30.24	4.18	1.79	18.40
Production (ton)	240,208	2,462,950	63,781	15,437	2,786,456
Yield (kg/rai)	371	257	145	289	260
RD 15					
Area (rai)	329,228	768,582	40,116	3,593	1,141,499
% of all area	2.52	2.43	0.38	0.12	1.96
Production (ton)	137,990	177,843	7,437	481	323,661
Yield (kg/rai)	419	231	183	134	284
RD 21 and RD 23					
Area (rai)	516,634	20,568	1,408,613	15,859	1,961,674
% of all area	3.96	0.07	13.37	0.53	3.37
Production (ton)	185,232	7,188	577,106	5,080	774,606
Yield (kg/rai)	359	349	410	320	395

Note: Varieties such as SP 60, Basmati, Other Non-Photosensitive and Mixed varieties are excluded. Therefore, the total do not sum to all country figures.

Source: Department of Agricultural Extension (in Thai), 1991.

Table A2.Fertilizer use in Thailand, 1967-90

Year	Agricultural use (combined nutrient content)				Use on rice			
	Total	N	P_2O_5	K_2O	Total nutrient	Wet season	Dry Season	Total
1967	254431	45247	28056	13152	86455	171092	10050	181142
1968	294321	49285	39010	15652	103947	198928	11390	210318
1969	273686	47339	61294	10950	119583	199505	13400	212905
1970	280279	48590	53814	10300	112704	168415	14740	183155
1971	261479	47929	40625	9650	98204	164696	15500	180196
1972	407950	69541	82482	16100	168123	228038	25000	253038
1973	418396	67472	76603	17500	161575	192940	39310	232250
1974	390332	66876	57334	14910	139120	132597	61145	193742
1975	506428	83949	76670	17930	178549	172462	70310	242772
1976	664391	115961	59482	20452	195895	240802	82530	323332
1977	764113	140726	79972	30517	251215	265662	104338	370000
1978	750978	130352	105747	26390	262489	291365	128635	420000
1979	792002	124919	121355	44132	290406	300000	178500	478500
1980	746900	126670	106742	36672	270084	320000	100940	420940
1981	834000	136819	117971	31400	286190	340055	154092	494147
1982	1042503	174765	134229	57648	366642	373851	169543	543394
1983	1272041	233388	154044	83701	471133	466454	202490	668944
1984	1246688	227712	142623	67916	438251	443808	204125	647933
1985	1250000	252900	124999	55663	433562	413929	196071	610000
1986	1350000	308501	132502	70326	511329	447857	212143	660000
1987	1548765	342784	148344	96245	587373	459240	180760	640000
1988	1992633	439720	200833	137456	778009	597600	254609	852209
1989	2297733	494233	188823	117793	800849	610000	260000	870000

Source:*Food Policy Analysis* (1985) and *Agricultural Statistics of Thailand, C–rop Year 1987/88 and 1989/90.*

Table A3.Area planted, total production and yield of Khao Dawk Mali in major growing areas of Thailand from 1980/81 to 1990/91.

Area = '000 rai
Production = '000 ton
Yield = kg/rai

Province	Year										
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
Ubon Ratchathani											
Area	719.1	821.1	780.0	1067.6	883.1	1211.3	1521.0	1625.4	1580.5	1834.6	1442.8
Prod.	205.7	203.6	196.8	272.5	242.0	368.2	508.9	515.9	535.8	613.3	377.7
Yield	260	248	252	255	274	304	335	317	339	344	262
Yasotorn											
Area	-	588.0	737.8	544.2	506.6	593.1	585.1	515.9	563.0	590.5	475.1
Prod.	-	167.7	131.8	183.0	170.7	209.0	201.0	227.5	202.7	280.5	115.6
Yield	-	350	179	350	337	355	385	410	360	360	243
Maha Sarakam											
Area	224.2	279.0	295.0	346.5	318.9	415.4	347.9	389.9	344.7	438.5	334.3
Prod.	55.3	85.0	67.5	103.9	95.7	161.1	54.3	115.1	101.6	144.7	84.5
Yield	247	305	255	300	300	357	196	395	295	330	253
Karasin											
Area	10.1	57.8	27.7	41.7	43.4	56.9	59.4	54.3	76.7	81.2	80.9
Prod.	3.6	19.3	8.6	13.3	14.3	18.5	19.0	17.5	21.4	27.6	21.7
Yield	360	335	310	320	330	325	325	320	350	340	270
Buri Ram											
Area	738.8	748.5	689.3	777.1	787.3	1126.6	1106.2	841.6	1423.6	1391.0	1335.2
Prod.	158.1	169.9	137.9	217.6	244.9	387.7	350.6	240.5	453.8	555.9	347.0
Yield	214	217	200	280	311	344	317	286	318	399	260
Roi Et											
Area	286.7	450.2	418.1	712.3	788.4	915.8	993.4	825.5	1045.2	1080.0	1075.6
Prod.	86.9	165.2	117.1	212.3	227.0	297.0	288.1	222.9	317.8	330.5	262.7
Yield	303	367	280	298	287	312	290	270	304	306	244
Khon Khaen											
Area	117.8	125.6	137.4	149.2	157.0	164.9	176.7	196.3	215.9	223.8	128.2
Prod.	37.8	40.1	43.7	48.3	50.7	54.2	57.6	64.6	71.3	74.7	33.5
Yield	321	319	318	324	323	329	326	329	330	334	261
Chiang Mai											
Area	36.4	49.9	53.7	50.4	52.4	94.1	88.9	98.8	96.5	94.0	85.7
Prod.	13.8	19.4	24.7	25.2	26.7	55.5	48.3	56.9	58.9	58.3	56.1
Yield	380	390	460	500	510	590	47	576	610	620	655
Chiang Rai											

Area	4.1	4.5	4.3	6.0	6.8	5.9	5.2	4.6	5.2	6.9	27.4
Prod.	2.1	2.5	2.3	3.2	3.7	3.3	2.9	2.6	3.0	3.8	14.9
Yield	520	570	530	530	540	565	545	560	570	550	543
Sri Saket											
Area	256.0	323.0	772.0	757.2	1033.0	1148.0	1358.0	1401.0	1461.0	2263.0	1323.8
Prod.	82.0	106.6	247.0	265.0	351.2	348.6	448.1	476.3	511.4	769.4	400.2
Yield	320	330	320	350	340	335	330	340	350	340	302

Table A3. (Continued)

Province	Year										
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
Sakon Nakorn											
Area	15.2	27.6	31.5	78.7	109.0	152.5	204.5	271.5	339.6	472.6	289.5
Prod.	4.6	8.5	9.8	25.0	35.4	50.5	69.3	93.7	120.5	170.3	77.7
Yield	302	307	311	318	325	331	339	345	355	360	268
Surin											
Area	-	-	935.9	1071.1	1082.5	1138.5	1121.7	503.2	1259.6	1189.0	1786.9
Prod.	-	-	238.6	320.3	410.3	430.4	382.5	137.9	341.3	392.4	483.0
Yield	-	-	303	299	379	378	341	274	271	330	270

Source: Bank of Agriculture and Cooperative and Department of Domestic Trade

Table A4. Quantity and value of Khao Dawk Mali rice exported from Thailand to rest of the world.

Quantity = ton
Value = million baht

Region	1988		1989		1990		1991	
	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value
Asia	96,314	870.83	349,449	3,779.38	386,105	3,550.33	475,591	4,686.10
Europe	6,530	326.62	190,638	1,339.46	143,335	1,387.98	155,162	1,544.61
Africa	6,185	57.88	16,434	174.63	30,303	286.28	24,728	213.66
Middle	9,312	77.83	112,847	1,004.85	75,945	592.67	45,420	626.95

East America	26,715	263.09	115,523	1,163.59	147,192	1,393.79	174,668	1,852.99
Oceania	3,487	34.62	14,808	160.74	22,747	250.34	23,739	293.42
World	148,455	1,367.81	687,606	6,623.27	701,650	7,461.39	823,109	8,261.58

Source:Private Rice Section, Department of Cereal Trade, Ministry of Agriculture and Cooperatives.

Table A5.Price of Khao Dawk Mali, RD 15 and local variety of rice in Thailand for the period 1989-1991,

Baht per ton

Province	Khao Dawk Mali			RD 15			Local variety		
	1989	1990	1991	1989	1990	1991	1989	1990	1991
Ubon Ratchathani	4,808	3,976	3,959	4,200	3,400	4,044	3,322	3,219	3,475
Surin	4,844	3,939	4,112	4,214	3,274	4,150	3,519	3,368	3,504
Buri Ram	4,888	3,932	4,055	4,211	3,397	4,100	3,213	3,182	3,486
Khon Khaen	4,837	3,951	4,034	4,100	3,500	4,077	3,300	3,375	3,425
Sri Saket	4,824	3,965	4,107	4,235	3,417	3,985	3,248	3,388	3,537
Sakon Nakorn	4,624	3,866	4,075	4,310	3,405	4,098	3,237	3,275	3,613
Chiang Rai	4,504	3,973	4,205	4,332	3,771	4,177	3,248	3,288	3,550
Chiang Mai	4,408	3,975	4,305	4,394	3,625	4,162	3,200	3,302	3,707

Source:Bank of Agriculture and Cooperative and Department of Domestic Trade

Table A6.Estimated costs and benefits of alternative policies for rice production

Policy alternatives	Fertilizer		Labor		Tractor		Total cost	Output	
	_ X_F (kg)	_ C_F (baht)	_ X_W (day)	_ C_W (baht)	_ X_M (day)	_ C_M (baht)	_ C	_ Y (kg)	_ R (baht)
1. 10% ↓ P_F	1.35	6.66	0.01	0.69	0.01	0.75	8.09	0.88	3.32
2. 10% ↓ P_W	0.10	0.52	0.42	27.58	0.02	3.69	31.79	6.98	31.79
3. 10% ↓ P_M	0.14	0.79	0.05	3.50	0.04	7.04	11.33	4.08	11.33
4. 10% ↑ P_Y	3.13	2.60	0.47	18.58	0.05	10.74	31.91	18.83	78.31
5. (1) + (2)	1.45	7.18	0.43	28.26	0.02	4.44	39.89	7.86	29.72
6. (1) + (3)	1.50	7.45	0.06	4.19	0.04	7.79	19.42	4.96	18.75
7. (1) + (4)	1.83	9.26	0.27	19.27	0.05	11.48	40.04	19.71	81.64
8. (2) + (3)	0.24	1.31	0.47	31.08	0.05	10.74	43.13	11.07	41.83
9. (2) + (4)	0.57	3.12	0.68	46.15	0.07	14.43	63.70	25.82	104.71
10. (3) + (4)	0.62	3.39	0.31	22.08	0.09	17.78	43.24	22.92	93.74
11. (5) + (3)	1.59	7.97	0.48	31.76	0.06	11.48	51.22	11.95	45.16
12. (5) + (4)	1.92	9.78	0.69	46.84	0.07	15.18	71.80	26.70	108.04
13. (6) + (4)	1.97	10.05	0.32	22.77	0.09	18.53	51.34	23.80	97.07
14. (8) + (4)	0.71	3.91	0.73	49.65	0.10	21.47	75.04	29.90	120.15
15. (5) + (10)	2.07	10.57	0.74	50.34	0.11	22.22	83.13	30.78	123.47

Table A6.(Continued)

Policy	Savings on pre-subsidy input (A) baht	Gains on pre-subsidy output (B) baht	Total benefit TB = _R+A+B (baht)	Net benefit TB - _C (baht)	Govern-ment subsidy (baht)	Net Imp act of policy	Cost effect-iveness (baht)
1. 10% ↓ P_F	9.18	-	12.51	4.41	9.92	-5.51	-55.52
2. 10% ↓ P_W	44.69	-	71.09	39.30	44.76	-5.46	-12.20
3. 10% ↓ P_M	21.44	-	36.89	25.54	21.51	4.02	+18.70
4. 10% ↑ P_Y	-	227.60	305.91	274.00	234.72	39.28	+16.74
5. (1) + (2)	53.88	-	83.60	43.72	54.68	-10.97	-20.06
6. (1) + (3)	30.62	-	49.38	29.95	31.44	-1.49	-4.73
7. (1) + (4)	9.18	227.60	318.42	278.42	244.98	33.44	+13.65
8. (2) + (3)	66.13	-	107.96	64.84	66.27	-1.44	-2.17
9. (2) + (4)	44.69	227.60	377.08	313.30	282.12	31.18	+11.05
10. (3) + (4)	21.44	227.60	342.78	299.54	257.78	41.76	+16.20
11. (5) + (3)	75.31	-	120.47	69.25	76.20	-6.95	-9.12
12. (5) + (4)	53.88	227.60	389.52	317.72	292.38	25.34	+8.67
13. (6) + (4)	30.62	227.60	355.29	303.95	268.03	35.92	+13.40
14. (8) + (4)	66.13	227.60	413.88	338.84	305.18	33.66	+11.03
15. (5) + (10)	75.31	227.60	426.38	343.25	315.43	27.82	+8.82

Source: Computed